International Journal of Agricultural Science, Research and Technology in Extension and Education Systems (IJASRT in EESs)
Available online on: http://ijasrt.iau-shoushtar.ac.ir
ISSN: 2251-7588 Print
ISSN: 2251-7596 Online
2023: 13(1):11-22, DOR: 20.1001.1.22517588.2023.13.1.2.8

Received: 07 March 2023
Reviewed: 17 March 2023
Revised: 21 March 2023
Accepted: 27March 2023

Profitability and Technical Efficiency of Maize-Based Cropping System Farmers in Ondo State, Nigeria

Tolulope Seun Olubunmi-Ajayi[1*]; Taye Timothy Amos[1]; Emmanuel Adesina Borokini[2]; and Oluyede Adeleke Aturamu[3]

[1]*Department of Agricultural and Resource Economics, Federal University of Technology, Akure, Ondo State, Nigeria.*
[2]*Department of Agricultural Extension and Management, Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria.*
[3]*Department of Agricultural Science and Technology, Bamidele Olumilua University of Education, Science and Technology, Ikere-Ekiti, Nigeria.*
**Corresponding email: tolulopeolubunmiajayi@gmail.com*

Abstract

This study was carried out to evaluate the technical efficiency of maize-based cropping systems in Ondo State, Nigeria. Primary data were used with the aid of a well-designed questionnaire. A multistage sampling procedure was used to randomly select 160 respondents. The data collected were analyzed using descriptive statistics, budgeting technique, and stochastic frontier production function model. The results of the budgetary technique revealed that the average gross margin per hectare was ₦17,715.03, ₦53,230.76, and ₦14,651 for sole maize cropping system, maize-cassava cropping system, and maize-yam cropping system, respectively. It was shown that household size and access to credit were the main determinants of the technical efficiency in sole maize cropping pattern, while access to credit and farming experience were the main determinants of technical efficiency in maize-cassava. In maize-yam, educational level and household size significantly affected technical efficiency. Farmers in the study area were producing at about 76% efficiency in sole maize cropping system, 89% efficiency in maize-cassava cropping system, 82% efficiency in maize-yam cropping system. The elasticity of variables inputs was 0.18 in sole maize cropping system, 0.61 in maize-cassava cropping system, and 0.33 in maize-yam cropping system. This indicates that all the maize-based cropping system had decreasing return to scale; therefore, the cropping systems fell within the rational stage of production surface. The implication is that maize-based farmers have not attained maximum efficiency in term of their production. Therefore, policy attention should be directed towards appropriate production technique that would improve productivity in the study area.

Keywords: Cropping Systems, Maize, Productivity, Technical Efficiency

1. Introduction

Nigeria has a total land area of about 98.3 million hectares out of which 71.2 million hectares (72.4%) are cultivable but only 34.2 million hectares (34.8%) are under use (Abang et al., 2001; Fatuase, 2017). Agricultural production is still highly dominated by the small holder farming system. The farms are dominated by small scale farmers who are responsible for about 95% of total production (Olutumise and Oparinde, 2022). This is not unconnected with the unattractiveness of agriculture which is a result of lack of necessary infrastructures in the rural areas which forms the bulk of agricultural zones in the country. In addition, small scale agriculture has in the time past suffered from limited access to credit facilities, modern technology, farm inputs and inefficient use of resources. Nevertheless, it is on record that 50% of world's population is dependent on subsistence agriculture (Ojo, 2000; Fatuase, 2017).

Maize is a major cereal consumed by nearly all Nigerian households (FAO, 2003; Oladoyin, 2022). It has great dietary and economic importance. Since the 19th century, maize has become the prime source of grain for feeding monogastic animals, especially in those parts of the country where cassava cannot be grown (Salau, 2013; Onu et al., 2018). Apart from animal feeding, it is the key to agro-allied industrial raw materials from which many products are manufactured. With regards to food, processed maize is used in several ways-'ogi', 'Eko' (wrapped semi-solid pap), with 'moinmoin'. It can be eaten as roasted or boiled; it can also be cooked along with beans. In some local areas, it can be pounded along with yams, cocoyam and water-yams (Oladoyin, 2022). Maize is of great importance to the people of Ondo State. The consumption of maize in western states of Nigeria varies between 2.6 and 2.8kg per person per week while it was estimated as 0.5 kg per person per week in Eastern States (FAO, 2003). Given this prime position of maize in the Nigerian economy, and given the fact that domestic supply has not been able to meet up with domestic supply; there is therefore the need to examine those factors that affect the profitability and efficiency of maize production.

Also, a key feature of the Nigerian agriculture is the dominance of the small-scale farms, which constitute an important and invaluable component of the Nigerian economy. It has been established that 90 percent of Nigeria's total food production comes from small farms and at least 60 percent of the country's population earn their living from these small farms. Therefore, effective economic development strategy will depend critically on promoting productivity and output growth in the producers since they make up the bulk of the nation's agriculture (Havnevik et al., 2007; Awunyo-Vitor et al., 2013). It has been realized that domestic production of food has not been able to meet the domestic demand for food crops (FAO, 2003; Oladoyin, 2022). The reason for this is that there are some problems at the micro level, one of which is the relationship between inputs used in production such as seeds, land, labour and capital. Also, it has been established that appreciable yield increase could be obtained through the use of modern technologies in production of crops.

