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Comparative Efficiency of Mechanized and Non-Mechanized Farms in Oyo State of Nigeria: A Stochastic Frontier Approach

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ABSTRACT This paper examined the technical efficiency of mechanized and non-mechanized maize farmers in Oyo State using stochastic frontier model to access the potentials in maize farms in Nigeria. The mean technical efficiency is 0.72 and 0.62 for mechanized and non-mechanized respectively. It was observed that the income of respondent could be improved if resources were efficiently used at the existing technology. Thus, in the short-run, there lies a potential of about 28 percent to increase the output of maize by adoption the technology and techniques of best practice rice farms in mechanized farms while the potential therein in non-mechanized farms is about 38 percent. Also, the entire variable specified in the efficiency model have positive coefficient with fertilizer being the only significant variable for both mechanized and non-mechanized. This implies that fertilizer application is an important variable regardless of the form of the farm. Other cost and labour is another variable that is significantly different from zero for mechanized farm.

INTRODUCTION

The agricultural sector in most developing countries like Nigeria is a most important sector of the economy. It contributes about 70 percent to the gross domestic product (GDP) of the nation and provides employment to millions of Nigerians (CBN, 1997). As the country experience consistent increase in population, food production declined due to decades of neglect of the sector. Massive food importation began in order to bridge the gap between supply and demand for food. In 1970 to 1975 food importation stood at 143 percent till 1976 to 1982 when the ratio of export to import declined to about 38 percent (CBN, 1997).

Concerted efforts were made by successive government both long run and short run to boost food production. This is evidenced in the establishment of institutions like Federal department of rural development (FDRD) in 1976 to coordinate an integrate rural and agricultural development and to initiate and develop appropriated strategies and projects which will help to increase agricultural productivity, employment opportunity in the country. Directorate of food, rural and road infrastructure (DFRRI) and the National Directorate of employment (NDE), which will create easy access to rural areas to facilitate increased food production, ease the transportation of farm produce.

Simultaneously, government made different economic reformation to boost food production among which are, Operation Feed the Nation (OFN), National Accelerated Food Production Project (NAFPP), Agro - Services, Green Revolution. Some projects are joint ventures for example NAFPP involves Federal, State government, USAID, IITA and National Research Institutions.

More recently, researchers have attempted to quantify the efficiency of individual firm using Stochastic Frontier Model (e.g. Battese and Coeli, 1992) in developing economy. The main advantage in using Stochastic Frontier Models is that it permits the estimation of technical, allocative and scale inefficiency and easy comparison of efficiency among farmers. Specifically, this study therefore examined the technical efficiency of maize farmers in Oyo state using Stochastic Frontier Model.

To achieve a desired growth and development of the economy, development of agriculture to an enviable height has been of great concern to all policy makers over the years. To this end, major food crops like maize, rice, wheat, cassava, yam, millet e.t.c and cash crops like timber, palm oil and some others cultivated by farmer continue to attract deserve attention.

In Nigeria, the economic importance of maize cuts across different spheres of human life. It is widely used as human consumption (food), industrial materials, feed inputs for animal and source

of employment and income to the farmers. As a human consumption item, pap, popcorn, tick porridge and boiled grain are notable foods consumed by majority of Nigerians mostly in the southern part of the country. Starch and some other items derived from maize as main products and by products are utilized by the brewing, manufacturing of adhesives, pharmaceuticals industries. Starch is also readily used by the jam - making industries and chemical producing companies. This work, therefore will add to body of literature of research work on technical efficiency of the maize farmers and studies on production frontier, particularly in Nigeria where little work have been done in the application of stochastic frontier to agricultural production data. More so, it could inform the policy makers and ADP officials on how best to improve resource-use among maize farmers.

MATERIALS AND METHODS

The study was conducted in Oyo State where agriculture is their main traditional occupation. The state Agricultural Development Programme established in 1989 is divided into four agricultural zones Ogbomoso, Oyo, Saki and Ibadan.

