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Efficiency of Maize Production among Smallholder Farmers in Southwest, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author MAA designed the study, wrote the protocol and the first draft of the manuscript. Author FMO did the statistical analysis and interpretation. Author OSO helped in the source for data. All authors read and approved the final manuscript.

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ABSTRACT

Maize is cereal crops commonly grown in Nigeria and it is a source of livelihood for many farming households. This study analyzed the resource use efficiency in maize production among smallholder farmers in southwest, Nigeria. A multistage sampling method was used to select two hundred and seventy (270) farmers for this study. Primary data were collected using well-structured questionnaires. Descriptive statistics, gross margin analysis and stochastic frontier production function were used as analytical tools. The results showed that the mean age of the farmers was 47.7 years. Most (76.3%) are males which were married (82.2%) with household size of 5.8. There is high (82.9%) level of literacy among the farmers. The average output of production was 5,038.25kg which were gotten from planting of improved maize seeds (88.5%). Maize cultivation is profitable enterprise because for every ₦1 invested, ₦1.74 will be realized as gain. The Maximum

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Likelihood Estimate (MLE) results revealed that the technical efficiency of maize farmers varied due to the presence of technical inefficiency effects on maize production. Farm size (5%), quantity of fertilizer (10%) and capital input (1%) are the factors significantly affecting technical efficiency. Also, household size (5%), marital status (1%) and gender (10%) are the factors that significantly influence technical inefficiency. The explanatory variables can account for 66% of the total variations in the efficiencies of production, while 34% of the variations are given to error. Policies and programmes that focus on encouraging more young people and women to agriculture should be enacted and implemented.

Keywords: Maize; efficiency; technical; farmers.

1. INTRODUCTION

1.1 Background to the Study

Maize is the most important cereal crop in the sub-Saharan Africa (SSA). Maize production covers the largest land area in Nigeria (7th in the world and 2.4% of the total) followed by Tanzania and South Africa. Top producers are South Africa (9th in the world but only 1.5% of the total), Nigeria and Ethiopia [1].

More maize is produced annually than any other grain. About 50 species exist and consist of different colours, textures, shapes and sizes. White, yellow and red are preferred by most people like many other regions. It is consumed as a vegetable though it is a grain. The grains are rich in vitamins A, C and E, carbohydrate and essentials minerals, and contain 9% protein [2]. They are also rich in dietary fiber and calories which are good source of energy [2].

According to FAO (2005), the land areas planted with maize in West and Central Africa alone increased from 3.2 million in 1961 to 8.9 million in 2005. This shows that expansion of land area resulted in increased production from 2.4 million metric tonnes in 2005. According to Oyekale and Idjesa (2009), maize is an important staple food in Nigeria. Declining yield of maize as a result of several environmental and biological factors has necessitated technological innovation focusing on maturity time, disease resistance and palatability of the crop.

Considering world cereal acreage, output and yields, maize (*Zea mays* L.) is ranked the fifth largest in land area occupation, fourth largest in output and third largest in yield [3]. Maize demonstrates its key role in assuring food security as it provides about 15% and 19% of the world's protein and calories, respectively [3]. In sub-Saharan Africa (SSA) region, maize botanically identified as increasingly becoming one of the

most important grain crops and is produced throughout the region under diverse environments. In Africa, maize is consumed directly and serves as staple diet for 300 million people and indirectly as part of the animal feed consumed in poultry, dairy and meat products. It is also used for the production of ethanol as a bio-fuel and used for medical purposes [4].

1.2 Economic Importance of Maize

The importance of maize cannot be exaggerated, it cuts across different spheres of human life. It serves as food for human consumption. It is used in making pap; popcorn, thick porridge and boiled grains which are notable food consumed by majority of Nigerians, especially in the Southern part of the country. Maize is industrially important chiefly for the production of starch and alcohol. The starch can be used as converter dextrin, syrup and sugar, while oil obtained from it is used to make soup or refine for cooking and salad dressing. [5] reported that maize is hydrolyzed and enzymatically treated to produce syrups, particularly high fructose corn syrup, a sweetener and in cases fermented and distilled to produce grain alcohol. Sweet corn is a genetic variety that is high in sugar and low in starch that is served like a vegetable. Another common food made from corn is flakes, while corn bread is made from maize.

