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Appraisal of Efficiency of Fadama Maize Farmers in Osun State, Nigeria

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Authors' contributions

This research work was carried out in collaboration between the two authors FOO and RSO involved. Author RSO designed the study, wrote the protocol and the first draft of the manuscript. Author FOO reviewed the experimental design and all drafts of the manuscript. Author RSO managed and performed the analyses of the study. Both authors read and approved the final manuscript.

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ABSTRACT

This study appraised the efficiency of fadama maize farmers in Osun State, Nigeria. Data were collected from 180 respondents selected through multistage sampling technique with the aid of structured questionnaire supplemented with oral interview. The collected data were analyzed using descriptive statistics, budgetary technique and the stochastic frontier production function. Results of the analysis revealed that; 68% of the respondents were male, 93% were married, and 67.9% had formal education with average farm size of 5.95 hectares of land. The result further revealed that 75.5% of the respondents made use of family labour, and 5 was recorded as mean household size. The results of profitability analysis showed that ₦307,200 was the mean net revenue and Total Variable Cost (₦82,229.29) accounted for 95.5% of the Total Cost (₦86,067.97). The estimation of the stochastic frontier production function showed that age, cost of seed, depreciation and operating expenses were negatively correlated with farm output, indicating that an increase in these variables brings about decrease in farm output. Contrarily, a positive relationship existed

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between farm output and family labour; farm size as well as hired labour, implying that an increase in the variables results in increase in farm output. The result further revealed that farm size; family labour and cost of seeds were statistically significant at 1% i.e. these were the variables influencing the level of maize output in the study area. The Technical Efficiency (TE) of the fadama maize farmers varied significantly between 0.48 and 0.97 with a mean technical efficiency of 0.82. The inefficiency model results showed that number of times of livestock disturbance; variety of seeds grown and level of formal education coefficients were negative suggesting an increase in these variables decreased the technical inefficiency and consequently increased the efficiency. The proportion and prominent constraints reported by the farmers were; lack of storage facility (95.6%), high cost of fertilizer (64.8%), inadequate credit facility (54.1%) and bad road (50.9%). The study concluded that fadama maize production was a profitable and lucrative economic activity, having empirically examined and appraised the efficiency of fadama maize farmers in Osun State, Nigeria. It is now recommended that; fadama, farmers should be provided with credit facilities to enable them finance their farming enterprises, modern inputs should be made available to the farmers at affordable rate by the Agro service centers of each Local Government Area of the State and efforts should be made by research institutes to generate new improved technologies on fadama production.

Keywords: Appraisal; fadama; maize production; profitability analysis; technical efficiency.

1. INTRODUCTION

Nigeria is a food-deficit country that on many occasions has been dependent on food imports [1]. Its agricultural sector has ceased to be an important contributor to foreign exchange earnings; even its contribution to employment has declined. According to [2], the growth index of agricultural production for crops has shown a decline from 7.4 percent in 1986 to 3.4 percent in 1995. Most studies showed that aggregate food production in Nigeria has been growing at about 2.5 percent in recent years, but the annual rate of population growth has been at 3.5 percent [3].

Food production in Nigeria throughout the year is of necessity due to availability of large expanse of land for agricultural production [4]. With the projected annual population growth rate of 5.5 percent and food production annual growth rate of 3.2 percent in the country, there is the need for an improved agricultural production system in Nigeria [4]. There are agricultural production systems that could be explored to support an all year round food production (especially vegetables) and one of such is fadama system of farming [4]. The word “fadama” in Hausa local language (one of the Nigeria’s three largest tribes) means a low lying area which is susceptible to periodic seasonal flooding [5]. Fadama farming, therefore, implies cultivation or growing of crops under irrigation or in the river flood plain. This is because flood plains are inaccessible during the normal farming season.

