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Resource Use Efficiency and Returns to Scale in Maize Production in Ondo State, Nigeria

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Abstract

One of the challenges facing smallholder farmers in Nigeria is the inefficiency of resource use. The study was therefore conducted to investigate resource use efficiency and return to scale in maize production in the study area. Data were collected from randomly selected 120 maize farmers using a self-designed structure questionnaire in the study area. Data were analysed with the aid of descriptive statistics and Cobb-Douglas production function. Findings showed resources in the area were inefficiently allocated. Seed, labour and fertilizer were under-utilized while farm size and pesticides were over-utilized. The returns to scale analysis showed that maize farmers in the area were in irrational stage one of the production curve. The study concluded that maize farmers in the area can increase production by employing more of productive resources.

Keywords: Allocative efficiency, return to scale, production, marginal value product

Introduction

Maize production is a common crop enterprise all over the world, including the continent of Africa. The world production output of maize is 785 million tons where Africa's share is just 6.5% (FAOSTAT, 2017). The area of maize land harvested in Africa in 2016 was 29 million hectares with Nigeria as the largest producer in Sub-Sahara Africa (SSA), harvesting 3% of Africa's total (FAOSTAT, 2017). The mean annual production of maize in Nigeria is 8 million tons (FAO, 2007). In 2016, Nigeria witnessed an annual production increase of 11.548 million tons but declined to 10.42 million tons in 2017. The brief rise in the annual production of maize was not a result of production efficiency but due to the expansion of cultivated land area (FAOSTAT, 2017).

One of the major drivers of the low output of maize in Nigeria is the inefficient use of allocated resources. This is to say that the maximum possible output of maize can be obtained when resources are maximally utilized. Maximum resource productivity implies obtaining the maximum possible output from the minimum possible set of inputs (Izekor and Alufohai, 2014; Ahmad *et al*., 2018; Aslak *et al*., 2019; Danquah *et al*., 2020). Izekor and Alufohai (2014) added that optimal productivity of resources involves efficient utilisation of productive resources in the production process.

Studies have shown that food crop farmers in Nigeria have low productivity because of inefficiency in resource use (Idiong, 2007; Oniah *et al*., 2008; *Zekeri and Tijjani, 2013;* Izekor and Alufohai, 2014). In addition, factors like the high cost of labour, pests and diseases, inadequate capital, transportation, poor access to credit facilities and high cost of inputs contribute to the low productivity of maize in Nigeria (Girei *et al*., 2018). This has defeated the attainment of the optimal level of production target of maize production enterprises of small-scale farmers in Nigeria. This, in turn, defeats the potential of maize enterprise contribution to household welfare and national development, in terms of food security, income and poverty among farming households (Idiong, 2007).

A key component of attaining the optimal production target in maize production is increasing resource use efficiency at the farm level. This includes increasing the productivity of the various resource inputs and technology (Girei *et al*., 2018) and ensuring a better return to scale. Most efficiency papers (Ibrahim *et al*., 2014; Ayinde *et al*., 2015) emphasized technical efficiency and those on resource use efficiencies (Oniah *et al*., 2008; Nimoh *et al*., 2012), did not investigate returns to scale which this paper does. The objective of this study therefore was to investigate the level of allocative efficiency of resource use among maize farmers in Ondo State with a view to giving an indication of optimal input utilisation necessary to obtain maximum return. The specific objectives included the estimation of the value of production elasticities, status of inputs utilization, and allocative efficiency of resources.

Research Methodology

Study Area

The study was conducted in Ondo State, Nigeria. The State was purposively selected for the study owing to the relative incidence of land degradation. It lies between Longitude $4^0 30^1$ and $6^0 00$ East of the Greenwich Meridian and Latitude $4^0 45^1$ and $8^0 15^1$ North of the equator. The state is located on a tropical coastal wetland with a mean annual rainfall of about 2800mm, and a mean number of rainy days of about 170. The mean relative humidity falls between 70-80% while the mean annual temperature is about 27.8°C. The land area is about 14,798.8 square kilometres with varying physical features like hills, lowlands, rivers, creeks and water bodies. The predominant occupation in the area is farming which is characterised by small holdings. The major arable crops grown in the State are maize, cassava, yam, cocoyam, and other crops. Farming is mainly carried out using simple farm tools with limited application of modern implements. The total population in the state is 3,460,877 (Ondo State Ministry of Economic Planning and Budget, 2010).

