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Micro-credit and Technical Efficiency in Food Crops Production: A Stochastic Frontier Approach

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ABSTRACT

The study which investigates the effect of micro-credit on technical efficiency in food crops production, involving the use of maximum likelihood estimation technique of stochastic production frontier, shows the returns to scale value of non-credit user's farmers (1.30) being greater than that of credit user's farmers (0.40). The mean technical efficiency for the two groups of farmers is between 0.5 (for credit user's farmers) and 0.9 (for non-credit user's farmers), while the estimate of σ^2, which is significantly different from zero at 1% for the two categories of farmers, indicate a good fit and correctness of the specified distributional assumption of the decomposed error term. γ is positively non-significant for the two groups of farmers (49% and 85% for credit user's and non-credit user's farmers), suggesting that variation in production is due to technical efficiency by those values, and that technical inefficiency is higher among credit user's farmers than non-credit user's group. Generalised likelihood ratio test implies the presence of one-sided error component which indicates the significant effect of technical inefficiency in food crops production in the areas of study, as well as the relevance of stochastic frontier model using maximum likelihood estimate technique used in this study. This study therefore concluded that to improve the technical efficiency of rural food crops farmers in Nigeria aims at increasing their production, policies design should emphasise more rural financial outlets to the financial institutions, whose lending should be timely and in larger amounts without discriminating against small farm holdings farmers.

Key words: *Micro-credit, Technical Efficiency, Stochastic Frontier, Food Crops, Rural farmers, Ogun state, Nigeria*

Introduction

Agriculture constitutes a significant sector of Nigeria's economy, and is significant in terms of employment of labour, contribution to Gross Domestic Product (GDP) and main source of foreign exchange earnings before early 1970s. The declining share of agriculture to the GDP (from 90% before independence in 1960, 56% in 1960-1964, to 32% in 1996-1998) is partly a reflection of the relative productivity of the sector. The average annual rates of growth in food crop production have also declined in recent years (CBN, 2003; FAO, 2003; World Bank, 2003; Amaza and Olayemi, 2002).

The national strategic importance of food is evident in its consideration as a key variable in matter relating to national security and in planning against disaster and other emergencies (Ogundari and Ojo, 2007). However, in Nigeria, the production of food has not increased at the rate that can meet the increasing population, while food production increases at the rate of 2.5%, food demand increases at the rate of more than 3.5% due to the high rate of population growth of 2.83% (CBN, 2004). A major indicator of depressed performance of the Nigeria agricultural sector is the food crisis experienced in the country in the past (and current) years, which has led the country to resort to increasing food importation and equally account for high rates of increase in

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food prices (Ogundari and Ojo, 2007; Yusuf and Malomo, 2007). The Federal Ministry of Agriculture (1993) has estimated and suggested that annual food crops supply in the country would have to increase at an average rate of 5.9% for her to be able to meet food demand, and reduce food importation significantly. Given the fact that Nigeria as a country is endowed with large expanse of land that has tremendous resources, favourable climate for producing food and other raw materials for export, and domestic industrial use, as well as human resources and available technologies for food production, there is no justification whatsoever for the country in resorting to importation of any of her staple food (Nasko, 1989). This probably must have informed federal government embarking on such programmes as National Programme on Food Security (NPFS) and, Root and Tuber Expansion Programme (RTEP).

Among the major factors accountable for observed changes in food crop production in Nigeria, according to Olayemi (1998), is the changing production technologies which affect variation in the yields and productivity of inputs used in the production of various food crops, an assertion which Rahji (2005) expressed succinctly by stating that, the main issue in the Nigerian agriculture is that of low productivity manifested inform of low crop yields and resource productivity, following Falusi (1995) submission that, despite all the human and material resources put into the (agricultural) sector in recent years, the rate of its productivity increase is declining. This is affirmed by FACU (1992) and FDA (1993) that productive efficiency for most crops still fall under 60 percent, thus indicating that there is scope for increase in output from existing hectarages. The implication of which is that Nigeria is yet to attain self-sufficiency in food crop production, despite increasing hectares being put into production annually.

