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Profitability and resource use efficiency of cocoa farmers in Idanre Local Government Area of Ondo State

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DISCOVERY SCIENTIFIC SOCIETY

ABSTRACT

Before this study, several studies investigated the resource use efficiency of cocoa farmers in the study area. However, there seems to be no consensus on the production stage of cocoa in Idanre LGA of Ondo State. Hence, this study focuses on the profitability and resource use efficiency of the farmers with a view to determining the current stage of their production. A Cobb-Douglas production function was postulated using an ordinary least squares technique to determine the production elasticity of inputs used by the respondents. To achieve the objective, a multi-stage sampling procedure was used to randomly select two hundred and forty (240) farmers. Data were collected through a well-structured questionnaire. Our results showed that the mean age of cocoa farmers was 47 years, males dominated cocoa production (80.0%), and their mean years of schooling were 8.27. Most of them were married (93.3%), with a mean household size of 8. The net returns per 50 kg (₦8,281.8) from cocoa production showed that the venture was profitable. The return to scale was 1.5334, indicating that the production of cocoa is still in stage I of the production region, thus suggesting that some resources are inefficiently employed. Based on our findings, the study concludes that resources are not optimally allocated. The study, therefore, recommends that cocoa farmers should increase labor, agrochemicals and farm size for optimal combination of resources. However, farmers are advised to reduce the cost of spraying and fertilisers usage.

Keywords: Profitability, resource use efficiency, cocoa production, productivity

1. INTRODUCTION

Cocoa (*Theobroma cacao)* is an important source of income for rural farmers. Approximately 58 countries are producing Cocoa worldwide. The global cocoa output produced per year is approximately 4.9 million metric tonnes, of which Africa produces approximately 81% of the world's total production and 15% is produced by

America. In contrast, Asia and Oceania produce 4% (ICCO, 2022). Nigeria was ranked fourth in the world after Cote d'Ivoire, Ghana, and Indonesia in terms of cocoa production (ICCO, 2022). Approximately 95% of cocoa grown in the world is produced by smallholder farmers who cultivate between 2.5 hectares of land (Anga, 2016). Cocoa cultivation provides a livelihood for approximately 5-6 million farmers in developing countries (Kozicka et al., 2018; Suh and Molua, 2022).

In West Africa, Nigeria inclusive, it is a significant source of income and employment generation. It provides direct employment for more than 2 million households and indirect employment for an additional 5 million people, including household dependents, and more than 20 million West Africans rely on the cocoa economy (Barrientos et al., 2008). In Nigeria, cocoa farms are characterized by smallholder farmers, who produce approximately 6% of the total world output (ICCO, 2022). Cocoa production is a source of foreign exchange earnings with an immense contribution to the total agricultural gross domestic product of the country. The value of cocoa exported by Nigeria in 2022 was N232.65 billion, or approximately 38.9% of all agricultural exports from the nation. Cocoa can be processed into many other products, including chocolate.

Despite these contributions, several challenges still confront the production of cocoa in Nigeria. These challenges include price volatility, noncompliance with cocoa certification requirements, pests and diseases, cocoa tree aging, government policy, and low productivity due to poor resource allocation among various inputs used by farmers. In Nigeria, low productivity is a major challenge among cocoa farmers, though cocoa output has increased recently. The recent increase can be said to be attributed to the government's sensitivity to developing cocoa production in the country. The stimulus package often introduced by the government seems to have little impact on cocoa production. This is because empirical evidence reveals that the average cocoa productivity in Nigeria is between 350 kg and 400 kg per hectare. This value is still well below the average productivities of cocoa farmers in Côte d'Ivoire (500–600 kg/ha) and Ghana (400 kg/ha) (Lanre et al., 2020).

