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ANALYSIS OF MAIZE PRODUCTION EFFICIENCY IN SELECTED COMMUNITIES OF ORLU LOCAL GOVERNMENT AREA OF IMO STATE, NIGERIA

M.I. Abubakar and A.C. Onwujiobi

Department of Agricultural Economics, Usmanu Danfodiyo University
Sokoto, Nigeria

ABSTRACT

The study analyzed production efficiency and the factors influencing technical efficiency (TE), allocative efficiency (AE) and economic efficiency (EE) as well as the returns to scale of maize production in some selected communities of Orlu Local Government Area of Imo State, Nigeria. A multistage sampling technique was employed in selecting a sample size of 264 maize farmers in August 2021. Data on farmers' socio-economic characteristics, input and output quantities as well prices, farmland management practices and constraints to maize production among others were collected using pre-tested, structured questionnaire. Maximum likelihood technique was used to estimate the unknown parameters of the double log stochastic frontier production function. The results indicated that the efficiency score obtained under the TE were higher than those obtained in AE and EE, respectively. Education level and maize farmers' TE are negatively related with a coefficient of -0.0972 at (P<0.010) but significantly and positively contribute to AE with coefficient of 0.1837 at (P<0.01) and EE with coefficient of 0.1724 at (P<0.001), respectively. The results also showed that the mean TE, AE and EE were 97.5%, 46.5% and 45.0%, respectively, indicating that farmers still have room for improvement of their efficiency in maize production in the study area. The returns to scale were found to be 0.1216, 0.1557 and 0.4569, respectively, suggesting decreasing returns to scale. Herbicides and pesticides inputs had negative elasticity of production. It is recommended that a good pricing policy should be enacted which will serve as an incentive to farmers so as to encourage more people to go into farming and improve the AE of the maize farmers in the study area. Also, farmers should look for possible local means fighting of and controlling the threats of rodent and insect-pest destruction, erosion and flooding to enable them to achieve their full potential.

Keywords: Stochastic frontier; allocative efficiency; technical efficiency

INTRODUCTION

Agriculture is the mainstay of the people of Orlu Local Government Area. A great percentage of the population of Orlu earns their living directly or indirectly through farming while the rest were engaged in small and medium scale trading (Onwujiobi, 2021). Research has shown that farming is the chief occupation of the local people in Imo state, hence, its economic growth and development heavily relies on the functioning of the agricultural sector of which the crop sub-sector plays a vital role (Osuji and Onubuogu, 2018). The crop sub-sector involves the production of cash and food crops, notable among the food crops are yam, cassava, cocoyam and maize. Some of the cash crops produced in Imo state include oil palm, raffia palm, rice, groundnut, melon, cotton, cocoa, rubber and maize. Maize (*Zea mays*) is one of the predominant crops grown annually in Orlu. It is grown in this area using multiple cropping with the integration of other crops like cassava, *Telfera* (*ugu*), pepper, cocoyam, three-leaf yam and yam on the same piece of land. Maize is an annual crop with less gestation period compared to the aforementioned crops. It is grown in both subsistence and commercial quantities (Osuji and Onubuogu, 2018).

Maize has numerous potential benefits and uses. It is a very important crop which serves as a source of food, income, employment, foreign exchange and raw materials for industries. Maize can be processed into a variety of food and industrial products including starch, sweeteners, oil, beverages, adhesive (glue), industrial alcohol and fuel ethanol. Maize is increasingly used as feedstock for ethanol fuel production (Ohajianya *et al*., 2010). Maize is one of the most widely consumed cereal crops in Imo state, and a staple of great socio – economic importance (Onwujiobi, 2021). The Government of Imo State and donor agencies have formulated and implemented some policies and programmes aimed at increasing maize output (Ohajianya *et al*., 2010). Maize production notwithstanding can be increased by increasing the farm – size, quantity of seeds, size of labor and expenditure on fertilizer and other agro – chemicals. Another way of increasing the production of maize to ensure food availability and security is by enhancing efficiency in the combination of the available resources.

Production efficiency is an economic term describing a level in which economy or entity can no longer produce addition amount of goods without lowering the production level of another product. In economics, an economy is said to be producing efficiently when it cannot make anyone economically better off without making someone else worse off. Productive efficiency occurs when an economy cannot produce more of one good without producing less of another good (Samuelson, 1948). According to Adeyonu *et al*. (2019) economic efficiency in agriculture implies getting the maximum amount of output per hectare of land cultivated or per animal, with the least cost of production in terms of manpower and other inputs.