Maize crop belongs to the grass family (Poaceae). It is ranked first as the most important cereal crop in sub-Saharan Africa. It provides food for more than 1.2 billion people in addition to other uses. Nigeria with an annual production of close to 8 million metric tons in 2013 is the largest producer in Africa. Maize is the third most widely grown crop in Nigeria, following sorghum and millet. It is highly productive, cheap, less rigorous to produce and adapts to wide range of agro ecological zones [6]. The rainforest agro-ecological zone of Nigeria is the major supplier of eating green maize, while the savanna zone in northern Nigeria comprising the (Derived Savanna, Guinea Savanna and Sahel) agro-ecological zones account for the large quantity of the pod [7]. Maize is not only an important cereal crop produced in Nigeria on the basis of output but also on the basis of number of farmers that produced it, as well as for its economic value [8]. An estimated 4.2 million hectares were harvested in 2013 with an average yield of 2 mt ha^{-1}. In addition to being an important source of food, many agro-based industries in Nigeria rely on maize as a source of raw material [9].

From the foregoing discussion, it is evident that Nigeria’s maize production industry is a growing diversified agricultural sector that holds the potential as a source of employment, food and raw material provision as well as enhancing non-oil export earnings, a vital policy for sustained national growth. In realization of the potentials of the maize industry, Nigerian government devoted considerable efforts to developing and disseminating information on viable production technologies, provision of better inputs and services for the local farmers to realize their full potential, in order to remain competitive in the

international market. The Federal and State governments also as a sign of interest to develop the industry, committed substantial amount of resources, through various ministries and departments by providing financial and technical assistance such as loans, grants, transfer and adoption of new technologies, supply of inputs at subsidy and providing enabling environment.

Despite these efforts, yield per hectare for maize in Nigeria is as low as 2.0 mt ha^{-1} far lower than world average which is 5.1 mt ha^{-1}. One important reason that could explain this low productivity is inadequate physical infrastructure, poor resources, in addition to low literacy level which limits the ability of the farmers to understand improved production technologies and fully utilize opportunities, other elements that are missing in the maize sector, are vital information and organizational factors essential to drive effective strategy for sustained growth. For instance, efficiency of production, a measure of the ability of a production unit to produce maximum output using available resources in the best possible way, given certain technological constraints, is generally low in Nigeria compared to international standards. In view of these facts, it is evident that there is the need to raise the level of technical efficiency in order to improved maize productivity. It is therefore imperative to study the performance of maize production industry across individual farms with a view to assessing how the existing inputs are utilized and possibilities that abounds for improving efficiency.

Due to the importance of maize in Osun State and some industries, there is need to estimate the costs and returns of fadama maize production and at the same time analyze the resource use efficiency in the production of this crop. In addition, the study will guide government, research workers and students of agriculture in re-focusing research efforts aimed at removing identified constraints in maize production.

2. METHODOLOGY

2.1 The Study Area

The study was based on fadama maize producers in Osun State, Nigeria. Osun State is one of the six states that made up South-Western Nigeria. It covers an area of appropriately 14,875 square kilometers, and located on latitude 7°30N and 7.50°N and between longitude 4°30E and 5°46E. It is bounded by Ogun, Kwara, Oyo, Ondo and Ekiti States in the South, North, West and East respectively. The state lies within the tropical rain forest. Traditionally, the people engage in agriculture and produce sufficient food and cash crops for domestic consumption, as input for agro-allied industries and for export. Other occupations of the people include cloth-weaving, mat-weaving, dying, soap making, wood carving, among many others.

2.2 Data Collection and Sampling Technique

The data, mainly from primary source, were collected from 180 fadama maize farmers selected using multi-stage sampling technique from three Local Government Areas with the aid of well-structured questionnaire. Egbedore, Ola-Oluwa, Atakumosa West and Ede North Local Government Areas “LGAs” were purposely selected at the first stage due to prominence of fadama farmers in the areas. The second stage was the use of simple random sampling technique to select, three towns/villages from each Local Government Area and finally, fifteen (15) respondents were selected from each three towns/villages.