Maize industries provide employment opportunity for many farmers, for example in 1964/65 cropping season, about twenty-eight percent (28%) of the Nigerian farmers cultivated maize. As at 1986, the production of maize was estimated to be 861,000 metric tonnes, land area under maize cultivation has increased from 653,000 Ha in 1984 to 5,000,000 [6]. Production has also increased from 1,000,000 tonnes to over 7,000,000 tonnes during the same period. Average yield of 1.4-1.5 tonnes per hectare been obtained is low compared to other places [7].

The oil in corn is used for cooking and making soaps. Sticky gum contains dextrin used for sealing envelopes and labels. Corn starch is well recognized for its uses in cosmetics and pharmaceutical industries as diluents. Corn seeds are functional in making alcohol and stem fibers for manufacture of papers.

1.3 Problem Statement

Nigeria, the most populous country in Africa about 175 million [8] is essentially agrarian in nature with over 80 percent of her food needs being produced by peasant farmers, cultivating in most cases less than 2 hectares of land [9]. Maize is one of the major foods consumed in the south western, Nigeria cultivating under subsistence method of farming. In South Western, Nigeria, Maize output is drastically low because maize farmers do not have adequate knowledge of resource combination [10]. The resource available at their disposal is even not well allocated which tantamount to low production. Empirical studies suggest that most developing countries are still facing the problem of high poverty level.

In addition to poverty, Nigerian population growth rate is very high; yet agricultural resources are limited, e.g. arable land. This calls for improving yields of major staples, such as maize for better food security and livelihoods of rural households. Thus, resources need to be used in the most efficient way to achieve this objective. Further, improved efficiency is expected to improve food security by cutting hunger halfway by 2015 [11].

Most farmers in these countries practice subsistence farming with low productivity. This may be attributed to high inefficiencies (technical and allocative) because farmers lack access to available resources or less information on efficiency, and low literacy levels limiting interpretation of such information to guide them in commercial production and efficient utilization of resources which lead to improve production in the study area.

1.4 Objectives

The main objective of this research work is to determine the efficiency of maize production among smallholder farmers in southwest, Nigeria. Specifically to;

- i. Describe the socio-economic characteristics of the respondents in the study area;
- ii. Estimate the costs and returns in maize production; and
- iii. Determine the resource use efficiency in maize production.

This research provides necessary impetus that can surmount the problems surrounding the production of maize. It enables farmers technical efficiency so as to boost their income by profits maximization.

1.5 Justification

Many works have been done on efficiency of large and medium-scale maize production, for instance, [12] worked on technical efficiency and constraints among medium scale maize production in Oyo state. [10] worked on farm size, efficiency and economics of size, suggested that medium farm size are most efficient. But there is a depth of information on the issue of small scale maize producers. This kind of study is focused on maize farmers on small scale using crude implements for farm operations. There is need to determine the technical efficiency of the maize farmers in the study area. Efficiency measurement is very important because it is the first step in a process that might lead to substantial resource savings. It is also very important factor of productivity growth. The study also tends to identify various problems confronting the maize farmers in the course of their production and suggest possible solution to the problems.

Hence, this study is expected to provide necessary impetus that can surmount the problems surrounding the production of maize. Findings in this study are also expected to teach farmers to be both allocatively and technically efficient so as to boost their income by maximizing profits. This aims to impact on the farmers how to transform agriculture from subsistence to commercial production and to make Nigeria a self-sufficient nation in line with vision 2020 of the millennium development goals (MDGs). Also, this study came up with findings that will improve the efficiency level of maize farmers in order to maximize the input used in production process by suggesting better method of maize cultivation. Finally, this study will provide information and recommendations that will assist policy makers in decision making towards improvement in maize production in the study area.