The low agricultural productivity in Nigeria is revealed, according to Amaza and Olayemi (2002), by the actual yields of major crops compared to the potential yields, implying that there is scope for additional increases of output from existing hectares of food crops, if resources are properly harnessed and efficiently allocated. The efficiency with which farmers use available resources and improved technologies, according to Rahji (2005), is important in agricultural production. Existing low level of productivity in food crops production is a reflection of low levels of technical efficiency, thus making the study that will examine the technical (in) efficiency of farmers engaged in food crops production inevitable, since increased output and productivity are directly related to production efficiency, arising from not only the optimal combination of inputs but also the given state of technology (Amaza and Olayemi, 2002; Amaza, *et al*., 2001). Determinig the efficiency status of farmers, according to Yusuf and Malomo (2007), is very important from policy perspective, because in an economy where (new or improved) technologies are lacking, efficiency study will show the possibility of raising productivity by improving efficiency without increasing the resource base or developing new technology, and as well helps to determine the under utilization or over utilization of factor inputs. Gain in efficiency of agricultural production, according to Hazarika and Alwang (2003), is viewed as being necessary for economic growth and the alleviation of rural poverty. This study, therefore, is meant to contribute to available literature on empirical measurement of technical efficiency, especially in the food crop sub-sector of agriculture in Ogun State, as this author is yet to by study in this area though there are some studies on production efficiency in livestock, particularly on poultry egg production, such as Yusuf and Malomo (2007), and Bamiro, *et al*., (2006). Furthermore, this study is relevant as Habibullah and Ismail (1994) claimed that past studies have found evidence of technical inefficiency among the farmers in developing countries of which Nigeria (encompassing the study area) is a member country, which probably account for food insecurity problem being experienced in these countries, as reflected by the gap between their food demand and supply.

This paper, therefore, broadly aim at analyzing the effect access to microcredit could have on technical efficiency of two categories of rural farmers in Ogun State, while specific objectives considered in order to achieve the broad objective include, to (i) describe the socio-demographic profile of the respondents, (ii) estimate technical efficiency of these categories of farmer, (iii) identify farm specific characteristics that influence the level of technical efficiency of each category of the farmers in Ogun State, and (iv) examine the sources technical efficiency differentials between the groups of food crop producing farmers in the State.

Theoretical framework

(i) Technical Efficiency:

This in production is defined as the physical ratio of product output to the factor inputs. The greater the ratio, the greater the magnitude of the technical efficiency, implying existence of difference in technical efficiency between firms/farms. The production function pre-supposes technical efficiency, whereby maximum output is obtained from a given level of inputs combination; hence it is a factor-product relationship. An important assumption underlying efficiency concept is that firms operate on the outer bound of production function that is, on their efficiency frontier, implying that when firms fail to operate on the outer bound of their production function, they are said to be technically inefficient. For such firms, an improvement in technical efficiency could be achieved in three ways, through (a) improved production techniques, which implies a change in factor proportions through factor substitution under a given technology, thus representing a change along the given production function; (b) an improvement in production technology, which represents a change in the production function itself such that the same amount of resources produce more output, or alternately, the same amount of output is derived from smaller quantities of resources than before, and (c) a simultaneous improvement in both production techniques and technology (Amaza, *et al*., 2001). The technical efficiency of individual farmers is defined by Ogundari and Ojo (2007), as the ratio of observed output to the corresponding frontiers output, conditional on the level of input used by the farmers. Olayide and Heady (1982) however, defined technical efficiency as the ability of a firm to produce a given level of output with minimum quantity of inputs under a given technology. In essence, technology according to Ogundele and Okoruwa (2004) plays a very significant role in determining the levels of technical efficiency of a firm, and that where the producing unit did not comply strictly with the accompanied recommendation, the result may be devastating. Efficiency level of farmers, according to Awotide and Adejobi (2006), has direct bearing on the cost of production which consequently translates to more profit to the farmers.

(ii) Stochastic Frontier Production Model Concept:

The stochastic frontier modeling, which is a deterministic parametric measure of efficiency, was first proposed by Aigner, *et al*. (1977) and, Meesusen and van den Broeck (1977) independently, is increasingly becoming popular because of its popularity and ability to closely marry economic concept with modeling reality. The modeling, estimation and application of stochastic frontier production function to economic analysis assumed prominence in econometric and applied economic analysis following Farrell's (1957) seminar paper where he introduced a methodology to measure technical, allocative and economic efficiency of a firm. However, over the years, Farrell's methodology has undergone many refinement and improvements which has led to the development of stochastic frontier model that enables one to measure firm level technical and economic efficiency using maximum likelihood estimate (MLE or MLM) method (a corrected form of ordinary least square method-COLS) (Ogundari and Ojo, 2007). The model, according to Yusuf and Malomo (2007), has over time too undergone improvement and extension in the hands of such researchers as Battesse (1992), Coelli (1995), Battesse and Coelli (1995), and Battesse, *et al*. (1996). The main feature of the stochastic production frontier is the disturbance term which is composed of two parts- a symmetric and a one-sided component. The symmetric (normal) component (V_i) captures the random effects due to the measurement error, statistical noise and other non-symmetric influences outside the control of the firm, and is assumed to have a normal distribution, while the one-sided (non-positive) component (μ_i), which is greater than unity, captures technical inefficiency relative to the stochastic frontier, and is the randomness under the control of the firm. The random errors, (v_i), are assumed to be half normal or exponential, while v_i are assumed to be independently and identically distributed as N (0, δv^2) random variables having zero mean (Amaza and Olayemi, 2002), independent of μ_is, which are also assumed to be independently and identically distributed as exponential (Meesusen and van den Broeck, 1977), half normal (Aigner, *et al*., 1977), truncated and gamma (Greene, 1990). The frontier, according to Forsund, *et al*. (1980), is concerned with the concept of maximality in which the function sets a limit to the range of possible observations. Thus, it is possible to observe points below the production frontier for firms producing less than the maximum possible output but no point can lie above the production frontier, given the technology available. The frontier represents an efficient technology and deviation from the frontier is regarded as inefficient (Umoh, 2006). Given suitable distributional assumptions for the error terms, direct estimates of the parameters, according to Umoh (2006), can be obtained by either the Maximum Likelihood Method (MLM) or the Corrected Ordinary Least Squares Method (COLS). However, the MLM estimator, according to Coelli (1995), is asymptotically more efficient than the COLS, thus explaining why MLM is preferred in empirical analysis involving stochastic frontier approach.