2.3 Data Analysis

Both qualitative and quantitative techniques were employed in analysis of the data.

While Descriptive Statistics was used to analyze the socio-economic variables of the farmers and constraints militating against fadama maize production, Budgetary Analysis and Stochastic Frontier Production Function were used to analyze the costs and returns on fadama maize production and the resource use efficiency of the fadama maize production in the study area.

2.4 Budgetary Analysis

This was used to estimate the costs and returns on fadama maize production of the farmers in the study area. It is specified as follows;

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

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

$$TC = TVC + TFC \quad (3)$$

Where,

GM = Gross margin
TVC = Total Variable Cost
TC = Total Cost
TR = Total Revenue (This was obtained from kilograms of maize grains sold)
NR = Net Revenue
TFC = Total Fixed Cost

2.5 The Stochastic Frontier Production Function

This was used to analyze the resource use efficiency in fadama maize farming in the study area. According to [10], the production technology of the farmers was assumed to be specified by the cobb-douglas frontier production function that is defined by:

$$InYi= In\beta_0+\beta_1InX_1+\beta_2InX_2+\beta_3InX_3+\beta_4InX_4+\beta_5InX_5+\beta_6InX_6+\beta_7InX_7+Vi-Ui$$

Where;

Yi = Farm output in monetary terms (₦)
Xi = Vector of inputs used measured in units (kg or ha or ₦)
X_1 = Farm size (in hectares)
X_2 = Cost of seed planted (₦)
X_3 = Hired labour (man-days)
X_4 = Family labour (man-days)
X_5 = Operating expenses (₦)
X_6 = Depreciation on farm implement (₦)
X_7 = Age of farmers (years)
Vi = Random variability in production that cannot be influenced by the farmers (Random errors)
Ui = Deviation from maximum potential output attributable to technical inefficiency
β = Vector of production function parameters to be estimated.

Technical inefficiency effects (Ui) is defined as;

$$Ui = \delta_0 + \delta_1Z_1 + \delta_2Z_2 + \delta_3Z_3 + \delta_4Z_4 + \delta_5Z_5 + \delta_6Z_6 + \delta_7Z_7$$

Where;

Z_1 = Level of formal education (years)
Z_2 = Sources of planting materials (1 for ADP, 0 for otherwise)
Z_3 = Variety of seed planted (1 for improved, 0 for otherwise)
Z_4 = Sex (1 for male, 0 for female)
Z_5 = Fadama farming experience (years)
Z_6 = Access to credit (1 for yes, 0 for otherwise)
Z_7 = Livestock disturbance (1 for yes, 0 for otherwise)
δ = Parameters to be estimated

3. RESULTS AND DISCUSSION

3.1 Socio-economic Characteristics of Respondents

Results of the socio-economic characteristics of the respondents show that majority (67.7 percent) of the respondents in Osun State were males. The results showed that 72.22 percent of the respondents were married. The results showed that most (75.56 percent) of the respondents were relatively young (less than 60 years) with the mean age of 52.03 years. Also, 51.67 percent of the respondents had between 5 and 8 members in their households. It was revealed that only 30 percent of the respondents had secondary education and above. The farmers were well experienced with 52.22 percent of them having more than 25 years of farming experience and 90.56 percent of them had 10 hectares of farm size or less.

3.2 Profitability Analysis

This section explains the cost and revenue analysis of fadama farmers and consequently a measure of profitability of fadama maize production in Osun State. The analysis (Table 2) show that fertilizer contributed the largest to the total cost. It accounted for 32.7% of the TC and 34.23% of the total variable cost. This was followed by cost of labour (25.4%). The mean total variable cost was ₦ 82,229.35 while total fixed cost was ₦ 3,838.68. The total revenue was ₦ 393,268.03 while the net revenue per farmer was ₦ 307,200 representing 78.11% of the total revenue indicating that fadama maize production was profitable in the study area.