Hence, this has been chosen as a vital way to improve total farm output and to curb food shortages because of its great impact on production. With the recent population explosion and the ongoing trend of continual increase in the population density, man may have no option than to make the best and most efficient use of the land available for farming as there may not be so much land as to allow for shifting cultivation (Norgrove and Hauser, 2015). The problem is that most rural farmers are not exposed to these new technologies and do not have access to the basic resources. In cases where they have been exposed to it, financial constraints will not afford them the opportunity to use. Hence, most farmers still depend on their old methods and manual labour for farming.

Again, as a result of the different uses into which maize can be put, there has been an increase in its demand over the years. It was reported that the domestic demand of 3.5 m metric tones far outstripped domestic production of 2.0 m metric tones, hence the increase in its price. To increase domestic demand, various efforts were made by various governments to raise the level of production but with limited success. Price fluctuations, disease and pest infestation, storage facilities and efficiency of resource utilization are the identified causes of low maize production in Nigeria and Ondo State in particular (Akande 1994; Samuel et al., 2011; Onu et al., 2018).

In view of these, the study was carried out to examine the technical efficiency of maize - based farming systems farmers in Ondo State, Nigeria. The specific objectives were to: (i). describe the socio-economic characteristics of the respondents; (ii). determine and compare the cost, return and profitability of maize – based cropping systems in the study area; (iii). estimate and compare the technical efficiency of maize – based cropping systems farmers in the study area; (iv). ascertain factors affecting the technical efficiency of the respondents in the different maize-based farming system in the study area; and (v). identify main problems encountered by the farmers in the area.

The null hypothesis of the study was stated in null form (H_0) as: There is no significant difference in the gross margin mean of of the maize based farmers in the area.

2. Materials and Methods

The study was carried out in Ondo State, Nigeria. The state is one of the 36 states in Nigeria including Federal Capital Territory (FCT), Abuja. Ondo state was created out of former Ondo province of former Western state in 1976. It is bounded by the states of Kwara and Kogi on the north, Edo on the east, Delta on the southeast, and Osun and Ogun on the west and by the Bight of Benin of the Atlantic Ocean on the south. Ondo state includes mangrove-swamp forest near the Bight of Benin, tropical rain forest in the centre part, and wooded savanna on the gentle slopes of the Yoruba Hills in the north (Olutumise et al., 2021). Agriculture is the mainstay of the economy, and the chief cash crop products are cocoa, rubber, timber (teak and hardwoods) and palm oil while the chief food crops are maize (corn), rice, yams, cassava, vegetables, and fruits. The state, primarily inhabited by the Yoruba, a people with a tradition of living in towns, has a high proportion of urban dwellers. Akure, the state capital, is rapidly developing into a commercial and industrial centre.

The study made use of primary data. The data were collected using a well-structured questionnaire administered to the maize – based farmers in the study area. The administration of the questionnaire was done through a well-trained enumerator from the state Agricultural Development Programme (SADP) after which the instruments have been thoroughly checked by the experts in the fields of Agricultural and Resource Economics, and Crop production following Olutumise (2022). The test-retest approach was used to determine the reliability of the instrument and a Cronbach's Alpha coefficient of 0.819 was gotten. Data were collected on the socio-economic variables such as age, level of education, sex, farming experience of the farmers, farm size, as well as the input-output data of the farmers. The output data include yield of maize in kg. The input data were labour, fertilizer and seeds. The research made use of purposive sampling technique in selecting two Local Government Areas (LGAs). The LGAs are Akoko South West and Akoko North East out of 18 LGAs in Ondo State. The selection was made based on the presence of large numbers of maize growers in the areas. In each of the LGAs, five communities were randomly selected and also from each of the communities, thirty-two respondents were randomly selected, thus making one hundred and sixty (160) respondents altogether. The study made use of qualitative and quantitative techniques to analysis the data. The qualitative method used descriptive statistics such as percentages and frequency distribution and mean, and this was used in describing the socio-economic characteristics and the different maize-based farming system of the respondent. The quantitative method involved the use of budgetary analysis and econometric methods. Budgetary analysis was used to determine the costs, return and profitability of maize – based cropping systems in the study area while Stochastic frontier production function was used to determine the technical efficiency of the farmers.

Budgetary technique: Net revenue (NR) was estimated by the difference between the total revenue and total cost while gross margin (GM) was estimated by the difference between total revenue and total variable cost. The GM and NR were estimated in the Equations (1), (2), and (3).

$$GM = TR - TVC \quad \ldots\ldots (1)$$

$$NR = GM - TFC \quad \ldots\ldots (2)$$

$$\text{Or } NR = TR - TC \quad \ldots\ldots (3)$$

Where: GM = Gross Margin, TR = Total Revenue, TVC = Total Variable Cost, NR=Net Revenue and TFC = Total Fixed Cost and TC = Total Cost.

Stochastic frontier production function (SFPF): SFPF was used to estimate technical efficiency of the farmers in the study area, as well as ascertain factors affecting the technical efficiency of the respondents in the different maize-based farming system in the study area. Stochastic frontier is implicitly expressed as shown in the Equation (4):

$$Y_i = f(X_j, \beta_j)\, e^{(vi-ui)} \quad \ldots\ldots (4)$$

Where Y_i is the output in a specified unit, Xj denotes the actual vector of inputs used in the production process, β_j is the vector of production function parameters, while v_i and u_i are the two error terms in the regression model. v_i is assumed to be independently and identically distributed as N (0, $\sigma^2{}_v$) and it is independent of v_i. vi is a one-sided component, which reflects technical inefficiency relative to stochastic frontier and identically distributed as | N (μ, $\sigma^2{}_u$) |. μ_i measures the technical inefficiency relative to the frontier and describes the distance of firm i-th from the frontier output (Battese and Coelli, 1995).

