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Full Length Research Paper

Technical efficiency of maize production in Oyo state

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Using a cross sectional data obtained through a multistage sampling technique this study estimates the technical efficiency of maize producing-farmers in Oyo State, Nigeria and further examined the factors that determines the differential in efficiency index. A multistage sampling technique was used to select 120 maize farmers in the study area. Data were collected and subjected to inferential statistics; stochastic frontier production model was used in the analysis to determine the relationship between the maize output and the level of input used in the study area. The empirical results revealed that farm size and Seed were statistically significant at 10 and 1% level respectively in the study area. The estimated gamma parameter (γ) of 0.12 in the study area indicates that 12% of the total variation in maize output is due to the technical inefficiencies. The mean technical efficiency (χ) was 0.961 while the return to scale (RTS) was 0.587 in the study, it was therefore concluded that there is scope for increasing maize production by 0.39% with the present technology. Therefore the study confirmed that more land can still be open for maize production in the area with the current level of input used.

Key words: Technical efficiency, maize production, Oyo State, stochastic production frontier.

INTRODUCTION

It is worth noting that, many factors contribute to low productivity, these include: farm management, resource use, population pressure, fragile ecosystem, poverty, land tenure, inadequate knowledge of appropriate technologies and technical know-how, in-adequate price incentives, socio-cultural factors and farmers' perceptions and attitudes which are inherently unpredictable. These factors influence and have effect on the production output and management practices as a whole.

Maize originated in Central and South America and was introduced into Africa by Portuguese in the 16th century. A report had it was introduced to Europe in 1942 from central and southern America by Christopher Columbus and latter spread to Africa by the Dutch in southern Africa (Okoruwa, 2006). Maize is a major and important cereals being cultivated in the Rainforest and derived savannah zone of Nigeria. It is also one of the popular cereals in Nigeria; it serves as the main staple food for millions of Nigerians.

The importance of maize cannot be overestimated, economic importance of maize cut across different spheres of human life, it also serves as food for human consumption, such as pap; popcorn, thick porridge and boiled grains are notable food consumed by majority of Nigerians, mostly in the southern part of the country. Maize is industrially important chiefly for the production of starch and alcohol. The starch can be used as converter dextrin, syrup and sugar; oil obtained from it is used to make soup or refine for cooking and salad dressing.

Maize industries provide employment opportunities for many farmers; for example, in 1964 to 1965 cropping season, about 28% of the Nigeria farmers cultivated maize, as at 1986 production of maize was estimated to be 861,000 metric tons (Titilola and Igben, 1986), land area under maize has increased from 653,000 ha in 1984 to its present level of 5,000,000 m ha., production has also increased from 1,000,000 m tons to 7, 000,000 m tons during the same period. Average yield of 1.4 – 1.5 t/ha being obtained is low compared to other places (IITA, 2007).

Objective of the study

The main objective of this research is to examine the technical efficiency of maize production in Ogbomoso Agricultural Zone of Oyo State.

The specific objectives are to:

1. Examine the determinants of technical efficiency

of maize producing-farmers in the study area,
2. Determine the technical efficiency of maize production in the study and
3. Determine the level of production in the study.

Hypothesis of the study

The following null hypothesis guided this study

H_1: There is no significant relationship between farm size and maize output.
H_2: There is no significant relationship between the quality of seed used and maize output.

Literature review

Efficiency is the act of achieving good result with little waste of effort. It is the act of harnessing material and human resources and coordinating these resources to achieve better management goal. Farrell (1957) distinguished between types of efficiency (a) Technical Efficiency (TE), (b) Allocative Efficiency (AE) and (c) Economic Efficiency (ER), by saying that farm efficiency can be measured in terms of all these type of efficiency. The appropriate measure of technical efficiency is input saving which gives the maximum rate at which the use of all the inputs can be reduced without reducing output and also defines Technical efficiency as measuring the effectiveness or competency with which the physical aspect of marketing are performed. These activities include processing sorting and transporting e.t.c. Allocative or price efficiency relates to the term exchange, the degree of competition and the responsiveness of the marketing system to the consumers need. It also concerned with the accuracy precision and speed with which price reflect consumers' demands to pass back through the marketing channels to producers. Economic efficiency is concerned with the realization of maximum output in monetary term with the minimum available resources. Technical efficiency is defined as the ability to achieve a higher level of output, given similar levels of inputs. Allocative efficiency deals with the extent to which farmers make efficiency 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 (Abdulai and Huffman, 2000).