3.3 Efficiency Analysis

3.3.1 Summary statistics of variables for the analysis

Table 3 shows the summary of variables for the estimation of stochastic frontier production function model. The mean farm output of maize production under fadama farming was 9,976.5 kg and given the average farm size of 3.5ha, this implies that about 2850.43 kg was produced per

ha. The mean average family and hired labour used was estimated as 34.19 man-days and 41.91 man-days, respectively. This showed that maize production under fadama farming was not highly labour intensive. An average cost of maize seeds planted was ₦6024.50, the mean operating expenses and depreciation was ₦5984.40 and ₦3198.90, respectively, while the average age of the farmers from the findings was estimated as 52.03 years, showing that the farmers were relatively young. The mean of farmer's years of experience was 25 years which shows that the farmers had adequate farming experience to be able to adapt easily with improved fadama technologies being promoted by the National Fadama Development Project (NFDP).

3.4 Analysis of Elasticity of Production and Return to Scale (Productivity Analysis)

The estimated coefficients in the general model of model 2 were used for the productivity (resource use efficiency) analysis. Some of the estimated coefficients (age, farm size, hired labour and operating expenses) of the included variables in the model (elasticities of production because the algebraic functional form was the cobb-douglas form) were positive and each was between zero and unity. This implies a direct relationship between output and each of the variable inputs and that the allocation of the variable inputs was in the stage of efficient allocation in the production function. This finding corroborated the a-priori assertion that resources allocation is efficient in small-scale agricultural production in the developing countries [11]. The return to scale (RTS) analysis is presented in Table 4. The RTS was 0.408, that is, it was less than unity and thus implies that they were experiencing decreasing returns to scale. Therefore, fadama maize farming in the study area was 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.

3.5 Stochastic Frontier Production Function Analysis

The estimates of the stochastic frontier production function for the farmers in the study area are presented in Table 5. The estimated coefficients of the explanatory variables showed that age, farm size, hired labour, operating expenses had positive effect on the change in output, while the remaining estimated coefficients that is: Family labour, cost of seed and depreciation had negative signs. This means an increase in the input on the farm decreases farm output of the farmer and vice-versa. Hence, the results follow *a priori* expectations meaning that as these variables increase, the value of the output (maize) decreases *ceteris paribus*. Farm size and cost of seeds were significant at 5 percent, indicating that these factors were different from zero and thus important in maize production under fadama farming system. These results conformed to the works on peasant farming setting in Nigeria by [12-14].

Table 1. Analysis of socio-economic characteristics of the respondents

Item	Frequency	Percent
Sex		
Female	48	23.33
Male	132	76.67
Age		
<30	18	
30-39	33	12.22
40-49	52	27.78
50-59	45	35.56
60 and above	32	24.44
Mean		
SD		
Educational level		
No formal education	23	12.78
Some primary education	30	16.67
Primary education	27	15.00
Some secondary education	46	25.55
Secondary education	42	23.33
Tertiary education	12	6.67
Household size		
1-4	7	3.89
5-8	93	51.67
9-12	68	37.78
13 and above	12	6.67
Mean		
SD		
Farm size		
<5ha	82	45.56
5-10ha	81	45.00
>10ha	17	9.44
Mean		
SD		
Farming experience		
<15	14	7.78
15-25	72	40.00
>25	94	52.22
Mean		
SD		

Source: Field survey, 2015

3.6 Technical Efficiency Analysis

3.6.1 Technical efficiency

The Technical Efficiency (TE) of the Fadama maize farmers varied significantly between 0.475 and 0.968 with a mean of 0.823. The significance of the TE was confirmed by a student's t-ratio test of significance at 5 percent level.

Comparing the average TE from this study with other studies revealed that the TE from the study is not far from the findings of [15-18]. With average TE of 89, 80, 75, and 90 percent, respectively. Similarly, the TE from this study is higher than the one recorded by [19,20] with average TE of 67 and 63 percent, respectively.