(iii) Model Specification:

The stochastic frontier production, independently proposed by Aigner, *et al*. (1977) and, Meesusen and van den Broeck (1977), whose original specification involved a production function specified for cross-sectional data with an error term having two components, one accounting for random effects and the other accounting for technical inefficiency as earlier discussed. The specification had been altered and extended to include the specification of more general distributional assumptions for the μ_i, such as the truncated normal or two-parameter gamma distributions, consideration of panel data and time-varying technical efficiencies, extension of the methodology to cost functions and also to the estimation of systems of equations and so on. The Cobb-Douglas and Translog functional forms are the most often used functional forms in stochastic frontier analyses. The specification which originally involve a two stage estimation procedure in which farm level efficiency was first estimated and then regress upon firm-specific variables, has since been replaced with a single stage estimation procedure, because the 2-stage has been recognised as being inconsistent in its assumptions regarding the independence of the inefficiency effects. The one-stage procedure developed by Kumbhakar, *et al*. (1991), Reifschneider and Stevenson (1991) proposed stochastic frontier models with an inefficiency effects (μ_i) are expressed as an explicit function of a vector of firm-specific variables and random error, while Battesse and Coelli (1995) version is different from others in that allocative efficiency is imposed, first-order profit maximising conditions removed, and panel data permitted (Coelli, 1996). The Battesse and Coelli (1995) proposed model specification, which builds hypothesised efficiency determinants into the inefficiency error component so that one can identify focal points for action to bring efficiency to higher levels, is expressed as:

$Y_i = f(X_i; \beta)\exp(V_i - \mu_i)$, i=1,2,…,N (i)

Where, Y_i = Quantity of output of the ith farm

X_i = Vector of jth inputs used by the ith farm

β = Vector of parameters to be estimated

$(V_i - \mu_i)$ = Stochastic disturbance term

V_i = Two-sided, symmetric component, normally distributed random error with zero mean

μ_i = One-sided, non-negative, efficiency component with a half-normal distribution, obtained by truncation of normal distribution mean μ_i and variance $\delta^2\mu_i$, such that:

$\mu_i = \delta_0 + \delta_i Z_i$ (ii)

Where, Z = Vector of variables that may influence the efficiency of a firm/farm

δ_i = Vector of parameters to be estimated

A higher value of μ implies an increase in technical inefficiency; while a value of zero indicates that the firm/farm is perfectly technically efficient (Battesse and Coelli, 1995). Technical efficiency of individual farmers in the context of the stochastic frontier production function as specified by Ogundari and Ojo (2007), Umoh (2006) is expressed as: $TE_i = Y_i / Y_i^* = f(X_i; \beta)\exp(V_i - \mu_i) / f(X_i; \beta)\exp(V_i) = \exp(-\mu_i)$ (iii), so that, $0 \leq TE_i \leq 1$.

Methodology

The Study Area

The study was carried out Ogun State, which is endowed with extensive fertile soils suitable for agriculture and enjoys abundant rainfall almost all year round, and as well has a number of rivers, and streams. The principal employer in the rural parts of the state is small farm-holding agriculture involving the use of crude implements, while major farming practice in the rural parts of the state is mixed cropping, as a means towards conserving their soil fertility and as a traditional crop diversification strategy. Main crops grown in the rural settings within the state include both arable food and tree crops.

Data Collection and Sampling Technique

Cross-sectional data were collected from 240 respondents from eight villages that were evenly distributed among four local government areas. A multi-stage sampling technique was used to select sample units within the state, while well structured questionnaire were used to collect information on the socio-economic characteristics of the farmers, in addition to the production cost and returns for crops as cassava, maize, and yam. Respondents were categorised into two main groups, namely users and non users of microcredit based on their statement.