2. METHODOLOGY

2.1 Study Area

The study was carried out in South West, Nigeria which lies between latitude 5°N and 9°N of the Equator and longitudes 2.5° and 6° East of the Greenwich Meridian, it is bounded by the Atlantic Ocean in the South, Kwara and Kogi state in the North, Edo and Delta state in the Eastern part of Nigeria, and Benin republic in the West. The study area has a land area of about 114, 271km representing about 12 percent of the country's total land area. The climate in southwestern Nigeria is predominantly humid with rainfall from 1500 mm to 300 mm per annum. The mean monthly temperature ranges from 18°C to 24°C during the rainy season and 20°C to -35°C during the dry season [13].

Hence, crop and livestock production is not constrained by the amount and distribution of rainfall. Mangrove forest, guinea savanna and tropical rainforest are the types of vegetation found in the geo-political zone. Although, some parts of the zone are fairly urbanized, the greater majority of the population still lives in the rural areas and their major occupation is farming. Other occupations include trading, artisanship, civil service, marketing, driving, etc. The official language is English, while the major informal

language for communication in this region is Yoruba, although with different dialects.

2.2 Sampling Technique

A Multi-stage sampling method was used to select small scale maize farmers for the study. At the first stage, three (3) states were purposively selected based on their maize production potentials, the second stage involved the random selection of three (3) Local Government Areas, while the third stage also involved the random sampling of 3 communities from each Local Government Area selected. The final stage involved the selection of 10 farmers randomly from each community. A total of 270 respondents were selected for the study.

2.3 Sources of Data

Data were collected with the aid of structured questionnaire administered on the respondents.

2.4 Analytical Technique

Descriptive statistics such as frequency counts, means and percentages; gross margin analysis and inferential statistics were employed. Microsoft excel and R were used as statistical packages.

Map of Nigeria Showing the Southwest States



Fig. 1. Map of Nigeria showing the Southwest States

Source: article.sapub.org/sors

2.4.1 Gross margin

The gross margin is the difference between the gross revenue and total variable cost.

$$GM = \sum_{i=1}^n P_i q_i - \sum_{j=1}^m c_j x_j \dots \quad (1)$$

Where,

GM = Farm gross margin
 P_i = Market price of output i
 q_i = Quantity of output i
 c_j = Unit price of the variable input j
 x_j = Quantity of variable input used
 m = Number of input used
 n = Number of output produced

2.4.2 Stochastic frontier production function (SFPF)

The efficiency of resource use was determined by Stochastic Frontier Production Function (SFPF). This was developed independently by [14] and [15] which is implicitly stated as;

$$Y = f(x_i \beta_i) \exp(V_i - U_i) \quad i = 1, 2, 3 \dots \dots \quad (2)$$

Where,

Y_i = The total output of the i th farmer,
 X_i = The vector of input quantities of the i th farmer,
 β_i = The vector of unknown parameter to be determined,
 V_i = Random variables
 U_i = Non-negative random variables which are assumed to account for technical inefficiency in production.

Technical efficiency of the respondents in the study area was estimated using Cobb Douglas production function of the SFPF model described as follows:

$$\ln Y_i = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \dots + \beta_5 \ln X_5 + V_i U_i \dots \dots \dots \quad (3)$$

Where,

Y_i = Value of maize output (₦)
 X_1 = Maize Farm size (ha)
 X_2 = Labour used (mandays)
 X_3 = Value of maize seeds planted (₦)
 X_4 = Value of fertilizer used (N)
 X_5 = Other capital input (N) (depreciation of farm tools and equipment)
 β_0 = Intercept

$\beta_1 - \beta_5$ = the regression parameters to be estimated.

V_i and U_i are as earlier defined.

