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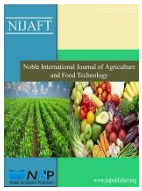

Original Article **Open Access**

RESOURCE USE EFFICIENCY OF RAIN-FED MAIZE FARMING IN NIGERIA

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ABSTRACT: Maize is one of the most resourceful staple food crops in Nigeria. The crop serves as the source of food, income and foreign exchange and has the potential of pushing the country out of the present food insecurity. In response, resources available for maize production need to be efficiently utilized. Therefore, this study analyzed the resource use efficiency of rain-fed maize farming in Nigeria employing information from the 2015-2016 General Household Survey conducted by the National Bureau of Statistics. Descriptive statistics, Gross Margin analysis, double-log function and Marginal Value Productivity analysis were the analytical techniques employed for this study. The descriptive statistics showed that majority (88.9%) of the respondents were males, also majority (66.7%) were in their productive age and aged between 18-59 years with a mean household size of 7. Result of the Gross Margin analysis revealed that an average of ₦35,807.06 was realized per hectare and ₦2.68 realized on each naira invested. The efficiency ratio (MVP/MFC) is greater than one (>1) for all the inputs except for agro-chemical (0.88) implying an underutilization of all inputs except agro-chemical which was over-utilized. Thus, all resources are yet to be efficiently utilized by the maize farmers. However, output and total revenue could be enhanced by increasing the quantity of labour, land, seed and fertilizer, and by decreasing the quantity of agro-chemical used. The study therefore advocates that more production inputs, especially improved maize seeds and fertilizer should be supplied to farmers at the right time and at cost that is within the reach of the farmers to increase output.

Keywords: Resource-use Efficiency, Rain-fed Maize Production, Nigeria.

1. INTRODUCTION

Maize (*Zea mays* L.) is one of the most resourceful and the most important staple cereal crop emerged having wider adaptability under various agro-climatic conditions in the world [1]. Maize has assumed one of the most important staple food crops in the world today, among the cereal crops; maize has the highest genetic yield potential. Globally, maize is cultivated in about 160 countries on almost 150million hectares; it contributes 36 % (782MT) in the global grain production [2]. Maize ranked third after wheat and rice in terms of world importance, however, maize is known as the world's highest supplier of calorie (19.5%) which is higher than the calorie supplied by rice (16.5%) and wheat (15.0%) [3]. In sub-Saharan Africa, maize is the most important cereal crop which is grown by an estimated 50% of the total population in Africa [1]. Maize is the main cereal crops of West Africa and the most important cereal food crops in Nigeria. Maize production with an output of 9,180,270 metric tons in 2013 was rated as the second grown food crop in the country after cassava which produced 52,403,455 metric tonnes [1]. In Nigeria, an average of about 4.7million tonnes of maize were produced between the year 1990 and 2015. Maize cultivation covers about 561,397,29 hectares, which is approximately 61% of total cultivable land in the country and about 98% these maize farmers practice rain fed farming [4].

Economic importance of maize cannot be over emphasizes, maize is widely consumed across the country for both domestic and industrial purposes. Maize is consumed either alone or in combination with other food material with the cereal pounded, ground, cooked, roasted, fried, or crushed in form of kunu, couscous, tuwo, donkwa, aadun, ogi, kokoro, maasa, egbo, abari, donkunnu, gwate, nakia, ajepasi, elekute, akple [5]. For industrial purposes, maize constitutes the major ingredient of animal feed for poultry, brewery for beer and malt drinks, ethanol for bio-fuel, starch and syrup for medical uses [6]. Over the years maize has not only serve as the source of food for man and livestock but also serve as a source of income and foreign exchange for farmers [7].

The term resource refers to those means available for the production of goods and services, while resource efficiency means using the limited available production inputs in a sustainable manner to obtain maximum output with less input. Major economic resources are; land, labor, capital and management. Agricultural inputs are seeds or planting materials, fertilizers, agro-chemicals etc., [8]. Efficiency in resource use is an important tool for increasing farmers output from the existing technology, as low crop

productivity is attributed to inefficiency of resource use, which slows down growth of food production in Nigeria [9]. Findings of Ogundari and O. [10] ascribed the gap between food production and population growth in Nigeria to low productivity of resources being used and technology, which arouse from deficit inessential farm inputs, which necessitates the use of crude tools. The resultant effect of low-level technology is low yield which is not enough to meet the food demand of the growing population.