Data Analysis:

Descriptive statistics, stochastic frontier production function (SFPF) and simple mathematical formulas were employed for data analysis. Descriptive statistics involving the use of frequency table, percentages, and mean, were used to describe respondents' socioeconomic characteristics, while stochastic frontier regression analysis was carried out to determine the technical efficiency and its determinants for each categories of farmer. This involves the use of an econometric computer software programme, FRONTIER VERSION 4.1c that is asymptotically efficient and normally distributed, and consistent (Bamiro, *et al.*, 2006), and enabled the estimates for all the parameters of the SFPF and inefficiency model to be determined simultaneously. Note that frontier 4.1c assumes that all necessary transformations have been done to the data before it receives it, and the programme estimates a linear function using the data supplied to it (Coelli, 1996).

Regression Analysis:

The Cobb-Douglas production functional form, which specifies the production technology of the farmers, was chosen instead of translog model, which though is more flexible, require considerably greater number of parameters (Battese, *et al.*, 1996), in addition to its (i.e. Cobb-Douglas functional form) wide acceptance/use, theoretical fitness, manageability and suitability when dealing with small farms/small farm holding farmers (Ajibefun and Daramola, 2000; Aihonsu, 1999; Singh, 1975). It is defined and expressed as:

$Y_i = f\,(X_i;\beta)\ \exp V_i - \mu_i$ ……………………………………………………..…(iv)

$\ln Y_i = \ln\beta_o + \beta_i \sum \ln X_i + e_i$ ……..…………………………………………..… (v)

Where, Y_i = Quantity of output (Kg)

X_i = Vectors of inputs used

β_i = Parameters of the inputs estimated

$e_i = V_i - \mu_i$ = Error term

The inefficiency model is explicitly expressed as

$\mu_i = \delta_0 + \delta_i \ln Z_i$ ……………..……………………………………….…(vi)

All estimates are obtained through maximum likelihood estimation (MLE) procedures, which comprises parameters of Cobb-Douglas functional form and inefficiency model, as well as variance and variance ratio expressed as:

$\delta^2 = \delta^2_v + \delta^2_u$ ………………………………………………………….... (vii)

$\gamma = \delta^2_u / \delta^2 = \delta^2_u / \delta^2_v + \delta^2_u$ ……………………………………………..(viii)

$0 \leq \gamma \leq 1$ (Battese and Cora, 1977)

Results and discussions

Summary statistics of socio-demographic characteristics:

Age being an important factor linked with productivity in agriculture (Uduma, 2007), table1 shows mean age were 50 years and 47 years for microcredit users and non-users, respectively. The age structure indicates that though majority of the respondents were in their prime age and thus have required physical strength for the cultivation of crops considered in this study, however, non-microcredit users are relatively younger than credit user respondents, implying that, young and active people are more productive than aged (Uduma, 2007), human capital input is said to decreases with (increase in) the age of the farmer (Hockmann and Pieniadz, 2008). Education which Ajibefun and Daramola (2000) claimed has strong relationship with level of technical efficiency, was found to be low as majority of the respondents fall within non-formal to primary education, represented by 73.08 and 77.95 percents, for credit and non-credit users, respectively. Nonetheless, microcredit users spent more years in school than non-credit users as reflected by their mean year of schooling of 5 and 4 for the two categories respectively. This, according to Kareem, *et al.*, (2008) and Bamiro (2007), has implication for productivity through the adoption of new technology, a fact corroborated in the table by the percentage of microcredit users with respect to the use of improved technologies (improved planting materials, agro-chemicals, inorganic fertilizer and tractorisation) for agricultural production being higher than that of non-credit users. The observed low literacy level, according to Adewuyi (2007), is an indication of poor human capital development. The larger family size of microcredit users (mean family size is 9) could be of advantages in terms of ready labour supply in the face of hired labour scarcity and high wage rate where one is found, a view that conform to Kareem, *et al.*, (2008) findings , while smaller size observed with non-users of microcredit (mean family size is 7) could be attributed to emigrational effect in search of other sources of income as a way of taking care of their credit needs, due probably to their inability to access credit facility. This agrees with Chavas, *et al.* (2005) findings in a study in Gambia. Most of the respondents are well experienced in food crop farming, as revealed by the highest percentage of 50 and 44 percents, which correspond to between 20-34 years of farming experience, while mean years of farming were 29 and 27, for users and non-users of credit, respectively. The number of years of farming (farming experience), according