This indicates that the average cocoa farmer is less efficient regarding resource allocation. The fact is that Nigeria has the potential to produce more than it is currently producing, given the availability of natural resources in the country. Several studies have attributed the decrease in productivity in cocoa to one factor or another. For example, Oduwole, (2004) and Cadoni, (2013) revealed that the productivity of cocoa trees was affected by aging farms. It was also revealed that 60% of cocoa farms in the southwest are older than 40 years (Popoola et al., 2015). However, Ogunlade et al., (2009), Ajewole and Iyanda, (2010), and Samuel, (2017) ascribed the low productivity of cocoa farms to climate variation and poor soil fertility; Ayoola et al., (2000) identified the use of low yield varieties as the major cause; and Anikwe et al., (2010) identified pest infestation as the major reason for the decline in cocoa output in the country.

Inkoom et al., (2022) noted that most of the suggestions to solve this perennial problem have often resorted to the adoption of technologies such as agrochemicals, hybrid cocoa seedlings, and other agronomic practices. However, they admitted that it was good but often failed to yield the expected results. Low productivity is a feature of production inefficiency. Inkoom et al., (2022) stated that production economists have contended that output growth does not necessarily depend on the quantum of technologies injected by farmers but on the efficiency with which these technologies are utilised at the farm level. A review of the literature showed that several studies had been conducted on resource use efficiency measurements. For example, Nkamleu et al., (2010) investigated productivity potentials and efficiencies in cocoa production in West and Central Africa.

The study used metafrontier function technique to determine the efficiency of cocoa farmers. He reported that technical efficiency in cocoa production is low, and the technology gap plays an important role in explaining the efficiency of cocoa farmers in one country compared with cocoa farmers in other countries. A similar effort was made by Massaquoi et al., (2022) in analysing the profitability of cocoa farmers in Sierra Leone, who found that cocoa farmers did not optimally utilise their resources. The study also revealed that cocoa farmers were operating in stage 1 of the production region. In Nigeria, estimated labor productivity and resource use efficiency in cocoa farming in Abia State, Nigeria. The study revealed that farm size, labour, fertiliser, and capital were overutilized, while seed was the only variable reported to be underutilized. Oluyole and Sanusi, (2009) carried out a study to evaluate the effects of farmers' socioeconomic variables on cocoa production.

The study identified farm size and the educational level of the farmers as factors affecting cocoa production. Analyzed the profitability and resource use efficiency of cocoa production in Osun State. The study concluded that the farm size, yield, and age of trees were less optimally allocated. The study revealed that only chemical input was efficiently utilized. In their assessment of resource use efficiency and investment in cocoa enterprises, showed that cocoa farmers' productivity is low. From the foregoing studies, it is evident that different factors are identified as causes of low productivity among cocoa farmers, and we found that these causes are location specific. The majority of cocoa producers in Nigeria are smallholders.

The Ondo State Government has made a significant number of interventions to boost cocoa production. Among the interventions was the distribution of cocoa seedlings to farmers at zero cost, the provision of an extension service free of charge, etc. Although the cocoa output increases, the success recorded still falls short of the state's potential. To achieve the optimum level of cocoa production, the need to investigate the resource use efficiency of inputs on cocoa farms is inevitable. Therefore, this study aimed to determine the profitability and resource use efficiency of cocoa farmers in the Idanre Local Government Area of Ondo State. Specifically, the study computed the cost and returns and determined the resource use efficiency of cocoa farmers. The outcomes of this research would be of immense benefit to producers, marketers and consumers in the cocoa value chain.

2. METHODOLOGY

Study area

This study was conducted in the Idanre Local Government Area (LGA) of Ondo State, Nigeria. The Idanre LGA is approximately 20 kilometres southeast of the State's capital, Akure. It has an area of 1,914 km2 and a population of 129,024 (National Population Commission, 2006). Idanre is Nigeria's largest cocoa-producing Local Government Area in Ondo State. Idanre LGA is divided into three major districts: Odode-Idanre, Alade, and Atosin. It is surrounded by mountainous hills, making it attractive for tourists. Idanre LGA region experiences both wet and dry seasons at latitude of 9.81°N from the equator and a longitude of 5.51°E from the Greenwich meridian. The climatic conditions of the study area also support the cultivation of food crops and the rearing of livestock.