Production is defined as the transformation of goods and services into finished products (that is input-output relationship) and this is also applied to every production process, maize production inclusive. Olayide and Heady (1982) define production process as one whereby some goods and services called inputs are transformed into other goods and services called output. In agriculture, the physical inputs which we use are: land, labour, capital and management. Pitt and Lee (1981) have estimated stochastic frontiers and predicted firm-level efficiencies using these estimated functions, and then regressed the predicted efficiencies upon firm –specific variables such as managerial experience, ownership characteristics etc in an attempt to identify some of the reasons for differences in predicted efficiencies between firms in an industry. This has long been recognized as useful exercises, but the two-stage estimation procedure has also been long recognized as one, which is inconsistent in its assumptions regarding the independence of the inefficiency effects in two estimation stages. The two-stage estimation procedure is unlikely to provide estimates, which are as efficient as those that could be obtained using a single stage estimation procedure.

Stochastic frontier

Empirical estimation of efficiency is normally done with the methodology of stochastic frontier production function. The stochastic frontier production model has the advantage of allowing simultaneous estimation of individual technical and allocative efficiencies of the farmers as well as the determinants of technical efficiency (Battese and Coelli, 1995). Economic application of stochastic frontier model for efficiency analysis include Aigner et al. (1977) in which the model was applied to U.S agricultural data, Ogundari and Ojo (2005), Ajibefun et al. (2002), Bravo and Pinheiro (1993) and Ali and Byerlee (1991) in which they offer comprehensive review of the application of the stochastic frontier model in measuring the technical and economic efficiencies of agricultural producers in developing countries.

Karl and Victor (1990). Technical efficiency is the ability of the firm to produce the maximum output from its resources. One firm is more technically efficient if it produces a level of output higher than another firm with the same level of input usage and technology. Measures of technical efficiency give an indication of the potential gains in output if inefficiencies in production were to be eliminated. Recent measures of technical efficiency in the Soviet Union have been incongruous with the presumption that bureaucratic obstacles in the command-economy system inherently foster waste in resource utilization and inefficiencies in production.

The ideas of production function can be illustrated with a farm using n inputs: X_1, X_2, … X_n, to produce output Y. Efficient transformation of inputs into output is characterized by the production function f (X_i), which shows the maximum output obtainable from various inputs used in production. Therefore, for the sake of this study, the stochastic frontier production function in which Cobb-Douglas was proposed by Battese and Coelli (1995) and confirmed by Yao and Liu (1998) represents

the best functional form of the production frontier and was used for data analysis in the study.

METHODOLOGY

The study area

The study was carried out in Ogbomoso Agricultural zone of Oyo State; this zone is rural in nature, the climate of the area favours maize production. Ogbomoso is located approximately on the intersection of latitude 8° 10' North, longitude 4° 15' East and altitude 213 m asl. Ogbomoso is regarded as a derived Savannah vegetation zone and a low land rain-forest area, the zone experience both wet and dry season annually.

Sampling procedure

Maize farmers are the respondents for this study; one hundred and twenty maize farmers were selected from this area.

The sampling technique employed is a multi-stage stratified random sampling technique. The first stage involved purposive selection of Ogbomoso Agricultural zone in Oyo State; this zone comprises of five local government areas, namely: Ogbomoso North, Ogbomoso South, Orire, Surulere and Ogo-Oluwa respectively. The second stage involved purposive selection of small scale maize farmers from the LGAs which are rural in nature such as, Ogbomoso South, Orire, Surulere and Ogo-Oluwa Local Government Area respectively, because the maize farmer are more concentrated in this area. The third stage involved simple random sampling, through random selection of thirty maize farmers from each of the LGAs making a total of one hundred and twenty maize farmers for the study.

Research instrument and data collection

Questionnaire and interview schedule were the research instruments used for this study to collect information from the farmers. Primary data were obtained with the interview schedule administered to the maize farmers.

Data analysis

The data obtained from the field were subjected to analysis using inferential statistics which was used to test the hypothesis. The Stochastic frontier production model was used to determine the relationship between the dependent variable and the independent variables as well as to determine the technical efficiency in farmers operation in the study area.

