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Economic Analysis of the Input Use Efficiency among Cocoa Farmers in Taraba State, Nigeria

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Authors' contributions

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

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ABSTRACT

The study examined the economic analysis of input use efficiency among cocoa farmers in Taraba State, Nigeria. Data used for the study were collected from 115 randomly selected cocoa farmers in Taraba State of Nigeria. The study reveals that majorities (86.9%) of the respondents are male and 56.7% are of age fifty years and below. Majority (91.3%) of the respondents had formal education while 65.2% had more than 10 years of farming experience. The study further reveals that the farmers are operating profitably considering their per capita gross margin and net farm income of N6, 980 and N144, 450 respectively. Critical factors affecting cocoa output are found to be cost of pesticide, labour and cutlass which are all significant at 1% level. The study also reveals that the farmers are operating on an increasing return to scale given an elasticity of production of 2.64 and all the resources are underutilized. It is recommended that farmers should be given incentives such as subsidy or credit facilities to enable them procure the critical inputs particularly pesticide, labour and cutlass in cocoa production.

Keywords: Input; efficiency; cocoa farmers; net farm income.

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1. INTRODUCTION

Cocoa is known to be the most important agricultural export crop in Nigeria. It has earned the country a significant percentage of the foreign exchange earnings as well as providing employment, directly and indirectly to over 3 million farmers [1]. Nigeria is the 4th largest producer of cocoa in the world, producing about 250,000 metric tons annually [2]. Given the latest technological breakthrough of research in cocoa, farmers can produce cocoa yields of 1000 kg/ha or more. The great parity between the current production and the potential in cocoa production in Nigeria is not unconnected with the low adoption rate of improved technology in cocoa production, infestation of disease and pest, inefficiency in the use and allocation of resource and a host of others [3].

To meet up with the current cocoa transformation agenda of the Federal government of Nigeria, it is imperative that the factors responsible for enhancing cocoa productivity be identified and as such a detailed examination of the farm efficiency of resource use in terms of technical allotment and economic efficiency for increasing productivity be done which necessitate this work. [4] defined efficiency in agriculture in relation to the possibility of farm's production to attain optimum level of output from a given bundle of input at the least cost. [5] has derived the three components of efficiency recognizable in the economic literature. They include: (i) Technical efficiency, (ii) Allocative efficiency, and (iii) Economic efficiency. He originated the current interest in efficiency measurement. [5] proposed an approach that distinguishes between technical and allocative efficiency. Technical efficiency refers to the ability of producing a given level of output with a minimum quantity of inputs under a given technology while allocative efficiency refers to the choice of the optimal input proportions given relative prices. Economic or total efficiency is the product of technical and allocative efficiency. Farrell's model, which is known as a deterministic nonparametric frontier [6], attributes any deviation from the frontier to inefficiency and imposes no functional form on the data and it is the frontier production function that enables the measurement of these efficiencies of farmers. This production function analysis enables the specifications and evaluation of the impact of the inputs on output distribution which is useful for policy making and agricultural production, technology promoting strategies as farmers can affect the distribution of output and thus income by varying the levels and combination of inputs.

A survey carried out by [7] revealed that farmers on the average weed their cocoa farms twice in a year instead of four times recommended and that they control capsids and black pod diseases by spraying twice instead of four times per annum thus leading to low cocoa yield in Ghana.

Inefficiency in resource use on cocoa farm in terms of pesticide, herbicide, simple implement, labour, fungicide and farm maintenance has been an important factor in the constant drop in cocoa output in Nigeria hence the need to undertake the study on how cocoa farmers allocate their resource for cocoa production. Therefore, the main purpose of this study was to analyze the economic efficiency of resource utilization in cocoa production so as to provide information for effective application and management of farm input in Nigerian cocoa farms.

2. METHODOLOGY

2.1 Sampling and Data Collection

The study was carried out in Taraba State of Nigeria. Two cocoa producing Local Government Areas (LGAs) namely, Krumi and Sardauna were purposively selected for the study. Total samples of 115 cocoa farmers were randomly selected (forty five cocoa farmers from Krumi and seventy cocoa farmers from Sadauna LGAs). The data used for the study were collected by administering a well-structured questionnaire to cocoa farmers in the study area. The questionnaire sought the general information on farmer's Socio-economic characteristics as well as the inputs used by the farmers. The data collected were analyzed with the use of descriptive statistics, farm budgetary technique and production function analysis. Descriptive statistics such as percentages and frequency was used to describe the socio -economic characteristics of the respondents in the study area. Farm budgetary techniques were used to estimate the cost and return of cocoa production in the study area. In doing this, budgetary technique was used to estimate the cost and returns on cocoa production while the production function analysis was used to ascertain how efficient the cocoa farmers allocate their resources.