Ecological problems like erosion, flooding, constant heavy rainfall and low soil fertility are peculiar constraints militating against maize production in Orlu local government area (Onwujiobi, 2021). In fact, soil erosion occurs at unsustainable levels when small rills are recognizable in a field. Soil conservation techniques are therefore tools which the farmer can use to prevent soil degradation and build organic matter (Afolabi, 2015). Also, there has been continuous increase in the demand for maize, which makes the demand outweighs the supply in the area (Ebukiba *et al*., 2020). Over the years, it has been observed that maize farmers are not combining their resources in a more efficient manner in Imo state as whole. This necessitates the need quantify the current levels of efficiency so as to estimate losses in production that could be attributed to inefficiencies in maize production in Orlu Local Government Area of Imo state, Nigeria.

Many researchers have carried out economics of maize production in Nigeria. The study by Alabi *et al*. (2020) on maize production in the country focused on economic market decisions among marginal maize farmers. The research works by Ebukiba *et al.* (2020) and

Shehu *et al*. (2017) on efficiency of maize production focused on technical efficiency and resource use efficiency, respectively. Ohajianya *et al.* (2010) focused on allocative efficiency among maize farmers in Imo state, Nigeria. Despite this, efforts have not been made to analyze maize production efficiency in Orlu area of Imo state, Nigeria.

The objective of this study is therefore, to analyze the productive efficiency among maize farmers in Orlu local government area of Imo state, Nigeria; determine the technical, allocative and economic efficiency levels of maize farmers and estimate the determinants of these efficiencies of maize production in the study area.

METHODOLOGY

Study Area

The study was conducted in Orlu local government area of Imo State, Nigeria. The area lies between latitude 05°47’47’’ or 5.79639° North of the equator and longitude 07°20’20’’ or 7.03889° East of the Greenwich meridian, which falls in a tropical rainforest zone of the South – eastern zone of Nigeria. According to the national population census, Orlu has an estimated population of 196,900 people in 2006 (National Population Census, 2016), and the population density varies from 230 – 1,400 people per square kilometers (Imo state Diary, 2010). The population growth rate is 3% per annum thereby giving a projected population of 202,798 in 2023.

Orlu is one of the oldest names in Imo state which can be referred to as the people of a sub – group (mainly the Isu and Orsu, the Ukwuani) of Igbo found within the area. Orlu as a name represents a tribe which is also a senatorial district in Imo state, hence the name, Orlu senatorial zone, and this has 12 local government areas in Imo state. The city centre of the local government area is within the host towns of Amaifeke, Ihioma/Ebenese, Umuna, Okporo, Umuowa, Umutanze, Orlu-gedegwum and Owerri-ebeiri (Onwujiobi, 2021).

Sampling Procedure

The target population for this study consists of farm households who produce maize across communities in Orlu Local Government Area. Multistage sampling technique was used in the study area. Firstly, six (6) communities (Obibi-ochasi, Ogberuru, Owerri-ihitte, Ihioma, Okporo, and Umuowa) were selected purposively based on the intensity of maize cultivation and concentration of the farmers’ populations in these areas. A random sample of 264 respondents was selected out of a sample frame of 845 using Krejcle and Morgan (1970) Sample Table.

Data Collection

A structured questionnaire was developed to collect primary data from the farm households who produce maize across communities in Orlu Local Government Area. The respondents were asked to answer questions which elicited socio – economic characteristics information such as gender, education, farm size, age distribution, marital status, and household size as well as data about the respondents’ input-output such as seed, fertilizer, and labour through personal interviews with respondents in the study area.

Information on farmland management practices and production constraints encountered on Maize farms was collected using rank order. Five questions on farmland management practices and production constraints and researchers' personal field experience. Each of the farmer's interviewed was asked to choose the most important and least important farmland management practices and constraints to his/her Maize production in the study area.

Table 1: Sample size for the study

Communities	Sample frame	Sample size
Obibi-ochasi	178	59
Ogberuru	166	47
Owerri-ihitte	156	35
Ihioma	102	40
Okporo	128	49
Umuowa	115	34
Total	845	264

Analytical Techniques

Descriptive statistics and stochastic production frontier model were employed to analyze the data gathered for the study. Descriptive statistics was used to analyze framers' socio-economic characteristics, farmland management practices as well as production constraints. SFA was used to analyze TE, AE and EE. The relationships between farmers' socio-economic characteristics with maize production efficiency were analyzed using maximum likelihood estimation procedure.