3.6.2 Presence of inefficiency effects in fadama maize production

The analysis of the variance parameters shows that the estimate of sigma squared (σ^2) was 0.947 and 0.692 in models I and II respectively. The gamma (Y) estimate was large (γ=0.93) in model II and significant at 5 percent level, indicating the presence of technical inefficiency effects in the Fadama maize production. The high value of γ indicates that about 93 percent of the variation in output of the production was due to technical inefficiency effects and not to random effects.

3.6.3 Inefficiency model

The estimates of the inefficiency model (Table 5) expatiate on the effects of the socio-economic characteristics of the fadama maize farmers. The coefficients of experience, sources of seed, sex and access to credit were positive indicating increase in technical inefficiency. In other words, the higher the variables (positive) the more the decrease in technical efficiency of the fadama farmers. This situation is contrary to a-priori expectation that farmers' farming experience would increase the farmers' level of technical efficiency [11,21].

On the other hand, livestock disturbance, variety of seeds and education coefficients were negative, indicating that the higher livestock disturbance, variety of seeds and education, the less the technical inefficiency. This implies that the higher the level of education of farmers, the higher the farmer's level of technical efficiency [11,21].

3.7 Table 6: Deciles Range of Technical Efficiency Estimates

The deciles range of frequency distribution of technical efficiencies of fadama maize farmers is presented in Table 6. The table shows that 86.8% of the farmers had TE of 0.70 and above, indicating that more than half of the farmers under this fadama farming were relatively efficient.

Table 2. Profitability analysis

Variable (Item)	Mean(₦)	Standard deviation(₦)	Percentage (%) of TC
A: Variable cost			
Cost of labour	21,880.45	12,875.54	25.40
Operating Expenses	7,181.28	2,513.90	8.34
Cost of Seed	7,229.4	3,673.08	8.39
Cost of Fertilizer	28,146	15,075.34	32.70
Cost of Transportation	7,965.36	5,435.89	9.25
Cost of Agrochemical	9,826.8	7,843.56	11.42
Total Variable Cost (TVC)	82,229.29	43,612.77	95.54
B: Fixed cost			
Cost on land leased	1,938.84	1,321.65	2.25
Depreciation cost on tools	1,899.84	1,184.44	2.21
Total Fixed Cost (TFC)	3,838.68	2,304.33	4.46
C: Total cost (TC)	86,067.97	44,045.29	100.00
Total Revenue (TR)	393,268.03	241,563.83	
Net Revenue	307,200	199,843.04	
Net Revenue/ha	71,290.00	23,763.33	

Source: Field Survey, 2015

Table 3. Summary statistics of the variables for analysis

Variables	Mean	Standard deviation	Minimum	Maximum
Quantity of Output (kg)	9,976.50	8,727.95	1,300	78,000
Age (years)	52.03	3.564	21	80
Farm size (ha)	3.50	1.092	0.60	12
Family labour (man-days)	33.20	30.55	0.00	164.00
Hired labour (man-days)	41.90	32.04	0.00	173.00
Cost of seed (₦)	6,024.50	3,590.93	1,125.00	21,000.00
Operating expenses (₦)	5,984.40	2,402.61	1,750.00	13,700.00
Depreciation (₦)	3,198.90	2,194.81	0.00	33,700.00
Experience (years)	24.8	14.79	2.00	62.00

Source: Field Survey, 2015

3.8 Problems Encountered in Fadama Maize Farming in the Study Area

Table 7 revealed the multiple responses result of the major problems encountered in the study area. Lack of storage facility was ranked first among the problems identified in the study area with 95.6 percent of the respondents emphasising on it as the major challenge confronting them. The study further revealed that about 64.8 percent of the respondents indicated high cost of fertilizer while 54.1 percent complained of inadequate credit facility. Also, 50.9 percent of respondents had problems of bad roads (high cost of transportation) whereas 48.4 percent of the respondents indicated inadequate hired labour. From the same Table, 47.8 percent and 41.5 percent of the respondents revealed that they had problems of livestock disturbance and price fluctuation respectively.