2.2 Analytical Framework

In farm production, technical efficiency is the physical ratio of output to the factor input.

Production function is a function that summarizes the conversion of inputs such as capital, labour and management into outputs of goods and services. This approach is widely employed to examine the impact of physical inputs on production. The stochastic frontier production function which was independently proposed by [8,9] assumes that maximum output may not be obtained from a given input or a set of inputs because of the inefficiency effects.

Consider the following functional form:

$$Q_i = \beta X_i + V_1 - U_1 \quad (1)$$

Where

Q is the vector of output (tons)
X is vector of farm inputs;
β is vector of parameter estimates to be estimated;
V_1 is random variation of Q_i due to factors outside the control of the farmers such as weather and natural disaster;
U_1 is factors within the farmers control that is responsible for the farmers inefficiency such as management.

In general, $V_1 – U_1$ is the composed error term. The technical inefficiency effect model can only be estimated if the efficiency effects are present. The error term has to be included in the model to justify that the production function employs a stochastic frontier approach otherwise it will be an ordinary production function that is estimated by ordinary least squares (OLS) regression technique.

A Cobb-Douglas function was fitted to the stochastic frontier production and estimated. This functional form has been used consistently in related efficiency studies carried out independently by [10,11,4]. In this study, a more flexible form like the translog function was used. The linear transformation is achieved by taking the natural logarithm of the equation and it is given bellow.

$$LnQ = \beta_o + Ln\beta_1 X_1 + Ln\beta_2 X_2 + Ln\beta_3 X_3 + Ln\beta_4 X_4 + Ln\beta_5 X_5 + Ln\beta_6 X_6 + Ln\ \beta_7 X_7 + e_i \quad (2)$$

Where:

Q is Cocoa output (kg);
X_1 is quantity of fungicides used (kg);
X_2 is quantity of insecticides (kg);
X_3 is Number of labour used;
X_4 is Cost of cutlass (N);
X_5 is Cost of spraying (N);
X_6 is Cost of file (N);
X_7 is cost of hoe (N);

e_i is composed error term defined as $V_1 - U_2$ in equation (1)

The functional form used has the ability to reveal whether the resources is constant returns to scale (in which case all the coefficients sum up to one) or increasing returns to scale (a situation where all the coefficients when summed up, is greater than 1) or when It is at a decreasing return to scale (that is, the addition of all the coefficients is less than 1). The marginal value product [MVP] is also estimated based on the coefficient of each resource and it is given by

$$MVP = \beta_i X_i \quad (3)$$

Where:

β_i is the estimate of input i
X_i is input i

Cost and returns to cocoa production was estimated with the use of budgetary analysis, hence, the following arithmetic relationship were used.

$$TC=TFC+TVC \quad (4)$$

$$GR = TFO \times P_X \quad (5)$$

$$GM = GR – TVC \quad (6)$$

$$NFI = GM – TFC \quad (7)$$

Where:

TC is total cost;
TFC is total fixed cost;
TVC is total variable cost;
GR is gross revenue;
GM is gross margin;
NFI is net farm income.

3. RESULTS AND DISCUSSION

3.1 Socio-economic Characteristics of the Farmers

The socio-economic characteristics of the farmers are described in Table 1. The table shows that most of farmers (56.7%) of the farmers are fifty years and below while 43.3% of the farmers are older than fifty years. This shows