Data collection and model specification

The sample for the study was selected from the population of cocoa farmers in the study area using a multistage sampling procedure. In the first stage, the three districts in the Idanre LGA were purposively selected because of their high involvement in cocoa farming. These communities include Odode-Idanre, Alade, and Atosin. In the second stage, we purposively selected five villages from each of the communities due to their high participation in cocoa production. The third stage involved a random selection of sixteen (16) farmers from the selected villages to obtain 240 respondents as our sample size.

Budgeting analysis

The budgeting technique is a popular method for evaluating the performance of a business. This study used budgeting to evaluate the gross margin of cocoa producers. The gross margin is the measure of the difference between the total revenue and total variable cost. The net farm income was obtained by either deducting the total fixed cost from the gross margin or the total revenue minus the total cost. Mathematically, the gross margin for cocoa production is expressed as follows:

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

$$TC = TVC + TFC \quad (2)$$

$$NFI = TR - TC \quad (3)$$

Where,

NFI = Net farm income realised by the ith farmer on the sale of cocoa per kg;

GM = Gross margin realised from the sale of cocoa by the ith farmer per kg;

TR = Total revenue of the ith farmer on sale of cocoa bean per kg;

TVC = Total variable cost incurred by the ith farmer for cocoa production per kg;

TC = Total cost incurred by the ith farmer for cocoa production

TFC = Total fixed cost incurred by the ith farmer on durable implements

Cobb–Douglas production function

Following Gujarati, (2003), the Cobb–Douglas production function for the input–output relationship of cocoa production was implicitly specified as follows:

$$Yi= f(X,b1\ X,b2\ X,b3\ Xb4\ X,b5.X,b6.X,b7X,b8,Ui). \quad (4)$$

Where,

Y_i= Cocoa output per kg produced by the ith farmer, X_1= age of household head in years, X_2= years of schooling, X_3 = family labor (man-day), X_4 = agrochemicals (litres), X_5 = labor used for spraying (man-day), X_6 = cost of transportation (₦) X_7 = fertilizer (kg), X_8 = farm size (Ha), bi…bn= coefficients of regression e = error term

The explicit functional forms of equation 4 are specified as

$\ln Y_i = b_o + b_1\ln X_1 + b_2\ln X_2 + b_3\ln X_3 + b_4\ln X_4 + b_5\ln X_5 \ldots + b_8\ln X_8 + e_i$ …….. (5)

The Cobb–Douglas production function was fitted to the cocoa input–output data collected because the coefficients of the variables can be interpreted directly as elasticities (Gujarat, 2003).

Production elasticity

The production elasticity of cocoa production in the study area was calculated by using equation 6. The sum of the elasticity gives the return to scale of production.

$$E_p = \frac{\partial y}{\partial x} * \frac{\overline{Y}}{\overline{X}} \qquad i = 1, 2, 3\ldots\ldots J \qquad (6)$$

Resource-use efficiency

The efficiency of resource use is calculated by the ratio of the marginal value product (MVP) to the marginal factor cost (MFC) of inputs based on the estimated regression coefficients. The marginal value productivity (MVP) and marginal factor cost (MFC) of the Cobb–Douglas production function were estimated as follows:

$$MVP = MPP.P_y = \beta_i \frac{\overline{Y}}{\overline{X}} \cdot P_y \qquad (7)$$

Where,

MPPxi is the marginal physical product of the input resource Xi, Py is output price, β = regression coefficient, and $\overline{Y}$ and $\overline{X}$ are the geometric means of the output and input, respectively.

