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Research Article

Technical Efficiency of Maize Small-Scale Farmers in Oyo State, Nigeria

[1]Matthew, M.D., [2] Ajibefun, I. A. and [2]Oduntan, O.
[1]Department of Agricultural Extension and Management, Federal College of Agriculture Akure, Nigeria.
[2]Department of Agricultural and Resource Economics, Federal University of Technology Akure, Nigeria.
*Corresponding author: matthewmd@futa.edu.ng

Abstract

This study examined the technical efficiency of maize small-scale' farmers in Oyo State, Nigeria. Primary data were collected for this study using a multistage sampling technique to select 300 maize farmers from the study area. The data were analysed using descriptive statistics and stochastic production frontier. The significant variables affecting maize production were seeds (a0.05), agrochemical (a0.01), labour (a0.05), fertilizer (a0.01) and farm size (a0.01), while the factors affecting inefficiency were age (a0.01), farming experience (a0.10), household size (a0.10) and extension contact (a0.10). The study recommended that governments should provide affordable input like fertilizers, seeds and herbicides for the farmer and also create policies that will make more land available to maize farmer in Oyo State which can help improve their level of efficiency.

Keywords: Technical Efficiency, Maize production, Stochastic frontiers, Oyo State, Nigeria

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Introduction

Maize accounts for the largest share of the country's coarse grain production as it is one of the most planted crops in Nigeria and also an important staple food (Oyewo, 2016; Zalkuwi *et al*., 2010). Maize farming is carried out in nearly all the geographical zones in Nigeria in small, medium, or large-scale capacities. However, the bulk of the country's maize production is concentrated in Borno, Niger, Plateau, Katsina, Gombe, Bauchi, Kogi, Kaduna, Oyo and Taraba States. These top ten maize producing States accounts for nearly two-third (64%) of maize produced in Nigeria (Olaniyan, 2015).

Nigeria's maize production scenario and conditions including the agro-cultural diversities had placed it at an advantage for production of a wide range of products like starch, alcohol, ingredient in infant and livestock feed industries, dextrins, sugars, and syrup among others (Onuk *et al*., 2015; Sowumi and Akintola, 2010). However, the level of production in the sector is presently facing challenges from erratic weather pattern such as heat stress, longer dry seasons and uncertain rainfall and longer dry spells in the rainy season (Muench *et al*., 2021; Nwaogu *et al*., 2020).

Within the agricultural sector, maize is one of the most cultivated and important crops in Nigeria. Aside from it being consumed locally in roasted or boiled form; it is also consumed in other processed forms such as cornflakes, custard, pap (ogi), golden morn especially in the southwest, southeast and south-south of the country (Oyewo, 2016). It also happens to be one of the important sources of carbohydrate, protein, vitamin B and mineral (Abdulaleem *et al*., 2019; Oyewo, 2016 and Zalkuwi *et al*., 2010;). Maize supplies more calories than rice and wheat; with a caloric supply of about 16.5% and 15.0% respectively (World Atlas, 2017). It provides job opportunities and contributes to the country's economic development, evidence from an increase in production (by 63%, from 2007-2017) (National Bureau of Statistics (NBS), 2021) and it is at present being cultivated in nearly all countries of the world (Aminu *and* Jaiyeoba 2015).

The second largest maize producer in Africa after South Africa is Nigeria and also the 14th largest producer globally. Data from the Food and Agricultural Organization (FAO) (2017) put Nigeria's total maize production in 2019 at about 11 MMT harvested from over 6.8 million hectares of land. This production level represents a growth rate of 49% relative

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to the production level recorded a decade earlier. However, the association of maize farmers in Nigeria gave a far higher production figure of 20 MMT in 2019.

Small-scale farmers are Nigeria's largest agro-producers, holding farms below 10 hectares of land for agricultural production. Small-scale farmers control 80 percent of Nigeria's agricultural community, producing between 80%-90% of the country's food production with low capital rates and minimal government support (Mgbenka, 2016). According to Girei *et al*. (2018) and Ebukiba *et al*. (2020) it was observed that there is competition for maize by both man and animal and the significance of increasing productivity should not be taken too lightly as higher maize productivity will lead to food supply to ever-increasing population. With the ban on importation of maize into Nigeria, small-scale farmers have comparative advantage and better opportunity for enlarging or increasing maize production output to make significant profit. Therefore, increasing efficiency in maize production is important to yield higher returns.