Table 1: Socio-economic characteristics of Respondents

Variables	Credit Users		Non-Credit Users	
	Frequency	%	Frequency	%
Age (Yr)				
16-30	2	1.93	10	8.00
31-45	40	38.46	37	27.21
46-60	42	40.38	64	47.06
61-75	19	18.77	22	16.18
>75	2	0.92	2	1.46
Total	105	100.00	135	100.00
Mean	50		47	
Family Size				
1-5	6	5.77	36	26.47
6-10	78	75.00	91	66.91
>10	20	19.23	8	6.62
Total	105	100.00	135	100.00
Mean	9		7	
Farming Experience(Yr)				
05-19	2	20.19	38	27.94
20-34	52	50.00	60	44.12
35-49	27	25.96	34	25.74
50-64	3	3.85	1	00.73
>64	-	-	1	01.47
Total	105	100.00	135	100.00
Mean	29		27	
Educational Status (Yr)				
Non-Formal	37	34.62	51	37.24
Primary	40	38.46	54	40.71
Secondary	19	18.27	25	18.38
Post Secondary				
(Grade II, NCE, OND)	3	2.88	3	2.21
Tertiary	6	5.77	2	1.46
Total	105	100.00	135	100.00
Mean	5		4	
Farm Size (Ha)				
0.1-1.5	7	1.25	24	0.84
1.6-3.0	20	1.80	44	1.59
3.1-4.5	32	2.34	30	2.50
4.6-6.0	22	2.73	18	2.78
6.1-7.5	10	3.85	06	3.08
>7.5	14	4.43	13	5.72
Total	105	278.90	135	313.65
Mean	2.70		2.32	

Source: Field Survey, 2008

to Rougoor, *et al*., (1998) and Tijani (1993), will impact positively on the farmer's production efficiency due to prudent resource allocation as he must have acquired practical knowledge through trial and error over time, hence experience and not age, according to Rahji (2005), is of policy relevance as it is amenable to manipulation than age. Again, micro-credit users are more endowed on average with more farmland resources as reflected in table 1, which might probably have arisen from the users' access to credit facility that must have enabled them to purchase or lease more land, which could result into increase in production efficiency of credit users respondent (Zeller, *et al*., 2001).

Productivity analysis:

The maximum likelihood estimate of the stochastic frontier Cobb-Douglas production function revealed that five of the variables (fertilizer, agro-chemical, labour wage, farm size and farm tools) have their coefficients significant at 1 percent level**,** while overall three of the six variables have positive sign (fertilizer, farm size and farm tools) and the remaining three have negative sign (planting material, agro-chemical and labour wage), for credit users respondent. However, non-credit users respondent have two variables being significant at 1 percent level (labour wage and farm ize), planting material significant at 5 percent level and agro-chemical significant at 10 percent level, while over all, four variables are found to be positively significant (fertilizer, agro-chemical, farm size and farm tools) and the remaining two variables found negatively significant (planting material and labour wage). The implication is that the positive ones exert positive effect equal to their coefficient values on the individual farmers' revenue and profit, while the negative ones have negative effect on the mentioned variables. The returns to scale of non-credit users' respondent is higher (1.30)

Table 2: Maximum Likelihood Estimates of the Stochastic Frontier Production Function

		Credit User		Non-credit User	
Variables	Parameters	Coefficient	Standard Error	Coefficient	Standard Error
Functional Model: Constant	β_0	0.406*** (4058.76)	1.000	0.201*** (452.146)	4.454
Planting Mats. (₦)	β_1	-0.391 (-0.537)	0.073	-0.616** (-2.187)	0.282
Fertilizer (Kg)	β_2	0.217*** (71.246)	3.048	0.707 (0.869)	8.142
Agro-xcal (ml)	β_3	-0.129*** (-2.814)	0.460	0.136* (1.874)	72.473
Labour Wage (₦)	β_4	-0.682*** (-6.487)	10.508	-0.182*** (-3.379)	5.394
Farm Size (Ha)	β_5	0.530*** (5296.138)	1.000	0.595*** (3093.045)	1.926
Farm Tools (₦)	β_6	0.454*** (11.413)	0.397	0.357 (1.051)	0.340
nefficiency Model:Constant	δ_0	0.137 (0.000)	1.000	0.373 (0.274)	1.360
Age (Years)	δ_1	0.121 (0.071)	1.710	-0.397 (-0.485)	818.718
Education (Years)	δ_2	0.512 (0.044)	1.159	0.734 (0.461)	15.922
Family Size	δ_3	0.200 (0.002)	1.000	-0.115 (-0.485)	236.817
Experience (Years)	δ_4	-0.305 (-0.084)	3.636	-0.210 (-0.485)	433.283
Sex	δ_5	0.262 (0.029)	1.044	-0.130 (-0.485)	26.856
Variance:Sigma-square	σ	0.629*** (6.286)	1.000	0.306*** (3.059)	1.000
Gamma	γ	0.491 (0.505)	0.973	0.847 (0.836)	0.101
Log Likelihood		-0.132		-0.168	
LR test				0.417	

Source: Field survey, 2008

Table 3: Farm Specific Technical Efficiency Level

Efficiency Level	Credit User		Non-credit User	
	Frequency	%	Frequency	%
≤0.80	4	3.85	1	0.74
0.81 – 0.85	1	0.96	3	2.21
0.86 – 0.90	13	12.50	15	11.02
0.91 – 0.95	68	65.38	73	53.68
≥0.96	18	17.31	44	32.35