Sampling Procedure and Data

A three-stage sampling technique was used in selecting respondents for the study. In the first stage, three (3) Local Government Areas (LGAs) were purposively selected based on the prevalence of maize enterprise in the LGAs. These LGAs were Ose, Owo and Akure-North, respectively. In The second stage, four (4) villages were purposively selected based on involvement in the maize production enterprise. In the final stage, ten (10) respondents per village were randomly selected, using a simple random sampling technique for the interview. Primary data were used for the study and were collected using structured questionnaires. Data collected included farm size, seed, labour, fertilizer, pesticides and output of maize, among others. Inputs and output prices were also obtained based on the prevailing market price in the area during the 2018 production season. Data collected were analysed with the aid of LIMDEP version 7.0.

Analytical Techniques

Data collected were analysed using descriptive statistics and the Cobb-Douglas production function. The Cobb-Douglas production function was used to compute the coefficients of the inputs used, which are also the elasticities of production input. The coefficients were used to estimate the marginal physical products (MPP) and hence the marginal value product (MVP) of the various production inputs. This was done to examine the marginal returns to maize farm enterprises in the study area. The Cobb-Douglas production function is appropriate, especially when the variables are measured in value terms (Olarinde and Ajetomobi, 2000).

Model Specification

The empirical specification of the model is of the form shown below:

$$Y = \beta_0 X_i^{\beta_i} \varepsilon_i \quad \text{..........} \qquad 1$$

Where Y = maize output

β_0 = intercept of the function

X_i = explanatory variables (i = 1-5)

ε_i = error term

The error term is assumed to be log-normally distributed with mean 1 and contains among other things, differences in efficiency between farms. The explicit form of the equation is as stated below

$LnY = \beta_0 + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_5 lnX_5 + \varepsilon_i$ --------------- 2

Where

Y = output of maize

X_1 = farm size in hectare

X_2 = labour in man-days

X_3 = seed in kilograms

X_4 = fertilizer in kilograms

X_5 = pesticides in litres

ε_i = error term

The marginal physical product (MPP) was given by:

$MPP_i = b_i * APP_i$ --- 3

Where:

MPP_i = marginal physical product of input i

b_i = elasticity inputs i

APP_i = *average physical product*

$APP_i = \frac{\bar{Y}}{\bar{X}_i}$ -- 4

Where $\bar{Y}$ is the mean of output and $\bar{X}_i$ is the mean of factor inputs, and b_0 and b_i are the constant and regression coefficients, respectively.

The marginal value products (MVPs) and allocative efficiency index (AEI) were computed using the inputs and output prices as follows:

$MVP_i = MPP_i * P_y$ --- 5

$AEI_i = \frac{MVP_i}{MFC_i}$ --- 6

Where:

P_y = unit price of output

MFC_i = unit price factor input i

Decision on the efficiency of resource use

The value of the AEI determines the decision on whether a resource is used efficiently or otherwise. Note that if:

(i) AEI = 1, the factor input is efficiently utilized, the farmers are therefore considered allocative efficient (Nimoh *et al.*, 2012).

(ii) AEI < 1, the factor input is over-utilized and

(iii) AEI > 1, the factor input is under-utilized.

The significance of each explanatory variable was determined using the t-test. The overall significance was determined by the F-ratio.

Results and Discussion

Summary Statistics of Factor Inputs

The summary statistics of productive resources used in maize production in the study area is presented in Table 1. The mean output of maize in the study area was 3,311±936.59 kg while the mean farm size cultivated was 3.03±0.79 ha. The mean man-day of labour used was 13.5±4.01 while the mean quantity of seed planted was 25.67±9.56kg. The mean quantity of fertilizer used was 26.12±7.72kg while the mean volume of pesticides used was 5.33±0.95 litres.

Table 1: Summary Statistics of Factor Inputs

Item	Output (kg)	Farm size(ha)	Labour (man-day	Seed (kg)	Fertilizer (kg)	Pesticides (ltr)
Mean	3,311	3.03	13.5	25.67	26.12	5.33
Std. Dev.	936.59	0.79	4.01	9.56	7.72	0.95
Skewness	0.36	0.25	1.46	0.78	0.94	0.49
Kurtosos	-0.67	-0.61	0.64	-0.79	-0.07	-0.63
Minimum	5,000	5	22	43	34	7
Observations	120	120	120	120	120	120

Source: Field survey, 2019

Production Function for Maize Production in the Study Area

The results of the estimated production function for maize production in the study area are presented in Table 2. The table shows that the R^2-value was 0.66, which implied that 66 percent variation in the output of maize is explained by the productive resources specified. The results further shows that the coefficients of farm size, labour, seeds, fertilizer and pesticides have the expected positive signs. The coefficients of the productive resources specified were significant at 1 percent alpha level each. This implied that the productive resources specified played significant roles in maize production in the study area.