Over the years, there has been several challenges bedeviling maize farming in Nigeria Getachew and Bamlak, (2014) and Ebukiba *et al*., (2020), which has been attributed to several factors. Some major ones include small land area cultivated by farmer of less than 2 hectares for cropping, limited supply of agricultural inputs such as fertilizer, Inadequate capital, absence of a conducive policy environment, climatic changes (World Atlas, 2017; Fasakin and Akinbode, 2019; Idisi *et al*., 2019) These challenges have greatly affected the efficiency of maize production. Small-scale farmers are further faced with inefficient use of their resources, which makes production low (Alabi *et al*., 2020).

A lot of research has been done on maize productivity and efficiency (Ebukibu *et al*., 2020; Abdulaleem *et al*., 2019; Girei *et al*., 2018; Ogunjimi *et al*., 2014;) but not much have been specific on Small-scale maize farmers in Oyo State, Nigeria and there is a depth of information on small-scale maize farmers efficiency that has not been studied. Hence there is need to look deeper into efficiency of maize production among small-scale maize farmers in order to come up with policy that will facilitate its production.

Technical efficiency is the ability to derive the greatest amount of output possible from a fixed quantity of inputs and maize production mainly depends on farmer's level of efficiency which is a function of their socioeconomic factors and their farm characteristics (Nchare, 2009 and Shamsudeen *et al*., 2017).

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The purpose of this study is therefore to identify how effectively farmers allocate resources to maximise production and to examine the causes of technical inefficiency, which reduces maize productivity in Oyo State, Nigeria.

Therefore, the objective of this study was to;

i. identify the factors influencing technical efficiency of maize farmers;
ii. identify the determinants of technical inefficiency among small holder maize farmers and;
iii. determine the technical efficiency level of maize production in the study area.

Findings from this study is expected to provide useful information and technical advice to maize farmers in Oyo State and Nigeria in general.

Materials and Methods

Methodology

Area and Scope of Study: This study was carried out in Oyo State of Nigeria which is located in South-West, Nigeria. The capital of the Oyo State is located in Ibadan, which is the second largest city in Africa.

Data Collection and Sampling Techniques: Primary data was collected with the aid of a structured questionnaire administered to maize farmers in the study area to obtain data on the estimation of technical efficiencies included physical quantities of production inputs (fertilizers, manures, labor, seeds, and land area under maize) and maize output. The multistage sampling procedure was employed in selecting respondents for this study. The first stage involved the purposive selection of Oyo State out of the six States in South-Western Nigeria based on the high production of maize in the region. In the second stage, three (3) Local Government Areas were randomly selected from the State. In the third stage, five (5) villages were purposively selected from each Local Government Area identified in stage 2 based on the relative intensity of maize farmers in the village as specified by Agricultural Development Programme (ADP) in the State to give a sub total of fifteen (15) villages for the study. In the fourth stage, twenty (20) smallholder farmers were randomly selected in each of the villages. In all, a total of three hundred (300) smallholder maize farmers were interviewed for the study. However, due to inadequate information given by the respondents, 234 were found useful for analysis. The simple random sampling selection was carried out with the aid of random numbers generated by a calculator in order to avoid selection/researcher's bias.

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Analytical Techniques: The Stochastic Frontier Production Function using the Cobb-Douglas functional form was used in determining the technical efficiency levels of maize farmers in the study area. The Stochastic Frontier Production Function has been used by various researchers (Ndubueze-Ogaraku and Ogbonna, 2016; Orewa and Izekor, 2012 and Orewa and Izekor, 2012) in assessing the efficiency level of farmers. The Stochastic Frontier Production Function Model is expressed implicitly as:

$$Y_i = f(x_i;\beta) + \exp(V_i - U_i) \qquad (1)$$

Where:
Y_i = the quantity of agricultural output (Kg)
X_i = the vector of the input quantities
β = the vector of production function/unknown parameters to be estimated
e_i = the error term, comprising of a random error term V_i and inefficiency component U_i.

Therefore, the model for Technical Efficiency of maize farmers is specified as:
$$lnY_{ij} = \beta_o + \beta_1 lnx_{ij} + \beta_2 lnx_{2ij} + \beta_3 lnx_{3ij} + \beta_4 lnx_{4ij} + \beta_5 lnx_{5ij} + V_{ij} - U_{ij} \qquad (2)$$

Where:
ij is the j^{th} observation of the i^{th} farmers,
ln = logarithm to base *e*,
Y = output of the maize farmers produced (*kg* grain equivalent) *per/ha*
x_1 = farm size (in *hectares*)
x_2 = quantity of seed used (in *kg/ha*)
x_3 = labour used in production (in man-days/ha)
x_4 = quantity of agrochemicals used (in *litres/ha*)
x_5 = quantity of fertilizer used (in *litres/ha*)

β_0 *to* β_5 are the parameters to be estimated.