The technical inefficiency of individual farm was empirically measured from expected value of inefficiency error term (v_i) conditional on overall decomposed error $\varepsilon_i = (v_i - u_i)$ such that technical efficiency (TE) can be calculated as index value ranges from zero to one, i.e., $0 \leq TE \leq 1$.

Model Specification

The choice of suitable functional form for the analysis was subjected to generalized likelihood ratio test, which lead to the choice of Cobb-Douglas functional form was defined as in Equations (5), (6), and (7) below.

$$\ln Y_i = \text{Ln } A + \sum_{i=1}^{5} \beta_i \text{ Ln } X_i + V - U \quad \ldots\ldots (5)$$

$$Y = b_0 + b_1X_1 + b_2 X_2 + b_3X_3 + b_4X_4 + b_5X_5 + (v_i - u_i) \ldots\ldots\ldots\ldots\ldots \quad (6)$$

$$\ln Y = b_0 + b_1\ln X_1 + b_2\ln X_2 + b_3\ln X_3 + b_4\ln X_4 + b_5\ln X_5 + (v_i - u_i) \ldots (7)$$

Where: subscript i refers to the observation of the i[th] farmer and
Y_i = total output produced (kg)
X_1 = Cost of labour (Naira (N))
X_2 = Agrochemicals (Naira (N))
X_3 = Cost of planting materials (Naira (N))
X_4 = Depreciation cost on implements (Naira (N))
X_5 = Cost of fertilizer (Naira (N))
β_i = the parameter to be estimated
In = natural logarithm
V_i = random error assumed to be independent of ui identical and normally distributed with zero mean and constant variable $N(0,\delta^2v)$
U_i = technical efficiency effects of production which are assumed to be independent of vi, they are non-negative truncation of zero or half normal distribution with $N(0,\delta^2v)$
V = random variables

Technical inefficiency model

The technical inefficiency model is defined to estimate the influence of some farmers socio-economic variables on the technical efficiency of the farmers (Fatuase, 2017).

The model is specified by where U_i is expressed as in the Equations (8) and (9).

$$U_i = \delta_0 + \sum \delta_i Z_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (8)$$

$$U_i = \delta_0 + \delta_1Z_1 + \delta_2Z_2 + \delta_3Z_3 + \delta_4Z_4 + \delta_5Z_5 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (9)$$

Where:
U_i = Technical inefficiency effect
Z_i = Education (year spent in school)
Z_2 = Farming experience in years
Z_3 = Household size (number)
Z_4 = Membership of cooperative society (1 = member and 0, otherwise)
Z_5 = Age (years)
δ_i = Unknown scalar parameters to be estimated where i = 1,2,3 represents the factors which influenced efficiency of the farmers.
δ_0 and δ_i = parameters to be estimated together with the variance parameter.

$\sigma^2s = \sigma^2 + \sigma^2v$

$\sigma^2 = \sigma^2v + \sigma^2u$

$\lambda = \sigma u / \sigma v$

$\gamma = \sigma^2u / \sigma^2v$

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.

3. Results and Discussion

3.1 Socioeconomic Characteristics of the Respondents

From the Table 1, it was revealed that the farmers were practicing three cropping patterns: Sole maize, maize-cassava cropping pattern and maize-yam cropping pattern. While maize-yam has the highest number of respondents, maize-cassava has the lowest number of respondents. The mean age was 43 years for sole maize cropping pattern, 49 years for maize-cassava cropping pattern, and 45 years for maize-yam cropping pattern. This show there is no serious difference in age of different maize-based farmers, all of them are young and they are in active farming years. The results showed that the household size ranged from 1 to 10 with mean household size of 6 for sole maize cropping pattern, 5 for maize-cassava cropping pattern, while 7 for maize-yam cropping pattern. Large household size would enhance savings in cost of labour used in maize-based cropping system. The mean year of farming experience for sole maize cropping pattern is 11.18 years, 20.82 years for maize-cassava cropping pattern, 14.71 years for maize-yam cropping pattern. Majority of the respondents had one form of western education or the other. This level of education would enable them in decision making, especially on the adoption of new technologies and innovations (Ogundari and Ojo, 2007). Farmers with higher level of education are likely to be more efficient in the use of inputs than their counterparts with little or no education. The Table also revealed that maize-yam cropping system farmers are more educated than both sole maize cropping system farmers and maize-cassava cropping system farmers. Majority of the respondents rely on informal sources of credit for financing their maize-based farming operations in the study area. This might be because the farmers were unable to cope with high interest rates charged by most of the commercial banks as well as inability to have enough collateral securities required to obtain loan from these formal financial institutions. This was in line with Aminu et al. (2013), Fatuase (2017) and Olutumise (2022) who also recorded low access to credit in their various studies carried out in southwest Nigeria. In sole maize cropping pattern, the mean value of loan obtained by the farmers was ₦94,642.86, in maize-cassava the mean value of loan obtained by the farmers was ₦55,090.91, in maize-yam the mean value of loan obtained by the farmers was ₦59,333.33. In sole maize cropping system farmers, the average mean hectare of land cultivated was 2.04ha, 1.91ha in maize-cassava cropping system, while maize-yam cropping system farmers cultivated 3.60ha. This implies that majority of the farmers in the study area are small scale farmers and this was also reported by Ojo (2000) that most crop farmers in Nigeria are smallholders.