The main challenge facing Nigerian agricultural sector is the provision of food to meet the requirements of the growing population which is the main thrust of agricultural development programmes [1]. Policy makers give adequate consideration to increasing the production of major food crops to make them readily available and accessible to the teeming population. Policy measures employed by government to boost maize production in the country include the Presidential Agricultural Transformation Agenda of 2011 aimed to define agriculture as a business enterprise, promote private sector investment in farming, along with the development of private sector driven marketing organizations, and the promotion of Incentive-based Risk Sharing for Agricultural Lending. The agenda targets maize as a primary value chain to be developed in all the regions of the country. Another policy document programme named; Agricultural Promotion Policy was rolled out in 2016 saddled with the responsibilities of making necessary readjustment to address the challenges of food insecurity and food quality standards in the export market [11]. However, in spite of these programmes, Nigeria is still challenged with food insecurity. In view of the above, this study attempts to examine resource use efficiency among rain-fed maize farmers in Nigeria.

Shehu, et al. [12] employed the double log function to analyze the resource-use efficiency of small-scale maize production in Tafawa-balewa local government area of Bauchi State. The study found that labour, seed and fertilizer were the inputs that significantly affect maize output. The double-log function gave the best fit with Adjusted R^2 of 81.16%. Maize production elasticity of 1.75 was obtained which suggested that maize farmers were operating on an increasing return to scale. The study concluded that resources were not efficiently utilized as fertilizer and seed were under-utilized and labour was over-utilized in maize production. Thus, more profit could be generated if more of seed and fertilizer, less of family and hired labour were utilized in maize production in the study area.

Sapkota, et al. [13] engaged the Cobb-Douglas production function to analyse the profitability and resource use efficiency of maize seed production in Palpa district of Nepal and found that farm yard manure, labor and tillage were over-utilized. However, chemical fertilizer and seed were under-utilized. The study concluded that for an optimum allocation of resources that will result into increased profitability, quantities offarm yard manure, labor and tillage should be decreased while quantities of chemical fertilizer and seed should be increased.

The economic importance of maize avail the crop the potential of pulling the country out of the present food deficit. Despite this economic potentials, maize has not been produced to meet the food and industrial need of the teeming population as quantities of maize demanded always exceeds quantities supplied. In response to this, resources must not only be devoted to maize production but also be efficiently utilized. This study aimed to contribute to existing knowledge of resource use efficiency by examining resource use efficiency in rain-fed maize production in Nigeria.

2. MATERIALS AND METHOD

2.1. Data and Descriptive Statistics

This study used data of 1,182 households from the 2015 General Household Survey (GHS) in Nigeria coordinated by the National Bureau of Statistics. The survey adopted a multi-stage stratified sampling procedure to select primary sampling units and dwelling units. Information on socioeconomic characteristics and agricultural production of the rain-fed maize farmers were obtained from the GHS dataset, which among others include; age, sex, marital status, household size, educational status, access to credit facilities, fertilizers, herbicides, pesticides, seeds, labour and quantity of maize produced NBS [14]

Table 1 shows the summary statistics of the data employed for this study. The data reveal that the quantities of seed used ranges between 0.17kg and 360kg with mean value of 12.47kg, quantity of labour was between 4mandays and 1954mandays with mean value of 221mandays. The minimum quantity of fertilizer and agro-chemicals were zero with maximum quantities of 21,000kg and 720kg and a mean value of 430.24 and 4.62 respectively. Farm size had a minimum value of 0.00024 hectares, maximum value of 6.9 hectares and a mean value of 0.84 hectares. Quantity of maize harvested ranges between 0.18kg and 76320.30kg with an average of 1147.35kg.