The study made use of cross-sectional observation of inputs and output of fifty respondents each of mechanized and non-mechanized farmers using a multistage random sampling technique with zones created by the Oyo State Agricultural Development Programme as the strata for the sampling. The variable in the model are:

Y represents the output
X_1 represents the labour
X_2 represents the fertilizer
X_3 represents the land
X_4 represents the other costs

All variables are expressed in value terms while the model to be estimated consist of a conventional production relationship between measured outputs.

The labour input is measured as Naira value of total man-days worked on the farm. No attempt was made to correct the labour input for quality difference e.g. sex, age, education etc. as the data necessary to do this are not available in the study area. The fertilizer is the value of actual physical quantities of the fertilizer applied during the season by each respondent. Unless the land area used in agricultural production is weighted by some measures of its productivity, the result tends to be meaningless. This study assumes that the quality difference in land is reflected in the differences in the rent paid by users. Other cost represents various costs expended on inputs like transport, herbicides, seeds etc. A priori, it is expected that increased use in the explanatory variables will increase output.

The Econometric Model: The stochastic frontier production function model originally proposed by Aigner et al. (1977) and Van den Broeck (1977) stated that the deviation from the frontier of an individual firm could be attributed to random components that are beyond the firm control (weather, diseases etc) and systematic components which consists of technical inefficiency which may be associated with management differences in the industry. Extensive review of its application in agriculture was noted in Battese (1992), Bravo Ureta and Pinheiro (1993), and Coelli (1995). In this study, the technical efficiency for a cross-section Nigeria maize farmer in Oyo State ADP was examined using Battese and Coelli (1995) specification, which may be expressed as:

$Y_{it} = X_{it}b + (v_{it} + u_{it})$
$i = 1 .....n$
$t = 1.....n$

Yit represents production of the ith firm

b Represents vector of the unknown parameters

X_{it} represents K* 1 vector input quantities of the ith firm

v_{it} represents random variable which are assumed to be N (0. d^2) and independent of the uit which is non-negative random variables which are assumed to account for technical inefficiency in production and often assumed to be independently distributed as truncations at zero of the $N(m_{it}\ d^2_u)$ distribution where mit = $z_{it}d$

z_{it} is a P*1 vector of variables which may influence the efficiency of a firm and (is 1*P vector of parameters to be estimated.

$d^2 = d^2v + d^2v$ and the ratio of the two standard errors is defined as the total variation of output from the frontier which can be attributed to technical inefficiency (Battese and Coelli, 1977).

$l = \frac{d_u}{d_v}$ or $l = \frac{d^2_u}{d^2}$

given the above specification, the technical efficiency of the ith farmer is defined by:

TE_i exp $(-u_i)$.

RESULT AND DISCUSSION

Non-Mechanized Farm: Table 1 shows the stochastic frontier production result using OLS estimates of the parameters, which shows the average performance of the sample farms. The regression coefficient is significantly different from zero at 10 percent level for fertilizer. This implies that fertilizer have a significant impact on the output of maize in the study area. The use of fertilizer is very important, as the fallow period cannot be accomplished.

Table 1: OLS estimates of average performance using semi-log production function

		Non Mechanized farms		*Mechanized farms*	
Variable	*Parameters*	*Coefficients*	*t-ratio*	*Coefficients*	*t-ratio*
Constant	b_0	0.80	(2.96)	0.03	0.45
Labour	b_1	0.26	(0.26)	1.29	1.62
Fertilizer	b_2	27.16	(6.86)*	0.69	3.46*
Land	b_3	1.57	(1.47)	1.29	0.62
Other cost	b_4	8.11	(0.69)	0.20	2.07*

The estimates t ratio are presented in the parenthesis, correct to two significant digit
* indicates significance at 10%.

The maximum likelihood estimates of the parameters, which show the best practice farm, that is, efficient use of the available resources and technology is given in table 2. It could be observed that the estimate of (which is the ratio of farm specific efficiency indices to the total variance of output was 0.95 and highly significant. This implies that about 95 percent of the variation in output among the farms is due to the differences in technical inefficiency.

