Efficiency of Maize Production among Smallholder Farmers in Southwest, Nigeria

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 4300kg which were gotten from planting of improved maize seeds (88.5%). 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 (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 variables can account for 66% of the variations in the efficiency. Policies and programmes that focus on encouraging more young people and women to agriculture should be enacted and implemented.

Keywords: Maize, efficiency, technical, farmers.

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1.0 Background to the study

~~Maize is a cereal crop that is grown widely throughout the world in a range of agro-ecological environments. Maize originated in Central and South America and was introduced into Africa by Portuguese in the 16th century. A report had that it was introduced to Europe in 1942 from Central and Southern America by Christopher Columbus and latter spread to Africa by the Dutch in Southern Africa [1]. It is also one of the popular cereals in Nigeria when it serves as the main staple food for millions of Nigerians.~~

Comment [CA2]: Not relevant. It is a brief introduction not history on maize

~~Maize is a world food staple. It was domesticated in Mesoamerica during prehistoric times. In the late 15th century, Food and Agriculture Organization Statistics Database [2], explores and traders carried maize back to Europe and introduced it to other countries. Maize spread to the rest of the world due to its ability to thrive in diverse climates. maize and rice tie for the second most widely grown crop in the world (wheat is first) [1].~~

Comment [CA3]: Information not relevant

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].

In South Western, Nigeria, Maize output is drastically low because maize farmers do not have adequate knowledge of resource combination [3]. 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 [4].

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. The study describes the socio-economic characteristics of the respondents in the study area; estimates the costs and returns in maize production; and determines 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. What is the objective of the work?

2.0 Methodology

The study was conducted in southwest geopolitical zone of Nigeria. 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.

Data were collected with the aid of structured questionnaire administered on the respondents. Descriptive statistics such as frequency counts, means and percentages; gross margin analysis and inferential statistics were employed.

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

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

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

The efficiency of resource use was determined by Stochastic Frontier Production Function (SFPF). This was developed independently by [5] and [6] which is implicitly stated as;

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

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:

$LnY_i = \beta_0 + \beta_1 LnX_1 + \beta_2 LnX_2 + \cdots + \beta_5 LnX_5 + V_i U_i$……(3)

Where:

$Y_i =$ Value of maize output (N)

$X_1 =$ Maize Farm size (ha)

$X_2 =$ Labour used (mandays)

X_3= Value of maize seeds planted (N)

X_4= Value of fertilizer used (N)

X_5= Other capital input (N) (depreciation of farm tools and equipment)

$\beta_0 =$ 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 (Ui) is a function of socio-economic factors (Yao and Liu, 1998) as given in equation 4:

$U_i = \sigma_0 + \sigma_1 S_1 + \sigma_2 S_2 + \cdots \ldots + \sigma_6 S_6 \ldots\ldots\ldots\ldots$ (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

3.0 Result 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 [7] 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 [8]. 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 [9]. 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.

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

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 total revenue was ₦722,485.05and 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, ₦1.74will be realized as gain.

$$\text{Benefit} - \text{cost ratio (BC)} = \frac{\text{Benefit}}{\text{cost}} \ldots\ldots\ldots\ldots (1)$$

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

$$\text{BC} = 1.74$$

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

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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 (X1) 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 (X2) 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 X2 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 (X3) was positive. This indicates that an increase (decrease) in this variable X3 would lead to increase (decrease) in the value maize output (Y) in the study area. The X3 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 (X4) was 0.48. This shows that X4 was positively related to the value of maize output in the study area. This implies that when X4 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 X4 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 (X5) and the value of maize output of maize. This implies that one naira increase in X5 would lead to N 0.36 increase in Y and vice versa. The coefficient was statistically significant at 1 percent level. Variable X5 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 (S1) 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 [10] 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 (S2) 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 [11] who found out that ageing farmers are less energetic to farm work.

Coefficient for marital status (S3) 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 (S4) 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 apriori 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 [8] 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 (S6) 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 aprior expectation and [12] 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

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Table 4 shows the distribution of respondents by their technical efficiency. Just 4.81percent 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 10.7percent. The TEs between 0.51 and 0.60 were 15.1%. while those between 0.61 and 7.0; and those above 7.0 shared 30.7 and 31.5 respectively.

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.

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

4.0 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.

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