Table1. Summary statistics

Variable	Minimum	Maximum	Mean	Std Dev	N
Seed Quantity (Kg)	0.17	360	12.47	23.50	1182
Labour Quantity (Manday)	4	1954	221	276.63	1182
Fertilizer Quantity (Kg)	0	21000	420.24	1482.63	1182
Agro-Chem (L)	0	720	4.62	25.69	1182
Farm size (Ha)	0.00024	6.90	0.84	1.09	1182
Maize Harvest (Kg)	0.18	76320.30	1147.35	3218.91	1182

Source: General household survey, 2015

2.2. Analytical Techniques

Descriptive statistical technique was employed to describe the socio-economic characteristics of the maize farmers. Gross margin analysis was used to analyze the cost and return structure of maize production. Marginal value product (MVP) was employed to evaluate how resources efficient the rain-fed maize farmers were.

2.2.1. Cost and Return Structure

The Gross Margin analysis was used to analyze the cost and return structure of rain-fed maize farming because very little fixed inputs were used and majority of the rain-fed maize farmers practice mixed-cropping with different crops maturing at different times. Following Omonona, et al. [15], Gross Margin which is the difference between total revenue and total variable cost was expressed as:

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

Where;

$$TR = P_y * Q \quad (2)$$

$$TVC = \sum_{j=1}^{n} V_j * W_j \quad (3)$$

GM = Maize farm Gross Margin;
TR = Total Revenue (₦)
TVC = Total Variable Cost
P_y = Market price of 1kg of maize;
Q = Quantity of maize produced in kg;
V_j = Unit price of the variable input j;
W_j= Quantity of variable input j used;
n= Number of variable input used

2.2.2. Production Function Analysis

A multiple regression model is a causal relationship between two or more independent variables and the dependent variable. Cobb Douglass multiple regression production function analysis was used to compute marginal value product (MVP) in order to determine the optimum, over-utilization and under-utilization of resources. Following Gujarati [16], it is expressed as;

$$Q = aX_1^{b_1}X_2^{b_2}X_3^{b_3}X_4^{b_4}X_5^{b_5}e^{u} \quad (4)$$

In its log-linearized form, it is given as;

$$InQ = Ina + b_1InX_1 + b_2InX_2 + b_3InX_3 + b_4InX_4 + b_5InX_5 + u \quad (5)$$

Where;
Q = quantity of maize produced (kg),
ln = natural logarithm
a = intercept
b_1-b_5= parameters to be estimated
X_1 = farm size (Hectares),
X_2 = total labour (Man-day),
X_3 = quantity of seeds used (Kg),
X_4 = quantity of fertilizer used (Kg) and
X_5= volumes of agro-chemical used (Litres).
μ = stochastic error term

2.2.3. Efficiency of Resource-Use

The most widely used measure of efficiency of resource use is the ratio of Marginal Value Product to Marginal Factor Cost. For a firm to optimally maximize a variable input, the ratio of its Marginal Value Product (MVP) to its Marginal Factor Cost (MFC) must be equal to unity. On the other hand, a ratio less than unity implies over utilization of the variable resource, while a ratio greater than unity implies that the variable resource is under-utilized. Following Sapkota, et al. [13] efficiency of resource (r) was estimated as:

$$r = {MVP}/{MFC} \quad (6)$$

where;

$MVP = MPP * Py$ (7)

$MFC = Px_i$ (8)

MPP = Marginal Physical Product

Py = Unity Price of Output

Px_i = Unit price of input X_i

r = Efficiency ratio

The relative percentage change in MVP of each variable input required to achieve an optimal resource efficiency, (r = 1) was calculated as follows;

$$C = \left[1 - {MFC}/{MVP}\right] \times 100 \quad \text{OR} \left|1 - \frac{1}{r}\right| \times 100 \quad (9)$$

Where C= absolute value of percentage change in MVP of each resource [17].

3. RESULT AND DISCUSSION

3.1. Socio-Economic Characteristics

The data in Table 1 shows the summary of socioeconomic characteristics of maize farmers, the mean age was found to be 53years and majority (50%) were between the productive age of 40 and 59years. Also, about 4 out of every 5 maize farmers were male, married, had a maize farm less than 2hectaresand and had no contact with extension agent. The farmers had a mean household size of 7 and about half of the farmers had household size between 6 and 10. About 2 out of every 5 maize farmers acquired vocational skills, 1 out of every 5 completed primary educations and about 1 out of every 10 completed tertiary educations.