Following Fatuase et al., (2015), the efficiency of resource, r, is given as

$$r = \frac{MVP}{MFC} \qquad (8)$$

Where,

r = efficiency ratio, MVP remained as previously defined.

Decision criteria for resource utilization:

r = 1 indicates efficient use of a resource, r > 1 indicates underutilization of a resource, and r < 1 indicates overutilization of a resource.

To obtain the necessary resource adjustments needed to be carried out on the farms, we follow Massaquoi et al., (2022) to calculate the resource use adjustment as follows:

$$Di = (1 - (MFCi/MVPi)) \times 100 \qquad (9)$$

Where,

Di = The absolute value of the percentage change in the MVP of the resource; MFCi = The marginal factor cost of the ith resource; and MVPi = The marginal value product of the resource.

3. RESULTS AND DISCUSSION

Socioeconomic characteristics of cocoa farmers

The mean age of the sampled farmers was 47.5 years, suggesting that cocoa farmers are still energetic in the study area (Table 1). A total of 80.0% were male-headed households, while 20.0% were female-headed households. In an African setting, male children have better access to resource endowments than their female counterparts. A total of 93.3% of the farmers were married, with an average household size of 8.0 persons. The mean years of schooling were 8.27, indicating that cocoa farmers in the study area were fairly educated.

Table 1 Descriptive statistics for cocoa farmers (n = 240)

Variable	Mean	SD
Age (years)	47.53	9.969
Marital status (1/0)	0.97	0.258
Gender (1/0)	0.8	0.403
Household size (in number)	8.13	3.947
Years of schooling (years)	8.27	3.354
Farm size (ha)	5.28	7.248
Years of farming experience (years)	23.33	8.321
Cost of transportation (₦)	7,743.33	10,374.37
Fertiliser (kg/ha)	9.23	1.47
Age of cocoa tree	22.63	11.243
Price per kg	10,000	3.807

Source: Field survey data, 2024

Cost and returns of cocoa production

The computations of the costs and returns of cocoa production are presented in (Table 2). The results showed that the TFC was ₦ 69,167.0, representing 80.5% of the TC, and the TVC was computed as ₦16,741.3, accounting for 19.5% of the total cost of producing 50 kg. The total cost incurred was ₦85,908.3. The total revenue was computed as ₦500,000 with a gross profit and net profit per kg of ₦9,665.2 and ₦8,281.8 respectively. These results indicate that cocoa production is highly profitable in the study area. The calculated profitability ratio indicates that for every ₦1 farmer who invested in cocoa production, he or she would gain 20 kobo. This further confirms the profitability of cocoa production in the study area.

Table 2 Costs and returns of cocoa production per 50 kg

Item	Mean/₦/year	Percentage (%)
Fixed Item		
Go-to-Hell	612.7	0.7
Sprayer	21,873.3	25.5
Head pan	2,376.7	2.8
Cutlass	7,125.3	8.3
Sack	3,429.7	4.0
File	1,369.3	1.6
Land	3,2380.0	37.7
Total fixed cost (TFC)	69,167.0	80.5
Variable Items		
Cost of transport	3,097.3	3.6
Cost of Agrochemicals	5,361.3	6.2
Cost of weeding	2,588.0	3
Cost of spraying	3,548.0	4.1
Cost of harvesting	2,146.7	2.5
Total variable cost (TVC)	16,741.3	19.5
Total cost (TC)	85,908.3	100
Revenue (TR)		
Value of cocoa	500,000.0	-
Gross profit/50 kg	9,665.2	-

Net profit/50kg	8,281.8	-
Gross ratio = (TC/TR)	0.2	-

Source: Field survey data, 2024

Regression results for the factors affecting cocoa production

The regression coefficients and t values of the estimated production functions are presented in (Table 3). This study specifically estimated the Cobb–Douglas production function. Two regression models were run and are presented here. The first one was estimated with the default standard error. The Breusch–Pagan/Cook-Weisberg test showed that our data suffered from heteroscedasticity, so we proceeded to estimate the data using a robust standard error. The adjusted R2 was 89.1, and the F value (51.46) was significant at the 1% probability level, suggesting that all explanatory variables included in the model contributed significantly to the net income of cocoa farmers. The VIF (2.63) was below 5.0, suggesting that there is an absence of multicollinearity among the variables in the model.