Source: Field survey, 2008

than that of credit users' respondent (0.40), indicating that, non-credit users are in stage I of production surface portraying increasing returns to scale while credit users are in stage II, the rational stage of production, and exhibit decreasing returns to scale, which Olayide and Heady (1982) stated is characteristic of small-scale peasant farming, applicable only in the short-run (Olayemi, 2004). Moreover, it suggests, according to Ogundari and Ojo (2007), that, efforts should be made to expand the present scope of production to actualise their potential production as resources have not been fully exploited, meaning that, more output could be achieved by employing more of the variable inputs. This conform to Habibullah and Ismail (1994) findings that productivity could be increased by raising technical efficiency through increased input usage.

Technical efficiency and associated inefficiency factors:

The estimated σ^2 is significantly different from zero at 1 percent level for the two categories of farmer (though that of credit users' farmer is higher, 0.629, than that of non-credit users' farmer, 0.306), indicates a good fit and the correctness of the specified distributional assumption of the decomposed error term. This agrees with Awotide and Awojobi (2006) finding. On the other hand, γ is positively non-significant for the two categories of farmer, with that of non-credit users' farmer being higher (85%) than that of credit users' farmer (49%), suggesting that more than 80 percent of the variation in output among non-credit users' farmer is due to difference in technical efficiency and more than 40 percent of such variation accounts for difference in technical efficiency among credit users' farmer. It further indicates that there is higher level of technical inefficiency among credit users than non-credit users. Put in another words, 85 and 49 percents of discrepancies between the observed, and frontier outputs, for non-credit and credit users' farmer respectively, are due to technical inefficiency. The generalised likelihood ratio test suggest the presence of one-sided error component, meaning that the effect of technical inefficiency is significant, thus confirming the relevance and preference of stochastic frontier model, using maximum likelihood estimate (MLE), to classical regression model for data representation.

For the associated inefficiency effects, the table revealed the coefficients of all the variables to be positive, except farming experience for credit users' farmer, while for non-credit users' farmer, all the variables record negative signs except educational status. Moreover, none of the variables for the two categories of farmer is significant, thus conforming to Umoh's (2006) finding. The implication is that these characteristics do not contribute to technical inefficiency, hence do not deserve further discussion.

The estimation of technical efficiency for individual farmer revealed that more than 95 percent of non-credit users' farmer records technical efficiency of over 85 percent, while more than 90 percent of credit users' farmer had technical efficiency of over 85 percent. Both users and non-users of credit had minimum technical efficiency of -0.466 and 0.782, maximum being 0.988 and 0.991, while mean technical efficiency are 0.457 and 0.942, respectively. The higher technical efficiency of non-credit users' respondent than that of credit users' respondent could be attributed to distortion in inputs and credit market, and inadequacy of credit provided by the identified credit sources to the credit users' farmer. Furthermore, technical efficiency value of credit users' farmer indicate that this category of farmers can have their efficiency increased, unlike non-credit users' farmer, if inputs and credit market imperfections are adjusted, and improved upon. This submission conforms to Sharma and Zeller (2001) statement that, access to credit is not a guarantee for higher technical efficiency, except it goes with complementary factors as access to agricultural land, well functioning markets for both input and output, and concluded that rather, access to credit will only enable (farming) households to adopt new technology as attested to by table 1, intensify agricultural production and invest in farm, all of which will eventually lead to increase income levels. Alves (1968) and Wharton Jr. (1960) stressed this view further, by stating that, borrower farmers, given subsidized interest rate and under general inflation condition, will try to build up assets rather than maximise income. The relatively smaller average farm size of non-credit users' farmer compare to that of credit users' farmer is a factor that could also be responsible for the formers' higher technical efficiency, as stressed by past studies (Munroe, 2001; Zyl, *et al*., 1996). The possibility of over-utilisation of resources by credit users' farmer is also suspected to be a contributing factor to their low (or high) technical (in) efficiency, given their access to credit facility. This submission is affirmed by Feder, *et al*. (1990) finding that, availability (and accessibility) of credit allows both greater consumption and greater purchased input use, leading to increase in farmers' welfare, while Diagne, *et al*. (1995) stated that, borrowing (a mark of access to credit) allows farmer to respond to input market rather than modifying their farming strategies to increase productivity. Whereas, technical efficiency, according to Rahman (2003) could, adversely be affected, by not having inputs to use at the correct time (and in required quantity, all of which are function of bureaucracy, fiscal and monetary policies).