that most cocoa farmers in the study area are still agile to do farm work. The resultant effect of this is that there would be an improvement in the efficiency in cocoa production which will increase cocoa output in the area. It should, however, be noted that the result is in line with [12] which shows that majority of cocoa farmers in Cross River state are youths. This is in sharp contrast to the findings of [13] which found out that majority of cocoa farmers in Oyo State are old. The study also found that most of the respondents (86.9%) were male. This is quite obvious because farm work is tedious and it is expected that more men would be involved in it than women. This finding is in line with the findings of [14] which found out that 76% of cocoa farmers in Ondo State were male. Table 1 also shows that all the respondents were married. This connotes that marriage is highly cherished by the people in the study area and could lead to an increase in household size which has positive implication on family labour supply. The study also revealed that just 8.7% of the respondents did not have formal education while majority of the farmers (81.3%) were having formal education. Out of the 81.3%, 39.1% of them were having secondary school education and above. This is a good pointer to improved productivity as the level of education is a tool with which an individual could be efficient at whatever endeavour being undertaken by the individual since the probability to adopt new technology is high [15]. Furthermore, the study reveals that most of the farmers (91.3%) had between 10 – 40 years working experience in farming, a strong indication that the farmers are capable of adopting new technology due to their varied experiences. It was also observed that majority (78.3%) was having farm size of 6 hectares and below which showed that most farmers in the study area are small scale farm holders.

Table 1. Socio-economic characteristics of the respondents

Variables	Frequency	Percentage
Age (years)		
≤ 30	20	17.4
31-50	45	39.1
> 50	50	43.5
Total	115	100.0
Gender		
Male	100	86.9
Female	15	13.1
Total	115	100.0
Marital status		
Single	0	0
Married	115	100.0
Total	115	100.0
Educational status		
No formal education	10	8.7
Primary education	60	52.2
Secondary education	40	34.8
Tertiary education	5	4.3
Total	115	100.0
Farming experience (years)		
≤ 10	40	34.8
11-40	65	56.5
41-60	10	8.7
Total	115	100.0
Farm size (acres)		
≤ 10	40	34.8
11-15	50	43.5
>15	25	21.7
Total	115	100.0

Source: Field survey, 2011

3.2 Cost and Returns Analysis on Cocoa Production

Table 2 shows the costs and returns of cocoa farmers. The table shows that while variable cost per farmer was N57,048, the average fixed cost and average gross revenue were N7,277 and N208,804 respectively. The gross margin and net farm income per farmer were N151,757 and N144,450 respectively. Thus cocoa farmers in the study area are operating profitably. Table 2 also shows that while total variable cost accounts for 88.7% of the total cost of production, the total fixed cost was 11.3%.

Table 2. Cost and returns to cocoa farmers

No	Item	Cost (N)
1	Total variable cost	2624200
2	Average variable cost per farmer	57048
3	Total fixed cost	334740
4	Average fixed cost per farmer	7277
5	Gross revenue	9605000
6	Gross revenue per farmer	208804
7	Gross margin	6,980,800
8	Gross margin per farmer	151,757
9	Net farm income	6,646,060
10	Net farm income per farmer	144,450

Source: Survey data, 2011

3.3 Determinants of Resource use Efficiency

Resource use efficiency which was measured by cocoa output produced by the farmers was estimated using the double log production

function. The result of the analysis is, however, shown in the equation below and explicitly shown in Table 3.

$$LnQ = -9.1+0.142X_1+0.792X_2+0.28X_3+1.19X_4 +0.021X_5+0.305X_6-0.079X_7$$

The result presented in Table 3 shows that the R^2= 0.6078 and it indicates that 60.76% of the variations in dependent variable were explained by independent variables included in the model. The F value was 10.96, significant at 1% level. The result further showed that, of the variables considered to affect the resource efficiency in cocoa production, cost of insecticide, labour and cutlass were found to have significantly affected cocoa output at 1% level and are also positively related to cocoa production, thus indicating that those cost items are critical cost in the production of cocoa. Invariably, more of those inputs are needed to increase cocoa production in other to generate more revenue in the study area.

The cost of fungicide and spraying are not significant, indicating that fungal diseases are not critical factors in cocoa production in the study area. However, the coefficients are positive meaning that there is a positive effect of fungicide and spraying on the yield of cocoa. This could be due to the fact that the level of rainfall in Taraba is relatively low compared to Western part of Nigeria where there are high incidence of cocoa myrid and other fungal diseases due to heavy rainfall that translate to high humidity which favours fungal growth.

Furthermore, the result of the analysis shows that the costs of hoe and file are not significant and has negative coefficient on cocoa production indicating that an increase in the cost of the two items will lead to a decrease in cocoa output. They are not significant due to the fact that the items (especially hoe) are not items that are constantly being used in the operation of cocoa production.