3.2 Costs and Returns Analysis

Table 2 shows the analysis of cost incurred by the farmers in the study area. Statistics reveals that cultivated sole maize farmers, cost of labour accounted for 44.94% of the total cost, while that for maize-cassava was 59.57% and that for maize-yam was 44.02%. Therefore, labout cost contributes to the production of maize as also reported by Fatuase et al. (2015) and Olutumise and Oparinde (2022). The overall percentage share of depreciation cost (TFC) out of the total cost (TC) was 26.04% for sole maize cropping system, 6.10% for maize-cassava cropping system, and 29.04% for maize-yam cropping system. Total Variable Cost (TVC) share out of the Total cost was 73.96% in sole maize cropping system, 93.90% in maize-cassava cropping system, and 70.96% for maize-yam cropping system. The fact that labour accounted for the largest share of the total cost is an indication that labour is an important determining factor in the different maize-based farming systems.

Again, Figure 1 reveals that the mean revenue per hectare for sole maize was ₦42,745.09 per ha, that for maize-cassava was ₦ 82,445.04, and that of maize-yam was ₦26,461.66 per ha. Sole maize farmers had highest revenue which ranges between ₦150001 and ₦200000, maize-cassava and maize-yam had highest revenue more than ₦200000.

Table 2 present the gross margin involved in maize-based cropping systems production in the study area. The cost elements in the Total Variable Cost include cost of labour, seeds, fertilizer, herbicides, pesticides. The revenue represents the sales accrued from maize, cassava, and yam. The Total Variable Cost (TVC) incurred by the producers in sole maize was ₦25,030.06 per hectare. For maize-cassava, it was ₦29,214.27 per ha but ₦31,810.66 per ha for maize-yam. While the Gross Margin (GM) was ₦17,715.03 per ha in sole maize, it was ₦53,230.76 per ha for maize-cassava, and ₦14,625.00 per ha for maize-yam. This implies that all the maize-based cropping pattern farmers in the study area were able to cover their total operating expenses per hectare and the production was profitable in the study area. Table 4 shows the net return of different maize-based cropping pattern in the study area. The total revenue (TR) for sole maize cropping system was ₦42,745.09 per hectare while the Total Cost (TC) was ₦33,841.69per hectare. Total Revenue for maize-cassava cropping pattern was ₦82,445.03 per hectare while the Total Cost was ₦31,110.98per hectare. Also, the Total Revenue for maize-yam cropping pattern was ₦46,461.66 per hectare while the Total Cost was ₦44,832.04per hectare. Gross margin per naira invested was ₦0.52 while the net revenue per naira invested was ₦0.26 for sole maize cropping system. For maize-cassava cropping system, the gross margin per naira invested was ₦1.71 while the net revenue per naira invested was ₦1.65 and for maize-yam cropping system, the gross margin per naira invested was ₦0.326 while the net revenue per naira invested was ₦0.0363. This finding indicates that maize-based cropping pattern cropping pattern is profitable in the study area but Maize-cassava is the most profitable cropping pattern in the study area.

Table 1. Distribution by the Socioeconomic Characteristics of the Respondents

Variables	Cropping Pattern					
	Sole Maize		Maize-Cassava		Maize-Yam	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Household size						
1-5	28	50.90	32	80.00	35	53.85
6-10	24	43.64	8	20.00	20	30.77
>10	3	5.46	-	-	10	15.38
Total	55	100.00	40	100.00	65	100.00
Mean	6		5		7	
Age						
21-30	25	45.50	1	2.50	7	10.70
31-40	5	9.10	28	70.00	31	47.60
41-50	16	29.00	7	17.50	11	17.00
51-60	3	5.50	2	5.00	12	18.50
≥ 60	6	10.90	2	5.00	4	6.10
Total	55	100.00	40	100.00	65	100.00
Mean	43		49		45	
Educational Level						
No formal Education	7	12.73	7	16.67	-	-
Primary Education	29	52.73	6	14.29	18	27.69
Secondary Education	10	18.18	20	50.00	18	27.69
Tertiary Education	6	10.90	6	14.29	28	43.08
Adult Education	3	5.45	1	2.38	1	1.54
Total	55	100.00	40	100.00	65	100
Years of farming Experience						
1 – 10	37	67.30	15	37.50	31	47.70
11 – 20	5	9.00	11	27.50	12	18.50
21 – 30	7	12.70	7	17.50	7	10.80
31 – 40	5	9.00	4	10.00	9	13.90
41 – 50	1	2.00	3	7.50	6	9.20
Total	55	100.00	40	100.00	65	100.00
Mean	11.18		20.82		14.71	
Income (N)						
≤ 100,000	25	44.83	30	75.00	35	53.57
101,000-200,000	10	18.18	-	-	9	14.29
201,000-300,000	11	20.69	8	20.00	9	14.29
>300,000	9	17.24	2	5.00	12	17.86
Total	55	100.00	16	100.00	28	100.00
Mean	94,642.86		55,090.91		59,333.33	
Farm size						
< 2.0	27	49.09	3	7.50	16	24.62
2.0 – 3.99	19	34.55	12	28.58	18	27.69
4.0 – 5.99	9	16.36	24	57.14	16	24.61
≥ 6.0	-	-	1	2.38	15	23.08
Total	55	100.00	40	100.00	65	100.00

Note: N means Naira (Nigeria currency)