Table 2: Maximum likelihood estimate of semi log stochastic frontier production function

		Non Mechanized farms		*Mechanized farms*	
Variable	*Parameters*	*Coefficients*	*t-ratio*	*Coefficients*	*t-ratio*
Variable	b_0	0.59	2.57	0.03	0.15
Labour	b_1	0.90	0.95	1.29	1.78*
Fertilizer	b_2	1.11	11.76*	0.69	3.76*
Land	b_3	21.16	2.02*	1.29	1.27
Other cost	b_4	6.80	0.72	0.20	4.82*
$\sigma^2 = \sigma^2 + \sigma v^2$		0.59	0.95	4.00	23.8
$\sigma = \sigma^2 / \sigma s^2$		0.01	0.00	4.82	0.00

Source: Data analysis 2003
The estimate t-ratio is presented in the parenthesis correct to two significant digits.
* Indicates significance at 10% level

The individual technical efficiencies obtained using the estimated stochastic frontier are presented in table 3. The predicted technical efficiency differs substantially among the farmers as it ranges from 0.30 to 0.99 with the mean technical efficiency estimated to be 0.62 that is, there is a considerable room of about 38 percent to improve the income of the respondents using the available technology. A frequency distribution of the predicted technical is in table 3 to give a better description of the distribution of technical efficiencies.

Mechanized Farm: The OLS estimates of the parameters, which show the average performance of the large-scale farms, are presented in table 1. The regression coefficients are significantly different from zero at 10 percent level for fertilizer and other costs. This implies they have significant impact on the output of maize in the study area. The use of fertilizer is very important, as the fallow period cannot be accomplished. Table 2 explain the maximum likelihood estimate of the parameters which shows the best practice farm, that is, efficient use of the available resources and technology were obtained using the program Frontier 4.1 (Coelli, 1994) which estimate the variance parameters in terms of $\sigma_s = = \sigma^2 + \sigma v^2$ and $g=\sigma^2/\sigma_3^2$, It could be observed that the estimates of σ, which is the ratio of the performance of farm specific efficiency indices to the total variance of output was 0.00. This implies that variation in the output among the farms is not due to the technical inefficiency. Coefficients of fertilizer and other cost are still positively significant in addition to labour. This shows the importance of labour, fertilizer and other cost in maize farms in the study area. The individual technical efficiencies obtained using the estimated Stochastic frontier is presented in table 3. The predicted technical effi-

Table 3: Estimate of technical efficiency indices for non mechanized and mechanized farms

Class interval	*Non-Mechanized Farms*	*Mechanized Farms*
0.30-0.39	6	12
0.40-0.49	5	3
0.50-0.59	8	5
0.60-0.69	17	2
0.70-0.79	8	3
0.80-0.89	5	10
0.90-0.99	1	15
Total	50	50

Source: Data analysis 2003

ciencies differed substantially among the farmers' and ranges from 0.20 to 0.99 with the mean technical efficiency estimated to be 0.72. Frequency distribution of the predicted technical efficiency is given in table 3. There appears to be considerable room for effecting improvements in the technical efficiency of the farmers in the region. The income of the sample farmer can be improved to the tune of about 28 percent.

CONCLUSION

The level of technical efficiency for mechanized and non-mechanized farm was calculated using a stochastic production function and their frequency distribution are presented in table 3. The mean technical efficiency is 0.72 and 0.62 for mechanized and non-mechanized respectively. Based on the findings in the literature, e.g. Battese and Coelli (1997), it is expected that the large farm size will enjoy the economies of scale than the small size farms. Technical inefficiency could be referred to failure of respondents to produce maximum output from given inputs, It was observed that the income of respondent could be improved if they used their resources efficiently at the existing technology. Thus, in the short-run, there lies a potential of about 28 percent to increase the output of maize by adoption the technology and techniques of best practice rice farms in mechanized farms while the potential therein in non-mechanized farms is about 38 percent. The estimated coefficients of the explanatory variables in the technical efficiency effects have important implications. All the variables have positive coefficients with fertilizer as the only significant variable both in mechanized and non-mecha-nized farms. The coefficient of other costs is significantly different from zero for mechanized farm; this implies it has a significant impact on the technical efficiency of mechanized farms.

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