Table 2. Socio-economic Characteristics of Respondents

Variables	Frequency	Percentage
Age (Years)		
18-39	190	16.07
40-59	597	50.51
60 and above	395	33.42
Mean	53	
Sex		
Male	1,051	88.92
Female	131	11.08
Marital Status		
Married	1,022	86.46
Non-Married	160	13.54
Household Size		
1-5	304	25.72
6-10	632	53.47
11-15	216	18.27
16 and above	30	2.54
Mean	7	
Education Level Completed		
No Education	169	14.30
Vocational Education	481	40.69
Primary Education	263	22.25
Secondary Education	167	14.13
Tertiary Education	98	8.29

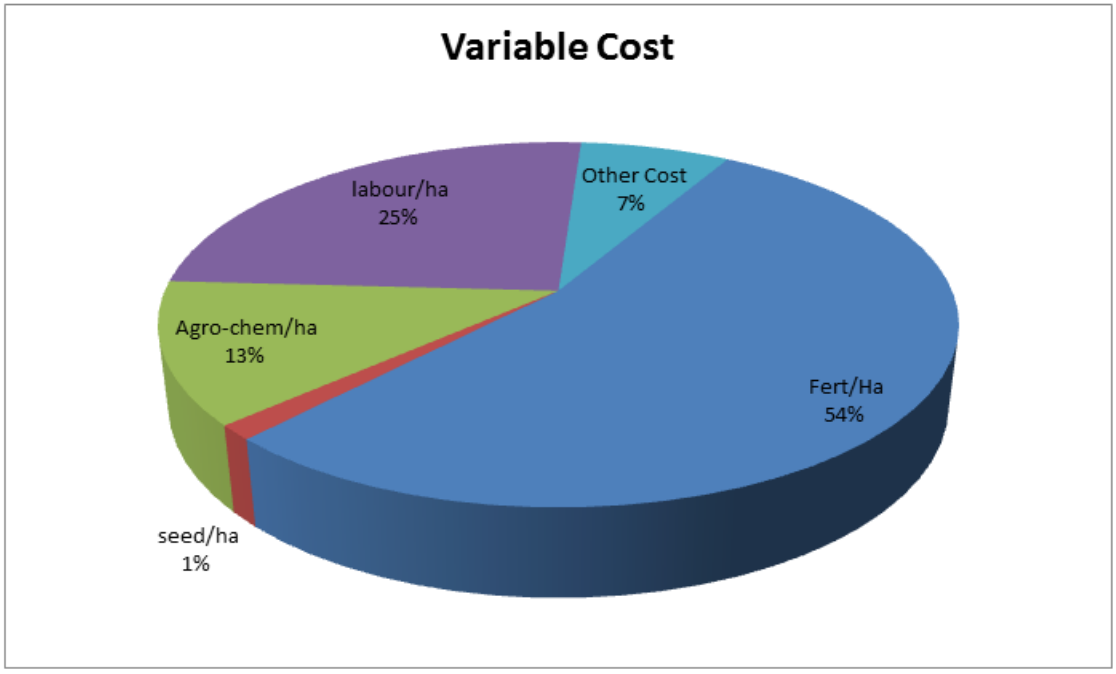
Post Tertiary Education	4	0.34
Farm Size (Hectares)		
Less than 2	1,009	85.36
2-3.9	137	11.59
4-5.9	28	2.37
6 and above	8	0.68
Mean	0.84	
Extension Contact		
Yes	158	13.37
No	1,024	86.63

Source: General household survey, 2015

3.2. Cost and Return Structure Analysis

3.2.1. Cost Structure

Figure 1. Share of Cost components in Rain-fed Maize Production



Source: General household survey, 2015

Figure 1 above shows the cost structure of rain-fed maize farmers. The result shows that cost of fertilizer constitutes the largest proportion (53.67%) of the variable cost as it consumed about half of the cost of production. This means that there was an intensive use of fertilizer by the maize farmers. On the other hand cost incurred on seed constituted the least proportion (1.32%) of the cost incurred in maize production. This implied that probably most of the farmers used maize seeds from previous farming season and low quality seeds from unscrupulous seed merchants.