Model Specification

The stochastic frontier function model, through the maximum likelihood estimation procedure is preferred in empirical analysis and found to be asymptotically more efficient than the method of ordinary least square (Gulak and Obi-Egbedi, 2019). The TE of an individual farm firm is defined in terms of the ratio of observed output (Yi) to the corresponding frontier output (yi*) conditional on the level of inputs used by the firm, and given the available technology. Therefore:

$$\mathrm{T}\frac{E_i yi}{yi} * i.e\ TEi\ = \frac{\exp(x_i'\beta + v_i - u_i)}{\exp(x_i'\beta + v_i)}\ \ \mathrm{TEi} = \exp\ (\ -\ u_i)\ldots\ldots\ldots (1)$$

Where:

TEi = Technical Efficiency of the *ith* farmer

Yi= observed output from the *ith* farm

yi* = Frontier output.so that 0$\leq$ TEi$\leq$1. Thus, the technical inefficiency is equal to 1-TE.

Following Obi-Egbedi and Gulak (2019) a two-stage estimation procedure was used in this study to run the stochastic production function. Sochastic production frontier was used to determine the mean technical efficiency levels of the respondents and the contribution of each input to productivity. The empirical stochastic frontier model used the Cobb-Douglass specification for the analysis of TE of maize farms. The cob-Douglass functional form was frequently employed in related efficiency studies (Mohammed, 2012; Shuaibu, 2019).

Stage I: Double-log Cobb-Douglass production function was used to estimate the TE, AE and EE of Maize farmers in the study area.

The double log Cobb-Douglass production model used for this study is as shown below:

$$\text{In}Y_i = \beta_0 + \beta_1 \text{In}X_1 + \beta_2 \text{In}X_2 + \beta_3 \text{In}X_3 + \beta_4 \text{In}X_4 + V_i - U. \text{............(2)}$$

Where:

Y = Output of maize from the ith farm.

X_1 = Farm size (hectares).

X_2 = labour (mandays).

X_3 = Quantity of seeds (kg)

X_4 = Fertilizer (kg)

X_5 = Herbicides and pesticides (litre)

β_0 = Intercept.

β_i = (I = 1,2,...,4) regression coefficients estimated while V and U are as defined earlier and ln is the natural logarithm.

Stage II: To examine the factors influencing the technical efficiency score, the independent variables hypothesized to determine technical efficiency are explicitly stated as:

$$Ui = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 \text{......................................(3)}$$

Where:

Ui = Transformed efficiency variable:

Z_1 = Education level of the farmer.

Z_2 = Age of the farmer (years).

Z_3 = Farming experience (years).

Z_4 = Household size

Z_5= Farmland management practices, while $\delta_1, \delta_2, \delta_3, \delta_4$ and δ_5 are parameters to be estimated.

The β's and α's are scalar parameters that were estimated, which reflect the elasticity of the agricultural inputs on output.

RESULTS AND DISCUSSION

Descriptive Statistics of the Variables Used in the Study

The summary of variables analyzed using descriptive statistics in this study is presented in Table 2. The results showed that the average maize output in the study area stood at 2.85kg/ha with an average farmland cultivated as 0.52 ha which implies that majority of the maize farmers in Orlu LGA are small scale farmers. This could be attributed to the limited availability of farmland due to land fragmentation as observed by Ohajianya *et al*. (2010); Mbanasor and Obioha (2003). About 42% of the farmers were females, more than half had secondary education. This implies that there is a good literacy level among maize farmers in the state. The average age and years of experience in farming of the respondents were about 51 and 29 years respectively, which implied that they are middle-aged farmers and were quite experienced in the study area. Also, the estimated means were lower than the highest efficiency level of 1. This is an indication that high inefficiency exists in maize production in the study area.

Table 2: Summary of descriptive statistics of efficiency and inefficiency variables

Variables	Average	Minimum	Maximum
Output (kg)	8890.625	1900	25250
Farm size (ha)	0.52	0.067	2.133
Seed(kg)	122.5	28	400
Fertilizer (kg)	3043.75	3000	10000
Agrochemicals (liters)	26.175	6	93
Labour (man-days)	129.761	50.1	286.8
Inefficiency variables			
Age (years)	51.21	23	78
Farm Exp (years)	28.72	4	65
Household size (persons)	7.27	2	15
Educational Level (years)	2.63	1	6