Table 2: Estimates of the Cobb-Douglas Production Function for Maize Production in the Study Area

Variable	Coefficient	Standard error	t-value
Constant	6.170***	0.237	26.072
Lnfarm size (X_1)	0.291***	0.079	3.677
Lnlabour (X_2)	0.439***	0.084	5.210
Lnseed (X_3)	0.725***	0.073	9.962
Lnfertilizer (X_4)	0.528***	0.087	9.206
Lnpesticides (X_5)	1.019***	0.155	6.588
R^2	0.66		
F-Cal	40.31		

Source: Field survey, 2019

***Significant at 1% alpha level.

Allocative Efficiency of Maize Production in the Study Area

The estimates of allocative efficiency of inputs used by maize farmers in the study area are presented in Table 3. The results showed that labour (X_2), seed (X_3) and fertilizer (X_4) were under-utilized (inefficiently used) as the MVPs for the inputs were greater than their respective factor prices (i.e. The allocative efficiency indices of the resources were greater than unity(AE1 > 1) while farm size (X_1) and pesticides (X_5) were over-utilized as the MVPs for the two inputs were less than their respective factor prices (i.e. The allocative efficiency indices of the resources were less than unity (AE1 > 1). This result supports the findings of Idiong (2007) and Oniah *et al*. (2008) that food crop farmers in Nigeria are resource-inefficient.

Table 3: Estimates of Allocative Efficiency for Maize Production in the Study Area

Inputs	Mean of input	Coefficient (EP)	APP	MPP	MVP	MFC	AEI	Inference
Farm size (X_1)	3.03	0.29	10.41	3.02	775	2,000	0.39	Over-utilized
Labour (X_2)	13.5	0.44	30.75	13.53	3,382.5	2000	1.69	Under-utilized
Seed (X_3)	25.67	0.73	35.41	25.84	6,460	400	16.15	Under utilized
Fertilizer (X_4)	26.12	0.53	49.47	26.22	6,555	120	54.62	Under-utilized
Pesticides (X_5)	5.33	1.02	5.23	5.33	1,332.5	1,600	0.83	Over-utilized

Source: Field survey, 2019

Returns to Scale in Maize Production

Returns to scale in maize production in the study area is presented in Table 4. The returns to scale was computed using the estimated coefficients of the regression model which are also the elasticities of production. The result showed that elasticities for farm size, labour, seed, fertilizer and pesticides were 0.291, 0.439, 0.725, 0.529 and 1.019, respectively (Table 4.). The elasticities of farm size, labour, seed, and fertilizer were less than unity and were estimated to be positive which shows that the variables were decreasing functions of maize output, and indicates that the allocation and utilisation of the variables were in economic relevance stage of production function (Stage II). The elasticity for pesticides (1.019) was greater than unity and showed a positive increasing function to the factors, indicating the under-utilization of the input (Stage I). The returns to scale was 3.002, which was an indication that on overall maize production in the study area was in stage 1 of production, implying that inputs were under-utilized by the maize farmers. This also implies that maize farmers could benefit from the economies of scale associated to increasing returns. This is an irrational stage of production (stage 1). At this stage, production could be increased by using more of the production factors. This result was in agreement with previous studies (*Oniah, et al., 2008;* Izekor and Alufohai, 2014) that small-scale farmers operate in the irrational stage (stage 1) of the production function with a returns to scale of greater than unity.

Table 4: Elasticities and Return to Scale in Maize Production

Variable	Elasticities
Farm size	0.291
Labour	0.439
Seed	0.725
Fertilizer	0.528
Pesticides	1.019
Return to scale	**3.002**

Source: Field survey, 2019

Conclusion and Recommendation

The study concluded that maize farmers in the study area were not efficient in the use of production resources. Labour, seed and fertilizer were under-utilized while farm size and pesticides were over-utilized. None of the inputs was optimally allocated or utilized. The farmers were operating in an irrational production stage (Stage 1), implying that maize farmers in the area were having the opportunity to expand output. Output expansion could be achieved by farmers in the area by increasing the use of labour, seed and fertilizer for optimum allocation by increasing the number of hours labour worked, increasing the plant population and reviewing the fertilizer application rate.

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