All variables included in the model except agrochemicals were statistically significant at the conventional concentrations of 1%, 5%, and 10%. The significant variables in the model were age, household size, labor cost of spraying, years spent in schooling, farm size, cost of depreciation, and cost of transportation. The age variable has a negative coefficient (3.106) at the 1% level of significance. This result is consistent with our *a priori* expectations. The implication of the result is that as the farmer ages, at a certain level of age, his productivity will decline. In other words, beyond the mean age (48 years) of cocoa farmers in the study area, farmer output will decrease. An additional year of age will reduce the output of cocoa farmers by 3.11%. The coefficient of years of schooling was 1.32, with a positive sign at the 1% level of significance. This implies that a one-year increase in education, ceteris paribus, leads to a 1.32% increase in the income of cocoa farmers. Educated Farmers have a better understanding of the benefits associated with adoption of innovations.

It is easier for educated farmers to adopt innovation than for uneducated farmers. This outcome agrees with the findings of Oluyole and Sanusi, (2009) in the Cross River State, Nigeria. The effect of household size on the productivity of cocoa production was consistent with the study's hypothesis. The coefficient of household income was estimated at 1.019, with a positive influence on the productivity of cocoa farmers. It was found to be statistically significant at the 1% level. This result implies that a 10% increase in household size leads to a 10.2% increase in the net income of cocoa farmers. Households with large members will have easier access to family labor than will small families. The agrochemicals had a positive effect on the output of cocoa farmers. However, the variable was statistically insignificant at all the chosen conventional probability levels. The reason could be due to overutilization of the input.

Similarly, the labor price for spraying was negative and statistically significant at the 1% level. The labor price is added to the total cost, which may push farmers to reduce the amount paid on labor service from optimum use, and this will, in turn, impact the production of cocoa farmers. This result agrees with our hypothesis that an increase in labor prices leads to a reduction in cocoa production. This result suggests that a 100% increase in the labor price of spraying, ceteris paribus, decreases the output of cocoa farmers by 62.3%. The transport cost was positively signed and statistically significant at the 1% level. However, this finding is not in line with our expectations. This result implies that a one-naira reduction in the transport cost, *ceteris paribus*, leads to an increase in the net income of cocoa farmers by 0.3%.

Furthermore, the coefficient of farm size was 0.641, with a positive influence on the farmer's income at the 1% level of significance. The sign of the coefficient is consistent with the study's hypothesis. This result implies that the expansion of cocoa farmland by one hectare, ceteris paribus, will lead to an increase of approximately 0.64% in cocoa production. This result is consistent with the earlier report of Oluyole and Sanusi, (2009) in the Cross River State of Nigeria on the effect of socioeconomic variables on cocoa production. This is possible if all agronomic practices recommended are followed.

Table 3 Cobb–Douglas Production Function of Cocoa Production

Variable	**Coef.**	**Coef. (Rob. std)**
Constant	20.665 (2.555)	20.665(1.916)***
Age in years	-3.106(0.528)	-3.106(0.401)***
Years of schooling	1.323(0.254)	1.323(0.249)***
Family labour	1.019(0.212)	1.019(0.235)***

Agrochemicals	0.110(0.094)	0.110(0.068)
Cost of spray	-0.623(0.118)	-0.623(0.129)***
Fertiliser	0.386(0.214)	0.386(0.233)
Cost of transportation	0.308(0.077)	0.308(0.099)***
Farm size	0.641(0.125)	0.641(0.119)***
F (8,41)	20.665(2.55)	14.66***
Adjusted R2	0.65	0.7
VIF	2.630	2.63
Breusch–Pagan/Cook-Weisberg test for Heteroskedasticity	0.044	-