Conclusions and recommendations

The study revealed that food crop farmers, especially microcredit users' respondent, are yet to achieve their best, as shown by their low technical efficiency (TE) value, meaning that there is room for improving their technical efficiency substantially, thus, calling for critical examination of TE, as a means of examining the role higher efficiency level can have on agricultural output, especially in this study areas. It further shows that credit alone can not engender higher technical efficiency except it goes with other complementary factors such as access to agricultural land, training on prudent use of loan taken, among others. Furthermore, the results of this study show that any expansion in the use of any resources by these farmers would bring more than proportionate in their output, given their returns to scale values, obtained for this study. It is therefore recommended that policy that will address both incessant inputs price increase and timely availability of these inputs should be formulated, while recapitalisation policy of the federal government extended to micro-finance banks of recent is a welcome development. Such policy thrust needs to be extended to encourage existing banks (both commercial and micro-finance) to have more rural outlets with well designed prudent loan utilisation training to go along with loan disbursement. In addition, land reform committee of the federal government should come up with policy that will make land ownership for agricultural practices easier, as the positive significance of land (proxy by farm size), for the two categories of farmer, in the estimated frontier model indicate.

Refrences

Adewuyi, S.A., 2007. Economic Analysis of Rice Production in Nasarawa State, Nigeria. Bowen Journal of Agriculture, 4(1): 35-46.

Aigner, D.J., C.A.K. Lovell and P. Schmidt, 1977. Formulation and estimation of stochastic frontier production function model. J. Econometrics, 6: 21-37.

Aihonsu, J.O.Y., 1999. Optimal laying period for profitable and sustainable egg production. Ife Journal of Agriculture, 20(1&2): 67-80.

Alves, E.R. de A., 1968. An economic evaluation of an extension programme in Minas Gerais, Brazil. Unpublished M.A. Thesis, Purdue University.

Amaza, P.S. and J.K. Olayemi, 2002. Analysis of Technical Inefficiency in Food Crop Production in Gombe State, Nigeria. Applied Economics Letter, 9: 51-54.

Amaza, P.S., J.I. Onu, and F.Y. Okunmadewa, 2001. Identification of factors that influence the technical efficiency of cotton farmers in Nigeria. Nigerian Agricultural Development Studies, 2(1): 133-145.

Bamiro, O.M., 2007. Economics of Vertical Integration in the Poultry Industry in South-West, Nigeria. Unpublished Ph.D. Thesis, Department of Agricultural Economics and Farm Management, University of Agriculture, Abeokuta, Nigeria.

Bamiro, O.M., D.O.A. Phillip and S. Momoh, 2006. Vertical Integration and Technical Efficiency in Poultry (Egg) Industry in Ogun and Oyo States, Nigeria. International Journal of Poultry Science, 5(12):1164-1171.

Battese, G.E., S.A. Malik and M.A. Gil, 1996. An Investigation of Technical Inefficiencies of Production of Wheat Farmers in Four District of Pakistan. Journal of Agricultural Economics, 47: 37-49.

Battese, G.E. and T.J. Coelli, 1995. A Model for Technical Inefficiency Effect in Stochastic Frontier Production for Panel Data. Empirical Economics, 20: 325-345.

Battese, G., 1992. Frontier Production Functions and Technical Efficiency: A Survey of Empirical Applications in Agricultural Economics. Agricultural Economics, 20: 185-208.

Battese, G.E. and G.S. Corra, 1977. Estimation of Production Frontier Model with Application to the Pastoral Zone of Eastern Australia. Australian Journal of Agricultural Economics, 21: 169-179.

Central Bank of Nigeria, 2004. Annual Report and Statement of Accounts. A CBN Publication, Abuja.

Central Bank of Nigeria, 2003.

Chavas, J.P., R. Petrie and M. Roth, 2005. Farm Household Production Efficiency: Evidence from the Gambia. American Journal of Agricultural Economics, 87(1): 160-179.

Coelli, T.J., 1996. A guide to FRONTIER VERSION 4.1c: A computer programme for Stochastic Frontier Production and Cost Function Estimation. Mimeo, Department of Econometrics, University of New England, Amidale.

Coelli, T.J., 1995. Recent Developments in Frontier Estimation and Efficiency Measurement. Australian Journal of Agric. Econ., 39: 219-45.

Diagne, A., M. Zeller and C. Mataya, 1995. Rural Financial Markets and Household Food Security: Impacts of Access to Credit on the Socio-economic situation of Rural Households in Malawi. Interim Report Submitted to the Ministry of Women, Children Affairs, Community Services and Social Welfare (MOWCACSSW) and Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ) in Malawi.

Falusi, A.O., 1995. An Overview of Nigeria's Rural Economy: Problems, Prospects and Potential. A paper presented at NCEMA, Ibadan, August, 20-25.

Farrell, J.M., 1957. The Measurement of Productive Efficiency. J. Royal Stat. Society, 120: 253-81.

Federal Agricultural Coordinating Unit (FACU), 1992. The Proceedings of the 4th Annual National Farming Systems Research and Extension Workshop. FACU Report, Ibadan, Nigeria.

