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Efficiency of Resource Use in Rainfed Maize Production System by Small-Scale Farmers in Central Agricultural Zone of Cross River State, Nigeria

O. O. Osim [a*] and M. O. Oniah [a]

[a] Department of Agricultural Economics and Extension, Faculty of Agriculture and Forestry, Cross River University of Technology, PMB 102 Obubra, Cross River State, Nigeria.

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The study determined resource use efficiency in maize crop production by small-scale farmers in the Central Agricultural Zone of Cross River State Nigeria. It specifically examined the allocative efficiency of resources used by small-scale farmers in rainfed maize production in the area. Primary data were used to conduct the study. Statistical tools employed were multiple regression analysis and allocative efficiency index (AEI). The results of the multiple regression analysis revealed that the variables of farm size (x_1), farm capital (x_3), fertilizer (x_4), farm credit (x_6), extension service (x_7), seeds planted (x_8) had a positive relationship with the output of maize. The allocative efficiency index (AEI) of the various productive resources showed that farm size (x_1), fertilizer (x_3), and herbicides (x_5) were found to be underutilized since their allocative efficiency index (AEI) was greater than one (1) and their marginal value product (MVP) were greater than their marginal factor

**Corresponding author: E-mail: ogonyiosim@gmail.com;*

cost (MFC) while Labour(x_2) was over-utilized as the allocative efficiency index (AEI) was less than one (1). Based on these findings, the following recommendations were made; maize farmers should improve their use of productive resources such as land, capital, fertilizers, herbicide and seeds. Labour factor should be maximally utilized to create a favourable return to a unit of man day employed in maize production in the area.

Keywords: Maize farmers; allocative efficiency; rainfed; small-scall; production; Central Agricultural Zone.

1. INTRODUCTION

"Maize (*Zea mays*) is one of the world's most important staple food crops and a staple food of great socio-economic importance in sub-Saharan Africa" [1]. "Nigeria is the 11th largest producer of maize in the world, and the 2nd largest maize producer in Africa after South Africa" [2]. "It is the most widely grown crop by smallholder farmers which covers over 25 million hectares in sub-Sahara Africa" [3]. Maize has received widespread attention from international and regional bodies due to its high productivity, wide adaptation, relative ease of cultivation, processing, storage, transportation and high-income generating potential.

"Maize is assumed to be a miracle seed for Nigeria's agricultural and economic development. Maize is one of the farm's products that gives an incredible return on investment as a little monetary investment in maize production can yield a sizeable level of income and profit" [4].

"Maize has been of great importance in providing food for man, feed for livestock and raw materials for some agro-based industries. It has the potential for food security and poverty alleviation. Maize grains are utilized in various ways, fresh corn can be roasted or boiled and can be taken as snacks, ripe and dried maize can also be milled into flour for the preparation of breakfast cereal, popcorn, corn oil, glucose, starch and alcohol" [5].

The output of maize produced in Nigeria had been reported to be at an average of 1.69 tons/hectare only which is very low compared to the average output in the United State of America of 11.00 tons/hectare in 2019 [6]. Could this be attributed to low productivity from maize farmers on grounds of inefficiencies of resource use? Farmers were found to be inefficient in the use of their farm productive resources in rice production in Obubra Local Government of Cross River, Nigeria [7], and so could one be tempted to say that this also applies to maize production? However, if farmers are aware of the level of their farm's productive resources, they may be able to improve their production [8]. Given this doubt, it is necessary to examine the resource use in rainfed maize production by small-scale farmers as this will help draw attention to those areas that could be better managed to improve maize production in our environment. In the Central Agricultural Zone of Cross River State, Nigeria, farmers cultivate maize under rainfed ecology using various farm resources to produce maize from their farm plots. One imagines then how efficiently these resources (land, labour, capital seeds, fertilizer, herbicide, farm credit and extension services) are used by small-scale farmers in this area to produce maize to meet the demand of both human and livestock requirements. The desire to provide answers to these questions created the pathway for this research.