It was assumed that the technical inefficiency measured by the mode of truncated normal distribution (U_i) is a function of socio-economic factors (Yao and Liu, 1998) as given in equation 4:

$$U_i = \sigma_0 + \sigma_1 S_1 + \sigma_2 S_2 + \dots \dots \dots + \sigma_6 S_6 \dots \dots \dots \quad (4)$$

Where:

S_1 = Household size (number)
 S_2 = Farmers age (years)
 S_3 = Marital status (1 married, 0 otherwise)
 S_4 = Educational level (years)
 S_5 = Farming experience (years)
 S_6 = Gender (1 male, 0 otherwise)
 σ_0 = Intercept
 $\sigma_1 - \sigma_6$ are parameters to be estimated

3. RESULTS AND DISCUSSION

3.1 Socioeconomic Characteristics

The socio-characteristics are presented in Table 1. The majority (62.6%) were below 50 years of age with mean age of 47.7 years. This implies that the respondents are still in the active and productive age and hence would possess the necessary strength to carry out tedious farm operations. It is a common belief that efficiency and productivity of farmers may increase with age, reach maximum level, and then decrease with age. This may be so because younger generations do embrace innovations which enhance efficiency. This correlates with [16] who noted age is a determinant of productivity and efficiency.

The gender is an important in any social or economic phenomenon. The male farmers took 76.3% share of the total population while 23.7% went to the farmers, this correspond to [9]. Majority (82.2%) of the farmers were married, this is expected to boost efficiency in the limited resources. The modal household size was 4 to 6 persons, which takes 40.0% of the total population. Knowledge gained through education enhances human labour effectiveness and increases farm productivity. The respondents (82.9%) are literate. Educated farmers are more innovative and more coordinated on the farm [17]. The mean farming experience (in years)

was 13.8 years. This reveals that, respondents in the study area have relatively high experience in maize farming. This invariably helps them to cope with risks and uncertainty thus increasing their productivity and efficiency. The mean yearly farm output was 5,038.25 kg. Most (88.5%) of the farmers cultivated improved varieties of maize.

total revenue was ₦722,485.05 and the gross margin was ₦307,133.27. Similarly the benefit cost ratio was ₦1.74. This reveals that in South Western Nigeria, maize cultivation is profitable because for every ₦1 invested, ₦1.74 will be realized as gain.

3.2 Gross Margin Analysis

The costs and returns on maize production in South Western, Nigeria in Table 2 shows the total variable cost was ₦415,351.78, while the

$$\text{Benefit - cost ratio (BC)} = \frac{\text{Benefit}}{\text{cost}} \dots \dots \dots (5)$$

$$BC = \frac{₦722,485.05}{₦415,351.78}$$

$$BC = 1.74$$

Table 1. Socio-economic characteristics of respondents

Variable	Description	Percentage (n=270)	Mean
Age (years)	Age of the household head (in years)		47.7
<31		4.1	
31-40		23.7	
41-50		34.8	
51-60		27.4	
>60		10.0	
Gender	Gender of the household head		
Male		76.3	
Female		23.7	
Marital status	married=1, otherwise = 0		
Single		6.3	
Married		82.2	
Divorced		2.6	
Widowed		8.9	
Household size	Number of persons living under the same roof		5.8
1-3		5.0	
4-6		40.0	
7-9		25	
10-12		12	
13-15		4	
>15		6	
Educational level	Number of years spent in formal institution		
None		17.1	
Adult education		16.3	
Primary education		28.5	
Secondary education		20.7	
Tertiary education		17.4	
Farming experience	Number of years spent in maize farming		13.8
1-10		51.9	
11-20		29.6	
21-30		11.1	
>30		7.4	
Farm output	The average maize output (in kg)		5,038.25
Maize varieties	Varieties of maize planted		
Local (0)		11.5	
Improved (1)		88.5	