Federal Department of Agriculture (FDA), 1993. A Workshop on Food Security and Nigeria Agriculture: A National Agenda. Organised by FDA of the Federal Ministry of Agriculture, Water Resources and Rural Development, Abuja, Nigeria.

Feder, G., L.J. Lau, J.Y. Lin and X. Luo, 1990. The Relationship between Credit and Productivity in Chinese Agriculture: A Microeconomic Model of Disequilibrium. American Journal of Agricultural Economics, 72: 1151-1157.

Food and Agriculture Organisation (FAO), 2003.

Forsund, F.R., C.A.K. Lovell and P. Schmidt, 1980. A Survey of Frontier Production Functions and their Relationship to Efficiency Measurement. Journal of Econometrics, 13: 5-25.

Greene, W.J., 1990. A Gamma-distributed Stochastic Frontier Model. J. Econ., 46: 144-64.

Habibullah, M.S. and M.M. Ismail, 1994. Production Frontier and Technical Efficiency: The Case for Beekeeping Farms in Malaysia. Bangladesh J. Agric. Econs. XVII(1&2): 31-43.

Hazarika, G. and J. Awang, 2003. Access to credit, plot size and cost inefficiency among smallholder tobacco cultivators in Malawi. Agricultural Economics, 29: 99-109.

Hockmann, H. and A. Pieniadz, 2008. Farm Heterogeneity and Efficiency in Polish Agriculture: A Stochastic Frontier Analysis. A paper presented at the 12th Congress of the European Association of Agricultural Economists.

Kareem, R.O., A.O. Dipeolu, A.B. Aromolaran and S.B. Williams, 2008. Economic efficiency in fish farming: Hope for Agro-allied Industry in Nigeria. Chinese Journal of Oceanology and Limnology, 26(1): 104-115.

Kumbhakar, S.C., S. Ghosh and J.T. McGuckin, 1991. A Generalised Production Frontier Approach for Estimating Determinants of Inefficiency in US Diary Farms. Journal of Business and Economic studies, 9: 279-286.

Nasko, G., 1989. Food Self-sufficiency in Nigeria: A Review of Federal Government Programme. Federal Civil Service Forum, N.I.I., Victoria Island, Lagos, Nigeria.

Olayemi, J.K., 2004. Principles of Microeconomics for Applied Economic Analysis. SICO Publishers, Ibadan, Nigeria.

Olayide, S.O. and E.O. Heady, 1982. *Introduction to Agricultural Economics*. Ibadan University Press, Nigeria.

Ogundari, K. and S.O. Ojo, 2007. Economic Efficiency of Small Scale Food Crop Production In Nigeria: A Stochastic Frontier Approach. J. Soc. Sci., 14(2): 123-130.

Ogundele, F.O. and V.O. Okoruwa, 2004. A comparative analysis of technical efficiency between traditional and improved rice variety farmers in Nigeria. African Journal of Economic Policy, 11(1): 91-108.

Rahji, M.A.Y., 2005. Determinants of Efficiency Differentials in Lowland Rice Production Systems in Niger state, Nigeria. Ibadan Journal of Agricultural Research, 1(1): 7-17.

Rahman, S., 2003. Profit Efficiency Among Bangladesh Rice Farmers. A paper presented at the 25th International Conference of Agricultural Economists, held in Durban, South Africa, 16-22, August.

Rougoor, C.W., G. Trip, R.B.M. Huirne and J.A. Renkema, 1998. How to define and study farmers' management capacity: Theory and use in Agricultural economics. Agricultural Economics, 18: 261-272.

Singh, J.P., 1975. Resource Use Efficiency and Returns to Scale in a Backward Agriculture. Ind. J. Agri. Eco., 30: 33-46.

Tijani, I.A., 1993. Economics of Plantain Production in Some Parts of Irewole Local Government, Osun State. Unpublished B.Sc. Dissertation, Department of Agricultural Economics, University of Ibadan, Nigeria.

Umoh, G.S., 2006. Resource Use Efficiency in Urban Farming: An Application of Stochastic Frontier Production Function. International Journal of Agriculture & Biology, 8(1): 38-44.

Wharton, C.R. Jr., 1960. The Economic Impact of Technical Assistance: A Brazillian Case Study. Journal of Farm Economics, 42: 252-267.

Yusuf, S.A. and O. Malomo, 2007. Technical Efficiency of Poultry Egg Production in Ogun State: A Data Envelopment Analysis (DEA) Approach. International Journal of Poultry Science, 6(9): 622-629.

Zeller, M., M. Sharma, A.U. Ahmed and S. Rashid, 2001. Group-based Financial Institutions for the Rural Poor in Bangladeshi: An Institutional-and Household-Level Analysis. *Research Report* 120, IFPRI, Washington, D.C.