2. METERIALS AND METHODS

2.1 Study Area

The study was conducted in the Central Agricultural Zone of Cross River State, Nigeria. "The zone lies between latitude $5^{o}25^{o}$N of the Equator and longitude $8^{o}25^{o}$E of the Greenwich meridian. It is bounded to the North by Yala and Ogoja L.G.A, to the south by Biase L.G.A, to the East by the Republic of Cameroon and to the West by Ebonyi State. It has a land mass of 8762 km^2, with an annual rainfall of 2942mm to 3424mm per annum" [9]. "Its average temperature is 29^{0}C. Farmers in the Central Agricultural Zone are predominantly arable crop farmers, though some farmers cultivate tree crops like cocoa and oil palm. Major crops grown in the area are yam, maize, cassava, melon, cocoyam, plantain, pepper, cocoa and rice" [10]. The Central Agricultural Zone of Cross River State is made up of six local government areas (Abi, Yakurr, Obubra, Ikom, Etung and Boki).

2.2 Method of Data Collection

Data for this study was collected majorly from primary sources. The primary data were obtained from a structured questionnaire and personal interviews. Data were collected on farm productive inputs such as land size, labour, farm capital, fertilizer, herbicide, farm credit, extension service and seeds planted. Personal interviews and field observations were also employed to validate the information supplied by the respondents. A direct contact approach was also used to help minimize the percentage of distraction and unnecessary delays.

2.3 Analytical Tools

Multiple regression analysis and allocative efficiency index (AEI) were used as analytical tools to investigate the objectives.

2.3.1 Multiple regression analysis

Multiple regression analysis was used to determine factors of resources in maize production in the area. The implicit model is as specified thus;

$$Y = f(x_1, x_2 \ldots\ldots x_n) \quad (i)$$

where:
- Y= output
- f= function
- X_1……. Xn= variables of interest,

This is explicitly specified thus:

$$Y=b_0+b_1X_1+b_2X_2+b_3X_3+b_4X_4+b_5X_5+b_6X_6+b_7X_7+b_8X_8+u \quad (ii)$$

where:
- Y = Output (kg) of maize
- X_1= Land size (hectare)
- X_2= Labour (man-days)
- X_3= farm Capital (naira)
- X_4 = Fertilizer (kg)
- X_5= Herbicide (lit)
- X_6 = farm credit (naira)
- X_7 = Extension (dummy)
- X_8= Seeds planted (kg)
- b_o= intercept
- U_t= Error term

The three functional forms of the model are expressed below;

Linear function:

$$Y = b_0+b_1X_1+b_2X_2+b_3X_3+b_4X_4+b_5X_5+b_6X_6+b_7X_7+ b_8X_8 + u \quad (iii)$$

Semi-log functional form:

$$Y = Lnb_0+b_1LnX_1+b_2LnX_2+b_3LnX_3+b_4LnX_4+b_5LnX_5+\ldots+ b_nLnX_n + u \quad (iv)$$

Double log functional form:

$$LogY=Logb_0+b_1LogX_1+b_2LogX_2+b_3LogX_3+b_4LogX_4 + \ldots + b_nLogX_n + u \quad (v)$$

2.3.2 Allocative efficiency

The allocative efficiency index (AEI) was used to determine the efficiency of the resource used. This was done by computing the ratio of the marginal value product (MVP) to the marginal factor cost (MFC) used in production. The ratio used in determining the efficiency of resources will be calculated as:

$$\text{AEI} = \frac{\text{MVP}}{\text{MFC}} \text{ or } \text{K} = \frac{\text{MVP}}{\text{Px}}$$

where:
- AEI or K= Allocative efficiency index
- MVP=Marginal value product of the various inputs. (MPP x P_y)
- MPP= marginal physical product
- P_y= unit price of output
- MFC= Marginal factor cost (cost of unit input) (P_x)

If the ratio is equal to one (1), it indicates that the resource is efficiently utilized. If the ratio is greater than one (1), it's indicative that the resource is underutilized, if the ratio is less than one (1), it indicates that the resource is excessively utilized.

Mathematically, this can be represented as:

If $\frac{\text{MVP}}{\text{MFC}} = 1$; the resource used is efficient,

If $\frac{\text{MVP}}{\text{MFC}} \neq 1$; the resource used is not efficiently utilized,

If $\frac{\text{MVP}}{\text{MFC}} > 1$; the resource used is under-utilized

If $\frac{\text{MVP}}{\text{MFC}} < 1$; the resource used is over-utilized

3. RESULTS AND DISCUSSION

Table 1 shows the result of multiple regression analysis of the field data. From the estimation of the three equations (Linear, semi-log and double-log functions). The double log functional model was chosen as the lead equation (LE) to discuss the result based on the apriori expectation, economic theory, and statistical and economic conditions.