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The technical efficiency of individual farmers was determined by comparing their actual output (Y_i) with the maximum possible output (Y_i^*) achievable with the given technology, such that $\boldsymbol{0 \leq TE \leq 1}$ as given as:

$$TE = \frac{Y_i}{Y_i^*} = \frac{E(Y_i|U_i, X_i)}{E(Y_i|U_i = 0, X_i)} = E[exp(-U_i|\varepsilon)] \quad (3)$$

TE ranges from zero (0) to one (1). As such, value of one (1) for this study indicates that the maize farmer is completely efficient, while a value of zero (0) indicates complete inefficiency.

The technical inefficiency (TI) effects U_i is given by:

$$U_{ij} = \delta_o + \delta_1 z_{1ij} + \delta_2 z_{2ij} + \delta_3 z_{3ij} + \delta_4 z_{4ij} + \delta_5 z_{ij} + \delta_6 z_{6ij} + \delta_7 z_{7ij} \quad (4)$$

Where:
U_{ij} = TI of the i^{th} farmer,
z_1 = age of the respondents (in years),
z_2 = sex of the respondent, (male or female)
z_3 = marital status (unmarried and married),
z_4 = household size (number of persons in farmers household)
z_5 = education level (in years),
z_6 = farming experience (in years),
z_7 = extension contacts (Number of meetings)
δ_1 to δ_7 are parameters to be estimated.

Results and Discussion

Estimates of the Technical Efficiency of Small-Holder Maize Farmers in the Study Area

Table 1 shows technical efficiency of maize farmers in Oyo State. The independent variables (inputs) are, farm size, seeds, labour, Agrochemicals, and fertilizer. The value obtained for variance (sigma squared), σ^2 was 0.121 which was significant at 5% level of significance implying the model is a good fit to the data with less unexplained variability. The result also showed that Gamma γ was 0.767 implying that 76.7% of the total variation in Maize output is due to the technical inefficiency of the farmers. The result also indicated a loglikelihood value of -258.715 which implied that the model fits the data better and provides a more accurate representation of the relationship between the input

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variables and the output variable in the production function. In general, the higher the loglikelihood value, the better the model fits.

The result shows the independent variables (inputs), farm size, seeds, labour, Agrochemicals, and fertilizer were all positive and significant in this study. Farm Size showed a positive coefficient (0.3730) and statistically significant at the 1% level, indicating that an increase in farm size leads to higher maize production among farmers which has a substantial influence on maize output levels. This aligns with the findings of Abdulaleem *et al*. (2019). Seeds was statistically significant at the 5% significance level, suggesting that an increase in maize seed quantity corresponds to an increase in maize output among farmers. The quantity of seeds employed is intricately linked to output determination, exerting a notable impact on farmers' productivity, as evidenced by the study's results. The results showed that labour had a direct association with maize yield implying that increasing the number of labours would result in an increase in production. The coefficient was likewise significant at the 5% level of significance. This is consistent with the findings of Oluwakemi and Loy (2022).

Agrochemicals (comparing of pesticides and herbicides) and Fertilizer were both significant at 1% level of significance. The result agrees with a priori expectation that moderate and controlled increase in pesticides, herbicides and fertilizer application is expected to increase productivity and vice versa. The significant level at 1% indicates that Agrochemicals and Fertilizer were a major determinant of output of maize farmers in the study area.

Additionally, because it is significant, it means that fertilizer application is a major determinant of Maize production output in the study area. This corroborates the findings of Olusola *et al*. (2014) which indicated that fertilizer application had a positive relationship with Maize output.

Technical Inefficiency of Maize Production Function: MLE Function

The sign of the independent variable's coefficients in the inefficiency model is crucial for explaining the observed level of farmer efficiency. While a positive coefficient has the impact of increasing inefficiency and decreasing efficiency, a negative sign indicates that the explanatory variable has the effect of decreasing inefficiency and increasing efficiency.

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The analysis in table 2 revealed that the coefficient of Age (z_1) (0.3072) is negative and significant at the 1% level of probability. This suggests that older maize farmers demonstrate greater efficiency in their production processes compared to their younger counterparts within the study area. This agrees with the work of Olusola *et al*. (2014) where the coefficient of age was negative and significant at 5%. There is a positive correlation between farming experience and age. Sex (z_2) had a negative coefficient suggesting that being female is associated with lower inefficiency in maize production within the study area. However, the coefficient was found to lack statistical significance, indicating a high likelihood that the observed effect of gender on inefficiency may be attributed to chance rather than a genuine relationship. These findings are consistent with previous research by Fasakin and Akinbode (2020).