Table 2. Distribution by Costs and Returns of the Respondents

Cropping Pattern	Sole maize	Maize-cassava	Maize-Yam
	Mean (₦ and %)	Mean (₦ and %)	Mean (₦ and %)
A: Variable Cost			
Cost of Labour	15211.83 (44.94%)	18533.08(59.57%)	19736.82(44.02%)
Cost of Maize seed	1763.88 (5.21%)	1904.71 (6.12%)	2209.33 (4.92%)
Cost of Cassava cutting	0	4350.26 (13.98%)	0
Cost of Yam bundles	0	0	6768.51 (15.09%)
Cost of vegetable seeds	0	0	0
Cost of Fertilizer	6600.40 (19.50%)	4397.62(14.14%)	2026.00 (4.52%)
Cost of herbicides	1440.65 (4.26%)	9633.22 (30.96%)	1070.00 (2.39%)
Cost of Pesticides	13.30 (0.04%)	28.60(0.09%)	0
Total variable Cost	25030.06 (73.96%)	29214.27(93.90%)	31810.66(70.96%)
B: Fixed Cost			
Land	7843.12 (0.23%)	837.969 (2.69%)	9843.55 (21.96%)
Depreciation cost on tools	968.51 (2.86%)	1058.75 (3.40%)	3177.83 (7.09%)
Total Fixed Cost (TFC)	8811.63 (26.04%)	1896.71(6.10%)	13021.38(29.04%)
C: Total Cost (TC)	33841.69 (100%)	31110.98 (100%)	44832.04 (100%)
Cropping Pattern	Sole maize	Maize-Cassava	Maize-Yam
Variables (Items)	(Mean in ₦)	(Mean in ₦)	(Mean in ₦)
Total variable cost (TVC)	25,030.06	29,214.27	31,810.66
Total Fixed cost (TFC)	8,811.63	1,896.71	13,021.38
Total cost (TC)	33,841.69	31,110.98	44,832.04
Total revenue / ha	42,745.09	82,445.03	46,461.66
Gross Margin /ha	17,715.03	53,230.76	14,651.00
Net Revenue /ha	8,903.40	51,334.05	1,629.62
GM/Naira Invested	0.52	1.7109	0.3268
NR/Naira Invested	0.2631	1.6500	0.0363

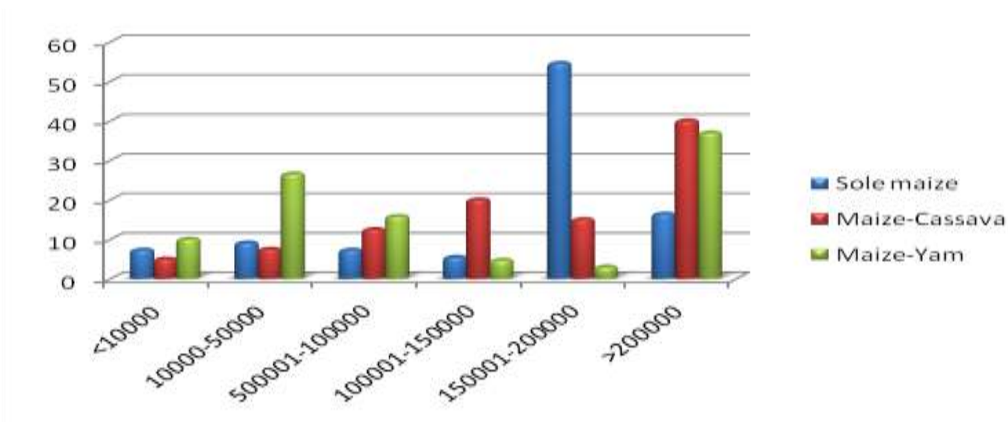

Figure 1. Distribution of the Respondents by accrued Total revenue

Test of Mean in the Gross Margin (GM)

The null hypothesis states that there is a significant difference in the profitability of maize-based cropping systems. From the Table 3, the null hypotheses for sole maize and maize-cassava were rejected likewise maize-cassava and maize-yam because both variables were significant at 5%. It was accepted for sole maize and maize-yam cropping system.

Table 3. Test of Mean of the Gross Margin

Pairs	Mean	Standard deviation	t	Significance
Sole-maize: Maize-cassava	77683.714	322242.1	2.407357	S
Sole-maize: Maize-yam	56838.42	234532.4	1.7973	NS
Maize cassava: Maize-yam	58854.67	276356.5	1.96035	S

3.3 Stochastic Frontier Estimates of Production Function Parameters

Table 4 revealed that in sole maize production, there is positive relationship between the revenue and each of cost of labour, cost of planting materials, and cost of fertilizer. Hence, the results follow *a priori* expectations whereas there is negative relationship between the farm output and each of cost of agrochemicals and cost of implements which mean that increase in these variables decrease output. This might be as a result of misuse of the agrochemicals and purchase of implements without using them. In maize-cassava, there is positive relationship between farm output and each of cost of labour, cost of fertilizer and cost of implements. There is negative relationship between the farm output and each cost of agrochemical and cost of planting materials. In maize-yam production, there is positive relationship between the farm output and cost of planting materials, cost of implements and cost of fertilizer and there is also negative relationship between farm output and each of cost of labour and cost of agrochemicals. The variables such as cost of implements, cost of planting materials and cost of fertilizer are significant at 5% level of significant in sole maize. Again, cost of planting materials and cost of labour are significant in both maize-cassava and maize-yam indicating that these factors were different from zero and thus important in maize-based cropping system. The signs and significance of the coefficients of the labour and planting materials is in conformity with the works on resource use efficiency of crop farmers in rural Nigeria by Aminu et al. (2013) and Fatuase (2017). Gamma (γ) obtained indicates that about 99% variation in sole maize, 51% variation in maize-cassava and maize-yam production among the farmers was as a result of differences in their technical efficiencies.