3.2.2. Return Structure

The result of the analysis of the return structure of maize production is presented in Table 3. The result indicated that proceeds made from maize production was N57,097.73 per hectare while the total variable costs incurred was N21,290.68 per hectare; thus, yielding, and a Gross Margin of N35,807.06 per hectare. However, the rate of return on every naira invested in maize production yielded a profit of ₦2.67, therefore, maize production in the study area was profitable. This result is in line with the findings of Girei, et al. [18], the findings also corroborate Alabi and Abdulazeez [19] who found out respectively that small scale maize farming is a profitable venture.

Table 3. Cost and Return Structure of Certified Rice Farmers

Variable Description	**Amount (N)**	**%**
(a) Total Value Product	57,097.73	
Variable Cost		
(b) Fert/Ha	11,427.94	53.68
(c) seed/ha	279.88	1.32
(d) Agro-chem/ha	2,673.52	12.56
(e) labour/ha	5,367.62	25.21
(f) Other Cost	1,541.72	7.24
(g) TotalVariable Cost (b+c+d+e+f)	21290.68	100
(h) Gross Margin (a-g)	35,807.06	
(i) Return per Naira Invested (a/g)	2.68	

Source: General household survey, 2015

3.3. Estimation of Resource-use Efficiency

The ratio of the Marginal Value Products (MVP) to corresponding Marginal Factor Costs MFC was used to determine the resource use efficiency (r). The estimated coefficients of the exogenous variables were used to compute the marginal value products (MVP) of the maize farmers while the prevailing inputs unit market price is taken as the marginal factor cost (MFC). The result showed that all the variables except for agro-chemicals were greater than unity. This implies that a unit increase in each of these exogenous inputs would increases the quantity of outputs except for agro-chemicals which will decrease the value of maize output, indicating that all the inputs are underutilized except for agro-chemicals which were over-utilized. This findings corroborate Inuwa [20] but in contrary with Zongoma, et al. [7] who discovered over-utilization of all resources among small scale maize farmers in Biu local government area of Borno state.

The percentage adjustment in marginal value products for optimum utilization of resources was also computed which requires that marginal value product must be equal to inputs unit price (MVP = MFC). It was discovered that for optimum resource utilization in maize production, 32.16%, 74.46%, 84.15%, 31.67% and 13.37% adjustment is required for fertilizer, labour, seed, land and agro-chemicals respectively.

Table 4. Resource use efficiency

Variable	**Coefficient**	**MVP**	**MFC**	**r**	**C**	**Efficiency**
Fertilizer	0.0253	147.3975	100	1.473975	0.321563	Under-utilized
Labour	0.7967	4641.566	1000	4.641566	0.784555	Under-utilized
Seed	0.3253	1895.195	300	6.317315	0.841705	Under-utilized
Land	0.2512	1463.489	1000	1.463489	0.316701	Under-utilized
Agro-Chem	0.1514	882.0549	1000	0.882055	-0.13372	Over-utilized

Source: General household survey, 2015

4.4. Conclusion and Recommendations

From the study, it is concluded that venturing into rain-fed maize production is a viable venture for job creation, income generation, poverty alleviation and more importantly improving the food security status of the country. An average rain-feds maize farmer realizes an average Gross Margin of N 35,807.06 from cultivating one hectare of maize farm. In addition, rain-fed maize output empirically responded positively to increases in farm size, seed, labour, and fertilizer but responded negatively to agro-chemicals. However, all the input resources were not efficiently utilized by the farmers. Therefore, farmers maize output could be enhanced by using more of land, fertilizer, labour seed and less of agro-chemicals. This study recommended that adequate attention should be given land expansion programmes to increase the farm size holding of the rain-fed maize farmers by governmental and non-governmental agencies to enhance increase maize production. Also, production inputs, especially improved maize seeds

and fertilizer should be supplied to farmers at the right time and at cost that is within the reach of the farmers.

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