The model (double log function) reveals that variables such as farm size (x_1) farm capital (x_3), fertilizer (x_4) farm credit (x_6), extension services (x_7), and seeds planted (x_8) had positive coefficients and were also significant. However, labour (x_2) and herbicide had negative coefficients and were also significant. The result also indicates that 75% (R^2) of variations in the output of rainfed maize are jointly explained by the explanatory variables, while the F ratio (42.490) indicates the overall significance of the model. The elasticity of production concerning the inputs were 1.585, -0.526, 2.848, 3.499, -2.032, 0.524, 2.742 for land, labour, farm capital, fertilizer, herbicide, farm credit, extension services and seeds planted respectively. Fertilizer was found to be the most important determinant of output in maize production in the area.

Table 1. Multiple regression estimates of rainfed maize production function using the functional forms

Determinant variables	Linear	Semi-log	Double-Log (le)
Constant	-05.688	-5719.008	1.044
	(1660)	(-1.175) **	(1.175) **
Land (x_1)	1307.903	542847	0.212
	(3.120) *	(0.991)	(1.585) **
Labour (x_2)	-7.290	-76.246	-0.74
	(-2.070)	(-0.133)	(-0.526) ***
Farm capital (x_3)	0.005	92.755	0.220
	(1.533)	(0.293)	(2.848) *
Fertilizer (x_4)	0.213	985.386	0.35
	(0.555)	(0.011) ***	(3.499) *
Herbicide (x_5)	-5.906	-838.372	-0.147
	(-0.544)	(-2.832) **	(-2.032) **
Farm Credit (x_6)	0.002	103.236	0.160
	(0.535)	(0.427)	(2.712) *
Extension (x_7)	17.979	258.461	0.047
	(0.275)	(0.707)	(0.524) ***
Seeds planted	36.740	605.999	0.311
(x_8)	(1.016)	(1.307)	(2.742) *
R^2	0.291	0.237	0.759
F-ratio	11.207*	4.203*	42.490*

***Source**: Field data, 2022*

**Significant at 1%, **significant at 5% and ***significant at 10%, (t-values) are in parentheses*

Table 2. Estimation of the allocative efficiency

Explanatory variable	Mean	Marginal value product MVP = B. ($\bar{y}/\bar{x}$) py	Marginal factor cost (MFC)	Allocative efficiency index (AEI)= MVP/MFC	Description of efficiency index
Output(Y)	756.509				
Land Size	0.803	15,069.826	10000	1506.9826	Under-utilized
Labour	124475	-0.050094	2000	-2.50	Over-utilized
Capital	11415	959566720	150000	63971.115	Under-utilized
Fertilizer	103.92	1268002	20000	63.4001	Under-utilized
Herbicide	2.409	2237238	3500	639.210	Under-utilized
Seeds planted	5.464	1671031	400	4177.57	Under-utilized

Table 2 shows the result of the estimated allocative efficiency of productive resources on maize production in the study area. The result indicates that farm size (x_1), fertilizer (x_3) and herbicide (x_5) were all found to be grossly underutilized since their allocative efficiency index (AEI) were all greater than one (1) and their marginal value product (MVP) was greater than their marginal factor cost (MFC). However, Labour (x_2) was over-utilized.

4. CONCLUSION AND RECOMMENDATIONS

Based on the findings of the study, it is concluded that farm-productive resources such as land, fertilizer, herbicide, and seeds planted, positively and significantly affect the level of maize production in the study area. The allocative efficiency index (AEI) reveals that land, capital, fertilizer, herbicides and seeds planted were all found to be underutilized since their allocative efficiency index (AEI) were all greater than one (1). Labour (x_2) was reported to be over-utilized.

This study recommends that more productive resources should be employed by rainfed maize farmers to increase rainfed maize production since all inputs except labour were found to be under-utilized. It is recommended that farmers be advised to use their productive resources to the point where the values of the marginal value products (MVPs) equate their factor Prices (i.e MVPs = P_x s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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