Table 4. Maximum Likelihood Estimate of the Stochastic Frontier Production Function

Variables	Cropping Pattern		
	Parameter	Coefficient	t-value
Sole Maize			
Constant	β_0	3.1672*	3.9793
Cost of labour	β_1	0.0099	1.1479
Cost of agrochemicals	β_2	-0.0361	0.7044
Cost of planting materials	β_3	0.3303*	3.0150
Cost of implements	β_4	-0.1489*	-2.3531
Cost of fertilizer	β_5	0.0220*	2.9614
Maize-Cassava Cropping Pattern			
Constant	β_0	3.9040*	2.3335
Cost of labour	β_1	0.0302*	2.2659
Cost of agrochemicals	β_2	-0.1184	-1.9278
Cost of planting materials	β_3	-0.0011*	2.9990
Cost of implements	β_4	0.3808	0.3987
Cost of fertilizer	β_5	0.3184	1.0958
Maize-yam Cropping Pattern			
Constant	β_0	1.3516	2.3557
Cost of labour	β_1	-0.1573*	-2.0876
Cost of agrochemicals	β_2	-0.0707	-0.2015
Cost of planting materials	β_3	0.0496*	3.6725
Cost of implements	β_4	0.3926	0.9501
Cost of fertilizer	β_5	0.1170	1.2015

Sole Maize cropping pattern: Log-likelihood function = 60.23 σ^2 = 0.39*. γ = 0.99*
Maize-cassava cropping pattern: Log-likelihood function = -59.32 σ^2 = 0.55*. γ = 0.51
Maize-yam cropping pattern: Log-likelihood function = -59.32 σ^2 = 0.62. γ = 0.51

Technical Efficiency Determinants

The estimated coefficients in the inefficiency model have important implications on the technical efficiency of the farmers. From Table 5, in sole maize cropping pattern, the coefficients of household size and access to credit are negative, in maize-cassava, coefficients of access to credit and farming experience are negatives, while in maize-yam, coefficients of educational level and household size are negative and are significant. This shows that they increase technical efficiency. However, the coefficients of educational level, farming experience and age are positive in sole maize, and in maize-cassava, coefficient of household, educational level and age are positive, in maize-yam, the coefficients of farming experience, age and access to credit are positive. This shows that these variables led to decrease in efficiency of the farmers.

Table 5. Technical Efficiency Determinants

Variables	Cropping Pattern		
	Parameters	Coefficient	t-value
Sole Maize			
Constant	δ_0	-3.0939**	-1.9722
Educational level	δ_1	1.0777	0.2111
Farming experience	δ_2	0.8537	0.1098
Household hold	δ_3	-0.8272*	-2.0952
Age	δ_4	0.4134	1.3570
Access to credit	δ_5	-0.1020**	-1.9633
Maize-Cassava Cropping Pattern			
Constant	δ_0	1.8074*	2.1081
Educational level	δ_1	0.2302	0.0547
Farming experience	δ_2	-0.0333*	-2.3493
Household hold	δ_3	0.0731	0.9684
Age	δ_4	0.0564	0.1907
Access to credit	δ_5	-0.0829*	-2.6414
Maize-Yam Cropping Pattern			
Constant	δ_0	-1.0079*	-1.9980
Educational level	δ_1	-0.0960*	-1.9677
Farming experience	δ_2	0.0322	1.5924
Household hold	δ_3	-0.0914*	-3.2067
Age	δ_4	0.0234	0.3275
Credit obtained	δ_5	0.3471	0.3769

*, ** Significant at 5% and 10%

Technical Efficiency Analysis

From Table 6, in sole maize cropping pattern, the frequency of occurrences of the predicted farm specific technical efficiencies ranged between 0.21 and 0.98. It ranged between 0.10 and 0.97 in maize-cassava and between 0.10 and 0.99 in maize-yam. In sole maize, a large proportion (69.08%) of the farmers had efficiency range of between 0.70 and 0.99 with mean of 0.76. It was (65%) with efficiency range between 0.50 and 0.89 and mean of 0.89 in maize-cassava. For the maize-yam, it was (53.84%) with efficiency range between 0.60 and 0.89 and mean of 0.82 indicating that the farmers in the study area are efficient. The implication of the mean technical efficiency of 0.76 in sole maize, 0.89 in maize-cassava and 0.82 in maize-yam from the analysis is that maize-based cropping system productivity could be increased by 30.92% in sole maize, 33.34% in maize-cassava, and 46.16% in maize-yam through better use of available resources as the wild range shows a considerable level of improvement for the farmers. Comparing the average technical efficiency from this study with other studies revealed that the technical efficiency from the study is not far from the findings of as Ogundari and Ojo (2007), Adedapo (2008), Ojo (2009), Adeyemo et al. (2010) and Aminu et al. (2013). Similarly, the technical efficiency from this study is higher than the one recorded by Ajibefun (2002) and Zalkuwi et al. (2010).

Analysis of Elasticity of Production and Returns to Scale

Table 7 shows that for the entire maize-based cropping systems, the estimated elasticity of explanatory variables of the stochastic model indicated that all the variables exhibited positive decreasing function to the inputs. This means that all allocation and use of each of these variables are in stage II of production surface that is the rational or efficient stage of factor usage. In order words, the maize farmers are capable of producing a given level of output at a minimum cost input ratio. The return to scale (RTS) presented in tables 18 and 19 was estimated to be 0.1772 for sole maize, 0.099 for maize-cassava, and 0.3312 for maize-yam showing that they were experiencing decreasing returns to scale. Therefore, maize-based cropping systems in the study area are in stage II, which is the stage of decreasing positive returns to scale. In order to increase efficiency at this stage, the use of input could be continued until the productivity of such input would reach its optimal level.