The coefficient of household size (z3) was negative ad significant at 10%, indicating that an increase in household size reduces the inefficiency of maize farmers, thereby enhancing their level of efficiency. This finding aligns with the anticipated expectations for household size, where an increase is presumed to increase farmers' efficiency levels due to greater access to labour resources. This finding is consistent with that of Oluwakemi and Loy, (2022).

The result also indicates that farming experience had a negative coefficient (-0.1535) and was significant at 10% level of significance. The negative coefficient implies that as farming experience increases, the inefficiency of the farming operation decreases. The result is consistent with that of Ebukiba *et al*. (2020) where their result revealed that farming experience was also significant at 5% level of probability and had a negative coefficient in regard to technical inefficiency of maize farmers. Extension Contacts (z_7) had a negative relationship with inefficiency, indicating that increased contact with extension services correlates with a reduction in inefficiency in the production process, thereby enhancing the efficiency of maize farmers in the study area. Moreover, the significance of the coefficient at the 10% level of probability suggests that this observed effect is unlikely to occur by chance. This agrees with the work of Oyewole and Oyewole, (2023) as they also had a negative value for the coefficient of extension workers in their work

Technical Efficiency Level of Maize Farmers.

The result as shown in table 3 showed that the level of the TE of maize farmers in the study area ranged between 0.422 and 0.961 with an average value of 0.746. The result also revealed that the majority (30.77%) of the maize farmers had TE between the range of 0.71

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Table 1: Stochastic Frontier Model: MLE (Parameters) for Technical Efficiency

Independent Variables	Parameters	Coefficient	Standard Error	*z*-ratio
Constant	β_0	7.8185	1.9125	4.0882***
Farm Size ($\boldsymbol{X_1}$)	β_1	0.3730	0.1526	2.4442***
Seeds ($\boldsymbol{X_2}$)	β_2	0.2202	0.0947	2.3252**
Labour ($\boldsymbol{X_3}$)	β_3	0.2172	0.1065	2.0403**
Agrochemicals ($\boldsymbol{X_4}$)	β_4	0.0988	0.0412	2.3949***
Fertilizer ($\boldsymbol{X_5}$)	β_5	0.8483	0.1662	5.1040***
Sigma squared (σ^2)		0.1213	0.0559	2.1705**
Gamma (γ)		0.7673		
Log Likelihood		**- 258.7156**		
Sample size (n)		**234**		

***** Significant at 1% level, ** Significant at 5% level**

Table 2: Determinants of Technical inefficiency among Small-scale maize farmers in the Oyo State

Independent Variables	Parameters	Coefficient	Standard error	t-ratio
Constant	δ_0	-5.4943	7.5260	-0.7300
Age (z_1)	δ_1	-0.3072	0.1226	-2.5064***
Sex (z_2)	δ_2	-1.5348	3.3291	-0.4610
Marital Status (z_3)	δ_3	-0.8420	1.5662	-0.5376
Household Size (z_4)	δ_4	-1.0132	0.5619	-1.8032*
Education level (z_5)	δ_5	0.2564	0.2804	0.9143
Farming experience (z_6)	δ_6	-0.1535	0.0842	-1.8230*
Extension Contacts (z_7)	δ_7	-3.8138	2.1455	-1.7776*

***** Significant at 1% level, * Significant at 10% level**

and 0.80. 29.49% of the maize farmers had technical efficiency scores between 0.81 and 0.90, while 2.14% had TE scores between 0.41 and 0.50. According to the mean TE score, on average, farmers were able to produce 74.6% of the maximum amount of maize using the inputs and technologies at their disposal in the study area. Thus, the maize yield could

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be increased by 25.4% with the existing level of resources available to them to be operating in the production frontier.

Table 3: Distribution of Maize farmers according to their Technical Efficiency Score

Technical Efficiency Score	Frequency	Percentages
0.41 – 0.50	5	2.14
0.51 – 0.60	13	5.56
0.61 – 0.70	66	28.21
0.71 – 0.80	72	30.77
0.81 – 0.90	69	29.49
0.91 – 1.00	9	3.85
Total	234	100.0
Minimum	0.422	
Maximum	0.961	
Mean	0.746	

Source: Field Survey, 2023

Conclusion and Recommendations

In this study, the technical efficiency of maize production in Oyo State, Nigeria was examined with the aid of stochastic production frontier model. The maximum likelihood estimate (MLE) revealed that efficiency of maize production in the study area is significantly influenced by seed, agrochemicals, fertilizer, labour and farm size. However, the mean technical efficiency was 0.746 which indicates that production can still be increased by 26.4% using available technology.

From the study, it was recommended that governments and stakeholders should provide affordable and subsidized input like fertilizers, seeds and herbicides as they were all positive and significant to maize production and also create policies that will make more land available to maize farmer in Oyo State which can help improve their level of efficiency.

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