Efficiency Measurement

The frequency distribution and mean (average) of the efficiency estimates from the stochastic frontier analysis (SFA) are shown in Table 3. The estimated efficiency scores ranged between 0.30 and 1.00 for TE, AE and EE. The results indicated that the efficiency score obtained under the TE were higher than those obtained in AE and EE, respectively. The computed mean (average) values were 0.975 for TE, AE (0.465) and EE (0.450), respectively. The mean TE is 0.975, suggesting that about 99.62% of the farmers (ranging from 0.850 – 1.0) are frontier farmers since their efficiency scores are within the range of the mean (0.850 – 0.984) and above; only 0.38% of the farmers are seen operating below the mean technical efficiency. Some of the farmers attained optimal TE (a ratio of one). This is not in agreement with the findings of Adeyonu *et al*. (2019).

Table 3: Efficiency estimate from SFA production function

Efficiency score	TE Frequency	AE Frequency	EE Frequency
<0.30	0(0.00)	8(3.03)	10(3.79)
0.310 - 0.444	0(0.00)	135(51.14)	150(56.82)
0.445- 0.579	0(0.00)	60(22.73)	48(18.18)
0.580 - 0.714	0(0.00)	44(16.67)	48(18.18)
0.715 - 0.849	1(0.38)	16(6.06)	7(2.65)
0.850 - 0.984	111(42.05)	1(0.38)	1(0.38)
0.985 – 1.00	152(57.58)	-	-
Total	264(100)	264(100)	264(100)
Mean (Average)	0.975	0.465	0.450
Minimum	0.836	0.290	0.267
Maximum	1.000	0.956	0.852

Note: Figures in parentheses are percentages n = 264

Factors Influencing Maize Production Efficiency

The determinants of the efficiency are the factors that influence the TE, AE and EE of the maize farmers in the study area. The factors consist of production factors such as farm size, quantity of seeds, labor, fertilizer, herbicides and pesticides, and inefficiency factors such as age, education level, farming experience, household size and farmland management practices. The results of the factors influencing maize production efficiency are presented in Table 4. Farm size of farmers was positively and significantly influencing the level of TE in maize production at (P<0.01). This positive influence of farm size on level of TE indicates that any increase in the quantity of farm size is more likely to increase the TE of the farmer. The result is in conformity with that of Iheke (2008), Onyenweaku *et al*. (2004), Opong *et al.* (2016) but differs from Bravo-ureta and Evenson (1994), Bravo-ureta and Pinheiro (1997). Also, farmland management practice is positive and significant education and maize farmers' TE are negatively related (P<0.01), which implies that the number of farmland management practices the farmer employs increases his TE.

From Table 4, age of the farmers contributes significantly (P<0.05) and negatively to TE in maize production in the study area. The negative influence of age on level of TE indicates that as farmers grow older and gain less experience in maize production, they tend to be less knowledgeable about utilization of inputs more efficiently.

The results further showed that, education level of farmers significantly increased both AE with coefficient of 0.1837 (P<0.01) and EE with coefficient of 0.1724 (P<0.001).

Table 4: Maximum likelihood estimation of factors influencing efficiency in maize production

Variables	TE	AE	EE
Production Factors			
Constant	2.2546(0.0442)***	3.8489(0.9691)***	1.5435(0.1400)***
Farm size	0.1837(0.0666)***	0.1547(1.1480)**	0.0738(0.0725)
Seed	-0.0023(0.0074)	0.0001(-3.6314)	0.1198(0.0610)**
Fertilizer	0.0004(0.0006)	0.0004(0.0002)**	0.0524(0.0383)
Agrochemicals	-0.0667(0.0333)	-0.0002(-2.8305)	-0.0351(0.0324)
Labour	0.0019(0.0011)*	0.0007(0.6421)	0.2460(0.0712)***
Inefficiency factors			
Age	-0.0534(0.0226)**	0.0088(-0.9578)**	0.0104(0.0042)**
Farm Exp	-0.0047(0.0297)**	-0.0069(-0.7879)	-0.0067(0.0048)
Household size	-0.0023(0.0439)	0.0055(-0.6838)	-0.0038(0.0131)
Educational Level	0.0972(0.0241)***	0.1837(0.2231)***	0.1724(0.0522)***
Farm Mgt Pract.	0.0307(0.0763)***	-0.0229(-0.5365)	0.0031(0.0182)
Diagnostic Statistics			
Sigma Squared	0.1091(0.0963)***	0.1540(0.0265)***	0.1615(0.0302)***
Gamma	0.0002(0.0004)	0.8782(1.0007)**	0.8910(0.0569)***
Log Likelihood	-80.2968**	-2.566**	-65.1136**
LR test	17.9635**	2.5317**	26.5344**