Model specification

$Y= f(X_1, X_2 \ldots Xn)$, Y = Output, value of total maize produced (kg), X_1 = Farm size (hectares), X_2 = Family labour (man day), X_3 = Hired labour (man day), X_4 = Seeds (kg) and X_5 = Fertilizer (kg).

The stochastic frontier production model

Linear function

$$Y = b_0 + b_1X_1 + b_2 X_2 + b_3X_3 + b_4X_4 + b_5X_5 + \mu + v$$

Cobb-Douglas production frontier function

$$\ln Y_i = \ln A + \sum_{I=1}^{5} \beta_i \ln X_i + V - U$$

$$\ln Y = b_0 + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + \mu + v$$

Inefficiency model

$$U_i = \delta_0 + \sum \delta_i Z_i$$

$$U_i = \delta_0 + \delta_1 Z_{1i} + \delta_2 Z_{2i} + \delta_3 Z_{3i}$$

Where
Z_1 = level of education (dummy), Z_2 = Years of farming (year), Z_3 = Family size (number).
When Y = dependent variable, Xs = independent variables, μ and v = error term, b_1's = parametric estimates and b_0's = the intercept term.
A and B_i = parameters to be estimated (i = 1, 2... 5)
X_i = the vector of (transformations of the) ith input used by jth farm
β = is a vector of unknown parameters and
V = random variables
U = non-negative random variables which are assumed to account for technical inefficiency in production.

δ_0 and δ_i = parameters to be estimated (i = 1,.....3) together with the variance parameter.

$$\sigma^2_s = \sigma^2 + \sigma^2_v$$

$$\sigma^2 = \sigma^2_v + \sigma^2_u$$

$$\lambda = \sigma_u / \sigma_v$$

$\gamma = \sigma^2_u / \sigma^2_v$: This measures the effect of technical efficiency variation of observed output.
$\gamma > 1$: This indicates that one-sided error dominates the symmetry error indicating a good fit and correctness of the specified distribution and assumption.

On the assumption that V_i and U_i are independent and normally distributed, the parameters β, $\sigma^2_u \sigma^2_v$, σ^2, γ and λ were estimated by the method of Maximum Likelihood Estimates (MLE), using the computer FRONTIER Version 4.1 (Coelli, 1996) which also computed the estimates of technical efficiency.

RESULTS AND DISCUSSION

Estimated production function

The Cobb Douglass production function was adopted for this result compared to the Ordinary Least Square (OLS) functional form.

The parameters and related statistical test results obtained from the stochastic frontier production function analysis are presented in tables below, Tables 1 and 2. There is a positive and significant relationship between farm size and maize output in this local government area. This implies that Land is a significant factor associated with changes in output in the study.

The coefficient of seeds is positive and statistically significant in the study area. This implies that as more of

Table 1. OLS and MLE result of the frontier estimates for the study area.

Variables	Parameter	Coefficient	Standard errors
Constant	β_0	0401	0.682
Farm size	β_1	0.279***	3.731
Family labour	β_2	0.018	0.467
Hired labour	β_3	-0.022	-0.568
Seeds	β_4	0.469 ***	8.439
Fertilizer	β_5	-0.101	-0.305
Constant	β_0	0.549	0.973
Farm size	β_1	0.284*	3.864
Family labour	β_2	0.025	0.671
Hired labour	β_3	-0.022	-0.583
Seeds	β_4	0.465 ***	8.761
Fertilizer	β_5	-0.165	-0.519
Inefficiency Model			
Level of education	δ_1	-0.048	-1.175
Years of farming	δ_2	-0.017	-1.121
Family size	δ_3	0.028	0.891
RTS		0.587	
Sigma squared	σ^2	0.038 *	7.376
Gamma	γ	0.12	0.539
Mean efficiency	χ	0.961	
Log Likelihood Function		28.587	

*, **, *** =10, 5 and 1% significance level, respectively. Source: Result from data analysis (2008).

Table 2. Frequency and deciles range of farmers' efficiency.