Source: Field Survey, 2018

Table 2. Gross margin analysis of maize production

Items		
Revenue		
1. Average total output (kg)	5,038.25	
2. Unit price per kg	143.40	
Average total revenue (1*2)		722,485.05
Average variable input cost (₦)		
3. Cost of maize seeds	45,774.57	
4. Cost of labour (man-day)	130,690.22	
5. Cost of agrochemicals	28,930.09	
6. Cost of fertilizer	212,956.90	
Total variable cost (3+4+5+6)		415,351.78
Gross margin		₦307,133.27

Source: Field survey, 2018

3.3 Productivity Analysis

The estimated sigma squared was 0.13 and statistically significant at 1 percent (Table 3). This shows a good fit and the correctness of specified distributional assumption of composite error term. In addition, the magnitude of variance ratio was estimated as 0.66. This is relatively high, thus, suggesting that systematic effects that are unexplained by the production are the main sources of random errors. There was an existence of technical inefficiency among the sampled farmers. The estimated gamma coefficients showed that in the study area, there was a 66 percent variation in the output of maize due to differences in their technical inefficiencies.

There was a positive relationship between maize farm size (X_1) and the value of maize output (Y) in the study area (Table 3). This implies that the larger the maize farm size, the more the value of maize output and vice versa. The coefficient was 0.16 and significant at 5 percent level. The magnitude and sign of the coefficient of variable maize farm size showed that the production of maize experienced decreasing positive returns to farm size and hence land as an input in the production process was efficiently allocated by the maize farmers.

The coefficient of labour used (X_2) was negative. This implies that value of maize output in the study area would decrease with an increase in labour used. Also, the coefficient of this variable X_2 was 0.74. The elasticity of production of labour used showed decreasing negative returns. This implies that labour was in the irrational stage of resource allocation.

The value of maize seed planted (X_3) was positive. This indicates that an increase

(decrease) in this variable X_3 would lead to increase (decrease) in the value maize output (Y) in the study area. The X_3 production elasticity of 0.5 indicated that the use of this variable was efficient in the process of production.

The partial elasticity of the value of maize output (Y) with respect to the value of fertilizer used (X_4) was 0.48. This shows that X_4 was positively related to the value of maize output in the study area. This implies that when X_4 is increased, there would be an appreciable increase in Y and vice versa. This corroborates the findings of [9] which established a positive coefficient for fertilizer use among maize farmers in Ondo state. The Coefficient of X_4 was however significant at 10 percent level. The implication of this result is that, maize farmers used fertilizer efficiently because the elasticity of production of fertilizer showed positive returns.

There was a positive relationship between other capital input (X_5) and the value of maize output of maize. This implies that one naira increase in X_5 would lead to N 0.36 increase in Y and vice versa. The coefficient was statistically significant at 1 percent level. Variable X_5 was efficiently used because the estimated coefficient showed decreasing positive returns and hence its allocation was in the rational stage of resource allocation.

In Table 3, when inefficiency model estimated is considered, the estimated coefficient for household size (S_1) was positively and significantly related to the technical inefficiency at 1% level. This implies that increase in household size would cause an increase in the technical inefficiency and this will lead to decrease in the technical efficiency which would cause a decrease in productivity. This result is not in line

with the work done by [18] that large household size increases farmer's productivity. This may be so when the resources meant for production are channeled to households' maintenance.

Estimated coefficient for farmers age (S_2) was positive. This implies that as farmer's age increases, his technical inefficiency increases and hence technical efficiency and productivity also decrease. This is an indication that older farmers are less technically efficient when compared with their young counterparts. This corroborates [19] who found out that ageing farmers are less energetic to farm work.

Coefficient for marital status (S_3) was negatively related to technical inefficiency and significant at 1%. This implies that marriage leads to farmers being less inefficient, more efficient and productive. It shows that married farmers are more responsible and efficient in production.

Educational level (S_4) was negatively related to technical inefficiency. This shows that the more the year the farmer spent in formal schools the less the technical inefficiency and more the productivity. This is an indication that the farmer's level of inefficiency declines as he/she

acquires more education in the study area. This is in accordance with the a-priori expectation that when educational level increases, efficiency and productivity also increase.