Table 6. Distribution of the Respondents by Technical Efficiency

Efficiency level	Cropping Pattern					
	Sole Maize		Maize-Cassava		Maize-Yam	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
0.00-0.19	-	-	7	17.50	6	9.23
0.20-0.29	3	5.45	3	7.50	5	7.69
0.30-0.39	3	5.45	2	5.00	4	6.16
0.40-0.49	2	3.63	4	10.00	5	7.69
0.50-0.59	4	7.27	4	10.00	2	3.07
0.60-0.69	5	9.09	8	20.00	7	10.76
0.70-0.79	8	14.54	6	15.00	21	32.30
0.80-0.89	18	32.72	5	12.50	3	4.61
0.90-0.99	12	21.81	1	2.50	12	18.46
Total	55	100.00	40	100.00	65	100.00

Table 7. Distribution by the Elasticity of Production and Return to Scale

Variables	Cropping Pattern		
	Sole Maize	Maize-Cassava	Maize-Yam
Cost of labour	0.0099	0.0302	-0.1573
Cost of agrochemicals	-0.0361	-0.1184	-0.0707
Cost of planting materials	0.3303	-0.0011	0.0496
Cost of implements	-0.1489	0.3808	0.3926
Cost of fertilizer	0.0220	0.3184	0.1170
RTS	0.1772	0.6099	0.3312

3.4 Problems Encountered in Maize-Based Farming Systems in the Study Area

Problem can be regarded as force that militates against human progress and development. Table 8 reveals the major problem encountered in all the farming systems in the study area. The problems vary in the degree of severity between the cropping systems. While sole maize farmers and maize-yam farmers ranked cost of labour as the most critical; it was ranked second by maize-cassava farmers. While sole maize farmers ranked bad road network first, it was ranked first by maize-cassava farmers and was ranked third by maize-yam farmers. Also while lack of storage facilities was ranked third by both sole maize and maize-cassava farmers, it was ranked second by maize-yam farmers. Price fluctuations was ranked fourth by both sole maize and maize-cassava farmers, it was ranked fifth by maize-yam farmers. The results were similar to the findings of Salau (2013) and Oladoyin (2022) among maize farmers in Niger and Ondo states, respectively. Formulating policy measures to ameliorate these problems will go a long way in boosting farmer's production level and increase the developmental process in Nigeria.

Table 8. Distribution of Farmers by the Main Problems Experienced

Problems	Cropping Pattern					
	Sole Maize		Maize-cassava		Maize-Yam	
	Freq.	Rank	Freq.	Rank	Freq.	Rank
High cost of labour	29	1st	10	2nd	21	1st
Price fluctuation	4	4th	4	4th	6	4th
Bad road network	11	2nd	20	1st	13	3rd
Lack of storage facilities	8	3rd	6	3rd	15	2nd
Total	55		42		65	

4. Conclusion and Recommendation

The study, having empirically examined the technical efficiency of maize-based cropping systems farmers, observed that the maize-based cropping patterns are all profitable in the study area but farmers have not attained their best. This has been confirmed by the presence of technical inefficiency effects in their operations. The study revealed that three types of maize-based cropping systems were common in the study areas. They are sole maize, maize-cassava and maize-yam. In sole maize cropping pattern, the average farm size was 2.04ha, it was 1.91ha for maize-cassava, and it was 3.60ha for maize-yam cropping system. The study also showed that in maize-based cropping patterns, farmers earned average net revenue of ₦42,745.09 per ha in sole maize, ₦82,445.03 per ha in maize-cassava, and ₦46,461.66 per ha in maize-yam. Thus, the gross margin per naira invested was ₦0.52 in sole maize, ₦1.71 in maize-cassava and ₦0.326 in maize-yam. Despite the profit earns in maize-based cropping system, maize-cassava made a significant difference in terms of total revenue, gross margin and the net revenue. The implication is that planting maize with cassava would yield more income if properly managed than any other cropping patterns with maize. The MLE estimate showed that in the sole maize cropping system, cost of implements, cost of fertilizer and cost of planting materials are significant in sole maize production. The technical efficiency level showed that all the maize-based cropping system farmers were efficient in their production process. The socioeconomic variables such as household size, access to credit, farming experience, and education are germane determinants of the technical inefficiency in the area. By implications, an educated and experienced maize-based farmer that have access to credit with a moderate household size will be technically efficient compare to their counterparts that do otherwise. Most importantly, farming experience make more significant influence when deciding on the maize-cassava pattern being the most profitable among the alternatives. They had mean of 76% efficiency in sole maize cultivation, 89% in maize-yam cultivation, and 82% in maize-yam cultivation. The return to scale shows that farmers were experiencing decreasing returns to scale in production with a value of 0.18 in sole maize cropping pattern, 0.61 in maize-cassava cropping pattern, and 0.33 in maize-yam cropping pattern. Therefore, maize-based cropping pattern production in the study area is at the rational stage of production surface. However, the maize-cassava system is more efficient and productive than the other patterns. Therefore, policy should be geared toward improving the maize-based cropping systems with attention to maize-cassava patterns, while farmers should be more enlightened by the extension agents to improve their allocation of resources. More experience farmers should be encouraged in the enterprise through incentives such as loan and subsidies of farm inputs, especially planting materials. Government should provide good road network that leads to both output and input markets, and also encourage farmers to use improved technologies because of high cost of labour. Storage facilities should be given priority by providing silos and other facilities that can be used to preserves maize and other crops. Price fluctuation should be critically and urgently addressed by the Government to safeguard the farmers from lost. The price can be control through a board system in line with a functioning storage facility.