Table 4. Return to scale analysis

Variables	Elasticity of production
Age	0.302
Farm size	0.964
Family labour	-0.559
Hired labour	0.381
Cost of seed	-0.301
Operating expenses	0.124
Depreciation	-0.503
RTS	**0.408**

Source: Field Survey, 2015

Table 5. Estimates of stochastic frontier production function

Variables	Model 1 (OLS)	Model 2 (MLE)
General model		
Constant	0.822*(0.742)	0.805*(0.756)
Age of farmer	-0.575 (0.895)	0.302 (0.934)
Farm size	0.936***(0.108)	0.964***(0.123)
Family labour	0.520***(0.225)	0.559***(0.204)
Hired labour	0.371(0.357)	0.381 (0.297)
Cost of seed	-0.327***(0.119)	-0.301***(0.102)
Operating expenses	-0.127(0.775)	-0.124(0.692)
Depreciation	-0.101(0.883)	-0.503(0.848)
Inefficiency model		
Constant	-	-0.244(0.669)
Experience	-	0.630***(0.239)
Education	-	-0.792***(0.200)
Source of seed	-	0.201(0.492)
Variety of seed	-	-0.193(0.474)
Sex	-	0.922*(0.464)
Credit	-	0.359*(0.921)
Livestock disturbance	-	-0.106(0.549)
Variance parameters		
Sigma Squared	0.947	0.692(0.145)
Gamma	-	0.930(0.148)
Log likelihood function	-34.12	-31.29
Technical efficiency (TE)		
Mean TE	-	0.823
Minimum (TE)	-	0.475
Maximum (TE)	-	0.968

*NOTE: * Estimate is significant at 5 percent and figures in parentheses are standard errors*
Source: Field Survey, 2015

Table 6. Deciles range of frequency distribution of technical efficiency

Deciles range of technical efficiency	Frequency	Percentage
0.40 – 0.49	4	2.5
0.50 – 0.59	10	6.3
0.60 – 0.69	7	4.4
0.70 – 0.79	18	11.3
0.80 – 0.89	93	58.5
0.90 – 0.99	27	17.0

Source: Field Survey, 2015

Table 7. Distribution of farmers by problems experienced

Problems	Frequency	Percent
Lack of storage facility	152	95.6
High cost of Fertilizer	103	64.8
Inadequate credit facility	86	54.1
Bad road (High cost of transportation)	81	50.9
Inadequate hired labour	77	48.4
Livestock disturbance	76	47.8
Price fluctuation	66	41.5

Multiple responses
Source: Field Survey, 2015

4. CONCLUSION AND RECOMMENDATIONS

The study confirmed the profitability of fadama maize production, having empirically examined and appraised the efficiency of fadama maize farmers in Osun State, Nigeria. The fadama maize production is a lucrative economic activity because of the availability in the vicinity of the production areas and across all the states in Nigeria.

Based on the findings of this study, the following recommendations are made for increased productivity, output and profitability of maize farmers in Osun State:

- The provision of credit facilities to the fadama farmers is to enable them finance their fadama farming enterprises.
- Fadama farmers should be provided with basic rural infrastructures such as portable water, transportation facilities, farm roads rehabilitation, electricity, processing facilities and storage facilities to make them develop favourable attitude towards the National Fadama Development Project (NFDP).
- Efforts should be made by research institutes to generate new improved technologies on fadama production.
- Modern inputs should be made available to the farmers at affordable rate by the Agro service centre of each LGA of the State.
- Adequate mobility for the extension staff of the project to enable them discharge their duties effectively, particularly in the areas of extension services delivery.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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