The elasticity of production which is derived directly from the coefficient of the Cobb-Douglas regression equation with respect to the various input costs were found to be 14.2%, 79.2%, 28%, 119%, 2.1%, 30.5% and 7.9% for fungicide, insecticide, labor, cutlass, spraying, file and hoe respectively.

The elasticity represents the ratio of the percentage change in cocoa output to the percentage change in the respective level of the resource used in cocoa production. The sum of the elasticity (When $b_1 + b_2 + \ldots + b_7$ equal one, there is constant return to scale, above one indicate increasing return to scale, and less than one indicate decreasing return to scale). From the study, the elasticity is greater than one (2.64) implying that the production is in an increasing return to scale and that a 100% increase in the resource considered for cocoa production in the study area will generate 264% increase in cocoa output. The positive marginal physical product (MPP) of the production resources also emphasizes the importance of these resources in cocoa cultivation.

The efficiency of resource use was obtained from the estimated equation by comparing the Marginal Value Product (MVP) of a particular input with the Marginal Factor Cost (MFC) of that input. The MVP of an input was obtained by the following equation: $MVP_{xi} = MPP_{xi} * P$ Where MPP_{xi} is the Marginal Physical Product and P is the unit price of the output (Q).The output price of cocoa was found to be N300 per kilogram as at the time of the survey. The MFC for an input is defined as: $MFC_{xi} = MPP * r_{xi}$ Where r_{xi} is the unit price of input x_i. The regression coefficients, which are equal to the elasticity coefficients in Cobb-Douglas production function, were used to measure the return-to-scale in the production of cocoa. As regards the resource use efficiency, whenever $MVP_{xi} > MFC_{xi}$ there is under utilization of resource xi but when $MVPxi < MFC_{xi}$ there is over utilization of resource xi $MVP_{xi} = MFC_{xi}$ there is optimum utilization of resource xi. Table 4 shows the analysis of how efficiently the resources are used among cocoa farmers in the study area.

Table 3. Cobb-Douglas production function estimate for the farmers

Inputs	Coefficient	P-value
Fungicide	0.1418346	0.105
Pesticide	0.7922252	0.000**
Labour	0.2799347	0.009**
Cutlass	1.189853	0.000**
Cost of spraying	0.0208593	0.876
Cost of file	0.3051421	0.197
Cost of hoe	-0.0793939	0.549
Constant	-9.070966	0.018*

Source: Survey data, 2011.
R^2 = 0.6078, F-value =10.96 significant at 1% level.
*** 1 per cent significant*

Table 4 shows the marginal value product and the marginal factor cost analysis of the study on input use efficiency in the study area. The

Table 4. Marginal value product and marginal factor cost for the cocoa farm

Input	Input Price P_x	$Mpp/\beta x_i$	$MFCx_i$	$MVPx_i$
Fungicide	55.102	0.1418346	7.801	42.55
Pesticide	91.33	0.7922252	72.354	237.667
Labour	1660	0.2799347	464.789	83.98041
Cutlass	127.8	1.189853	127.8	356.9559
Spraying	5309	0.0208593	1.1074	6.25779
File	249	0.3051421	0.7598	91.54263

Source: Survey data, 2011.

analysis shows that all the input variable costs are underutilized given the fact that all the marginal value products are greater than the marginal factor cost of inputs considered except for labour which indicated overutilization. Thus these findings are in line with the study of [16] which shows that the inputs of cocoa farmers were underutilized.

4. CONCLUSION AND RECOMMENDA-TIONS

The study found out that majority of the cocoa farmers are male and are below the age of fifty years, therefore they are considered to be agile. Majority of the respondents have formal education and long years of farming experience. The study further reveals that the farmers are operating profitably. Critical costs determining cocoa output are found to be cost of pesticide, labour and cutlass. The farmers are operating at an increasing return to scale given an elasticity of production of 2.64. It was also found that all the resources are underutilized except labour.

It is recommended that more resources, particularly pesticide and cutlasses be employed in cocoa production in as much that the resources significantly affected cocoa output in the study area. Labour saving devices in cocoa production should be developed to cut cost of labor. Therefore, incentive for farmers to enable them procure the critical inputs should be put in place either in form of subsidy or credit so that cocoa output can be enhanced and the farmers livelihood improved.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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