References:

1. Abang, S.O., Ekpeni, E., Usani, W.W. (2001). Technical and Allocative Efficiencies of Small-Scale Growers in five selected Local Government Areas of Cross River State. Global J. Applied Sci., 7 (1): 102-106.

2. Adedapo, K.D. (2008). Technical Efficiency of Maize Farmers in Ogbomoso Agricultural Zone of Oyo State. International Journal of Agricultural Economics and Rural Development, 1(2): 102 – 107.

3. Adeyemo, R., Oke, J.T.O., Akinola, A.A. (2010). Economic Efficiency of Small-Scale Farmers in Ogun State, Nigeria. TROPICULTURA, 28(2): 84 – 88.

4. Aminu, F.O., Ayinde, I.A., Ambali, O.L. (2013). Effect of Ill Health on Technical Efficiency of Dry Season Vegetable Farmers in Ojo Local Government Area of Lagos State, Nigeria. World Journal of Agricultural Research, 1(6): 108 – 113. Dio:10.12691/wjar-1-6-3.

5. Awunyo-Vitor, D., Bakang, J., Cofie, S. (2013). Estimation of farm level technical efficiency of small-scale cowpea production in Ghana.

6. Battese, G.E., Coelli, T.J. (1995). A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data. 20: 325-332.

7. Fatuase, A.I. (2017). Climate Change Adaptation: A Panacea for Food Security in Ondo State, Nigeria. Theoretical and Applied Climatology, 124(3-4): 1 – 9.

8. Food and Agricultural Organization, (2003). FAO. Food and Agricultural Monthly Bulletin of Statistics, 5 (12): 23.

9. Havnevik, K., Bryceson, D., Birgegård, L. E., Matondi, P., Beyene, A. (2007). African agriculture and the World Bank: development or impoverishment? Nordiska Afrikainstitutet.

10. Iheke, O., & Amaechi, E. (2015). Effect of Land Fragmentation on Smallholders' Productivity in Imo State, Nigeria. International Journal of Agricultural Science, Research and Technology in Extension and Education Systems (IJASRT in EES), 5(3), 195-201.

11. Lawrence Balogun, O. (2011). Determinants of Poverty among Rural Households in South Western States, Nigeria. International Journal of Agricultural Science, Research and Technology in Extension and Education Systems (IJASRT in EES), 1(3), 99-104.

12. Norgrove, L., Hauser, S. (2015). Estimating the consequences of fire exclusion for food crop production, soil fertility, and fallow recovery in shifting cultivation landscapes in the humid tropics. Environmental management, 55, 536-549.

13. Ogundari, K., Ojo, S.O. (2007). Productivity Potential and Technical Efficiency of Agro-Forestry-Based Technologies in South-Western Nigeria. Journal of Agriculture and social sciences. Available at http://www.fspublishers.org.

14. Ojo, S.O. (2004). Improving Labour Productivity and Technical Efficiency in Food Crop Production: A Panacea for Poverty Reduction in Nigeria. Food Agric. Environ., 2(2): 227 – 231.

15. Ojo, S.O. (2009). Backyard Farming: A Panacea for Food Security in Nigeria. Journal of Human Ecology, 28 (2): 127 – 133.

16. Oladoyin, O. P. (2022). Evaluation of Profitability of Maize Production in Akoko South West Local Government Area, Ondo State, Nigeria. International Journal of Advanced Economics, 4(2), 30-39.

17. Olutumise, A. I. (2022). Determinants of market participation and preference for production of pepper (Capsicum spp.) among farmers in southwest, Nigeria. Heliyon, 8(9), e10585.

18. Olutumise, A. I., Oparinde, L. O. (2022). Climate Information and Health Variables as Determinants of Technical Efficiency: Insight from Food Crop Farmers. International Journal of Agricultural Science, Research and Technology in Extension and Education Systems (IJASRT in EES), 12(3).

19. Olutumise, A.I., Ajibefun, I.A., Omonijo, A.G. (2021). Effect of climate variability on healthcare expenditure of food crop farmers in Southwest, Nigeria. International Journal of Biometeorology, doi:10.1007/s00484-021-02079-z. Epub ahead of print. PMID: 33474613.

20. Onu, E., Natalia, P., Kruseman, G. and Fuylpanu, Y. (2018). Sub- Saharan African maizee – based foods technological perspectives to increase the food security. General Food Security 17:48 – 56.

21. Salau, S. A. (2013). Determinants of technical inefficiency among maize-based farming households in Niger state. Ethiopian Journal of Environmental Studies and Management, 6(5), 543-550.

22. Samuel, A., Saburi, A., Usanga, O. E., Ikotun, I., Isong, I. U. (2011). Post-harvest food losses reduction in maize production in Nigeria. African Journal of Agricultural Research, 6(21), 4833-4839.

23. Zalkuwi, J.W., Dia, Y.Z., Dia, R.Z. (2010). Analysis of Economic Efficiency of Maize Production in Ganye Local Government Area of Adamawa State, Nigeria. Report and Opinion, 2(7): 1 – 9.