The estimated coefficient for farming experience was negative. This shows that the more the farming experience, the less the technical inefficiency and the more the technical efficiency and productivity. This implies that experienced maize farmers are more productive and efficient. This result corroborates the findings of [9] that the farmers with more experience tend to be more efficient in production because with time new skills are developed. Also, increase in year of cultivation may also enhance critical evaluation of the relevance of better production decision, including optimal use of available farm inputs.

Estimated coefficient for gender (S_6) was significant at 10 percent level. It was positively related to technical inefficiency. This implies that in the study area, men are more inefficient and less productive than their women counterparts. This supports the a-prior expectation and [20] that women as better efficient in the management of resources.

Table 3. Maximum likelihood estimates for the parameters of the stochastic frontier production function

Variable	Coefficient	Standard error	t-value
Efficiency model			
Constant	0.5640	0.098	5.7502***
Farm size (X1)	0.1635	0.069	2.3699**
Labour cost (X2)	-0.7403	0.830	-0.8917
Maize seed(kg) (X3)	0.5524	0.970	0.5696
Quantity of fertilizer(kg) (X4)	0.4871	0.253	1.9227*
Capital input(X5)	0.3568	0.095	3.7428***
Inefficiency model			
Constant	0.4005	0.347837	1.1514
Household size (S1)	0.1511	0.067852	2.2269**
Age (S2)	0.8377	0.849078	0.9866
Marital status (S3)	-0.8762	0.290884	-3.0122***
Educational level (S4)	-0.1363	0.1261	-0.1081
Farming experience (S5)	-0.1035	0.090638	-1.1419
Gender (S6)	0.583	0.325644	1.7903*
Variance Parameter			
Sigma squared	0.1337	0.039424	3.3913***
Gama	0.6606	0.094719	6.9743***
Log likelihood function	113.018		

*, **and *** significant at 10%, 5% and 1% respectively

Source: Field survey, 2018

Table 4 shows the distribution of respondents by their technical efficiency. Just 4.81 percent of the respondents had their technical efficiencies (TE) equaled to 0.30 or less, while 7.0 percent had theirs between 0.31 and 0.40. Also, those with TEs between 0.41 and 0.50 were 10.7 percent. The TEs between 0.51 and 0.60 were 15.1%, while those between 0.61 and 0.70; and those above 0.70 shared 30.7 and 31.5 respectively.

Table 4. Distribution of respondents by technical efficiency

Technical efficiency	Frequency	Percent
≤0.30	13	4.81
0.31 – 0.40	19	7.04
0.41 -0.50	29	10.74
0.51 – 0.61	41	15.18
0.61- 0.70	83	30.74
>0.70	85	31.48
Total	270	100
Minimum	0.10	
Maximum	0.99	
Mean	0.89	

Source: Field survey, 2018

The summary of predicted technical efficiency obtained using the estimated Stochastic Frontier model (Table 3) showed that the minimum and maximum technical efficiencies (TE) of the maize farmers were 0.10 and 0.99 respectively while the mean was 0.89. This shows that if the efficiency of resources usage is increased by 11.0 percent, the maize farmers in the study area would operate on the production frontier given the existing technology.

The implication of the finding is that maize farmers in the study area are highly efficient in using the available resources.

4. CONCLUSION AND RECOMMENDATIONS

The study examined the efficiency of maize production among smallholder farmers in southwest, Nigeria. It was gathered that maize production is a profitable agribusiness. The MLE results revealed that the technical efficiency of maize farmers varied due to the presence of technical inefficiency effects on maize production. Farm size, quantity of fertilizer and capital input are the factors significantly affecting technical efficiency. Also, household size, marital status and gender are the factors that significantly influence technical inefficiency. Since women are better managers of resources,

priority should be given to women in agriculture. Policies and programmes that focus on encouraging more young people to agriculture should be enacted and implemented.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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