Farmland Management Practices

The level of inefficiency recorded by a farmer may be due to several factors, among which are the human factors (Amaza *et al*., 2006) and ecological factors; technical inefficiency may occur due to lack of technical-know-how on the part of the farmer or due to presence of ecological problems which may partially or wholly destroy the farm thereby reducing or destroying in totality the output of the farm. Adequate use and efficient knowledge of the farmland management practices is very essential in production processes as it will help to minimize the negative effects of the ecological factors thereby reduce the losses that could be incurred due to the problems of these factors and improve the farmer's technical efficiency. Most of the farmland management practices integrated by the farmers are used as coping strategies to manage or reduce the negative effects of ecological factors. The farmers practiced a combination of farmland management practices. And these are presented hereunder in Table 5.

Table 5: Distribution of respondents according to farmland management practices

Farmland management practice	Frequency	Percentage	Total labour (man-day)	Rank
Mound making	263	99.62	9667.33	1st
Bush clearing	262	99.24	8900.03	2nd
Weed control	259	98.12	16384.15	3rd
Mulching	241	91.29	3238.51	4th
Bush burning	238	90.15	338.83	5th
Crossbar making	228	86.36	8380.55	6th
Ridging	222	84.09	8129.26	7th
Chemical fertilizer application	215	81.44	4581.81	8th
Bush fallowing & shifting cultivation	206	78.03	-	9th
Application of dung	190	71.97	3849.02	10th
Remoulding	112	42.43	2475.08	11th
Crop rotation	72	27.27	-	12th
Drainage making	23	8.68	200.24	13th
Cover cropping	8	3.03	60.94	14th
Total			65,853.61	

*Multiple responses

Constraints to Maize Production

Constraints to Maize production are presented in Table 6. A total of 15 constraints were identified by the respondents as presented in the table. Result shows that the most important constraint to maize production in this area is rodent and insect pest destruction (98.48%), followed by inadequate fertilizer (78.03%). This problem, in most cases tremendously affects the output of maize as the rodents can eat up full ears of maize and damage the rest on a farm. According to the respondents there is no appropriate chemical that could be used in the control of rodents and other damaging agents without having a negative implication on human health. Few farmers resorted to the use of scarecrow while the rest are helpless. On the other hand, insect – pests affect the output of maize both on the farm and during storage, as it affected the quantities of maize stored this year for the next farming season.

Table 6: Constraints in maize production

Constraints	Frequency	Percentage	Rank
Rodent and insect pest destruction	260	98.48	1st
Inadequate fertilizer	206	78.03	2nd
Inadequate government support	183	69.32	3rd
Constant rainfall, flooding and erosion	121	45.83	4th
Use of crude implement	56	21.21	5th
Inadequate land	48	18.18	6th
Epiphytic weed, weeds and plant disease	47	17.80	7th
Poaching/theft	46	17.42	8th
Low output and output price	42	15.91	9th
Inadequate labour	32	12.12	10th
Lack of improved seeds and expensive planting material	16	6.06	11th
Late rainfall and seasonal production	14	5.30	12th
Inadequate extension services	4	1.52	13th
Personal health issue	3	1.14	14th
Palm tree and other forest tree canopy	2	0.76	15th
Total	1050*	409.08*	

*Multiple responses

CONCLUSION

Based on the findings of this study it can be concluded that the efficiency of maize production recorded substantial inefficiencies, but opportunities still exist for improvement of such in the study area. The efficiency scores obtained under the technical efficiency (TE) were higher than those obtained in allocative efficiency (AE) and economic efficiency (EE), respectively. The inefficiency results further revealed that, education level of farmers significantly increased both allocative efficiency (AE) and economic efficiency (EE). Rodent and insect pest destruction, inadequate inorganic fertilizer, inadequate government support, frequent rainfall, flooding and erosion were the five most important constraints limiting maize production in the study area. The returns to scale values recorded are suggesting decreasing returns to scale scenario, which in the long run, maize output will increase less proportionately to increase in inputs. Herbicides and pesticides inputs had negative elasticity of production, implying that as the level of the inputs used increases, maize output will decline. This study, therefore, suggests that farmers should look for possible local means of fighting and controlling the challenge of rodent and insect-pest destruction, erosion and flooding to enable them to achieve their full potential.

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