Range	Frequency	Percentage
< 0.5	3	2.5
0.5 – 0.6	0	0.0
0.6 – 0.7	0	0.0
0.7 – 0.8	0	0.0
0.8 – 0.9	13	10.8
> 0.9	104	86.7
Total	120	100.0

Source: Result from data analysis, 2008.

these variables are employed, there will be an increase in total output of maize produced.

Sources of inefficiency

The sources of inefficiency were examined using the estimated (δ) coefficients associated with the inefficiency effects in Table 1, the inefficiency effects are specified as those relating to education, experience and family size.

The estimated coefficient of education and years of farming shows inverse relationships to the maize output, and these negative relationships between them is unexpected. This could be due to the generally small number of years of formal education as observed and also the year of farming experience could be due to the fact that farmers with long years of experience are used to obsolete methods of farming. The estimated coefficient of family size is positive and insignificant in the study. This implies that maize farmers with more family size tend to be more technically efficient in maize production.

The Return to Scale (RTS) was 0.587 in this study; this indicates a positive decreasing return to scale in the area, which implies that maize production was in stage II (that is, the rational zone) of the production surface. Hence, production is efficient.

This shows that effort should be made to expand the

present scope of production to actualize the potential in it. That is, more of the variable inputs should be employed to achieve more output.

The estimated sigma square (σ^2) in the study was 0.038 which is significant different from zero at 1%. This indicates that one sided error term dominates the symmetry error indicating a good fit and the correctness of the specified distributional assumptions. Therefore if γ is statistically different from zero implies that traditional average (OLS) function is not an adequate representation for the analysis.

The determinants of technical efficiency of the maize farmers in the study area include farm size and seed. The implication is that the signs of the estimated coefficients have important implications (the variables greatly impact) on the Technical Efficiency of the maize farmers in the study, which means that the tendency for any maize farmers to increase his production depend on the amount of farm size and quality seed available to him in the study area.

The estimated gamma parameter (γ) of 0.12 in the study area indicates that 12% of the total variation in maize output is due to the technical inefficiencies in the area.

The technical efficiency in this study is also presented in Table 1, the predicted technical efficiencies differ substantially among the maize farmers, and ranking from 0.100 the minimum and 0.997 the maximum with the mean technical efficiency estimated to be 0.961, a frequency distribution of the technical efficiencies is presented in Table 2, which shows that the highest numbers of farmers have technical efficiencies of 0.9 and above; this also indicated that there is a wider distribution of technical efficiencies in the production level in the area, which revealed that there is a considerable room for effecting improvements in the technical efficiencies of the farmers in the local government.

Therefore, there is scope for increasing maize production in the zone by 3.9% with the present technology.

Summary

Technical efficiency of maize production in Ogbomoso Agricultural zone of Oyo State was examined for this study. A multistage sampling technique was used to select 120 farmers in the study area. Data were collected and subjected to inferential statistics Ordinary least square (OLS) and Stochastic frontier production model which was used to determine the relationship between the dependent variable, independent variables and the technical inefficiency in farmers' operation in the study.

The empirical results revealed that farm size was statistically significant at 10% level while Seed was positively and statistically significant at 1 percent level in the study area. The estimated gamma parameter (γ) of 0.12 in the study area, indicates that 12% of the total variation in maize output is due to the technical inefficiencies in the study. The mean technical efficiency (χ) was 0.961 in the zone. The return to scale (RTS) was 0.587 in the study area.

It was therefore concluded that there is a positive and significant relationship between farm-size; seed and the output in the study area and also access to good quality (variety) of seed have positive impact on output. It was recommended that efforts should be intensified on the part of extension agents in educating the farmers so as to boost their efficiencies in maize production.

Conclusion

It is therefore, concluded that maize production in this study area is in stage II which is the rational stage of the production frontier, hence, the maize production is efficient and also there is a positive and significant relationship between farm size, quality of seed and technical efficiency in maize production in the study area which means that an increase in the level of quality of seed used and an expansion in the farm size brings a proportionate increase in the output level, therefore, the Null hypothesis were rejected.

RECOMMENDATION

Based on the findings in the study area, the following are recommended:

1. The study confirmed that more land can still be open for maize production in the study area with the current level of input used.
2. More efforts should be intensified on the part of extension agents in educating the farmers so as to boost their efficiencies in maize production, also results of better researches of improved agronomic practices should be extended to the farmers in this area by the extension agents.

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