Note: Figures in parentheses are standard errors. ***, **, *, asterisks mean significance at the 1%, 5% and 10% levels, respectively.
Source: Field survey data, 2024

Production elasticity of resources used by cocoa farmers

The production elasticity for each of the model variable inputs is presented in (Table 4). The sum of the coefficients of the variables in the model was positive and greater than one (1.5334), which implies that the production of cocoa in the study area is in the stage of increasing returns to scale. In other words, the RTS of 1.5334 indicates that the production of cocoa is in stage I of the production surface. That is, each additional unit of input employed in production translates into one unit increase in cocoa production compared with the preceding unit. This result confirms the gross inefficiency and underutilisation of inputs by farmers.

Table 4 Production Elasticity (EP) and Return to Scale (RTS) in Cocoa Production

Input	**Production elasticity**
Farm size	0.6412
Spraying	-0.623
Agrochemicals	0.1102
Fertiliser	0.3858
Family labour	1.0192
Return to scale (RTS)	1.5334

Source: Field survey data, 2024

Resource use efficiency of cocoa farmers

Table 5 presents the marginal value product, marginal factor cost, efficiency index, and resource use adjustment of each resource use. The efficiency indices of spraying, family labor, agrochemicals, fertilizer, and farm size were all positive and greater than one. This implies that these inputs are underutilized by cocoa farmers in the study area. The source of divergence may be attributed to a lack of technical expertise and low managerial skills.

The result of resource optimisation in cocoa farming, suggests that the expenditures on spraying and family labor employed by farmers should be increased by 4.3% and 32.3%, respectively. Also, quantity of agrochemicals and farm size cultivated are expected to be increased by 65.0% and 82.5%, respectively, to obtain efficient production. However, the farmers are advised to reduce the quantity of fertilizers use. These findings are similar to the suggestions of Massaquoi et al., (2022) that farmers should increase the unit of family labor, farm size, and agrochemicals to ensure efficient production on cocoa farms.

Table 5 Resource use efficiency

Inputs	**MPP**	**MVP**	**MFC**	**r**	**D%**
Spraying	-0.623	-6230	-5962.11	1.04	4.3
Family Labour	1.019	10190	6902.02	1.48	32.3
Agrochemicals	0.11	1100	385	2.86	65.0

Fertiliser	0.386	3860	5914.64	0.65	-53.2
farm size	0.641	6410	1121.75	5.71	82.5

Pq = ₦ 10,000 MPPx denotes the marginal physical product of the resource. Px denotes the price of the resources, MFC = marginal factor cost.

Source: Field survey data, 2024

4. CONCLUSION AND RECOMMENDATIONS

This study determined the resource use efficiency of cocoa farmers in the Idanre Local Government Area in Ondo State. From the study, it was concluded that cocoa farmers are still productive in age, males dominate cocoa production, and the majority of the farmers are educated and married with a household size greater than the national average of 6. The study concluded that the production of cocoa is profitable in the study area. The estimated production function revealed that all but the quantity of agrochemicals used had a significant influence on the output of cocoa farmers at 1% and 5%, respectively.

The computed return to scale showed that the production of cocoa in the study area is in stage I of the production region, suggesting that the resource combination in cocoa production is efficiently allocated. Based on these findings, the study recommended that cocoa farmers increase the use of labour, agrochemicals and farm size on cocoa farms for the optimal combination of resources. However, farmers are reducing their expenditure on spraying and the quantity of fertilisers applied on farms.

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Informed consent

Written & Oral informed consent was obtained from individual participants included in the study.

Conflicts of interests

The authors declare that there are no conflicts of interests.

Ethical approval

Not applicable.

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Data and materials availability

All data associated with this study are present in the paper.

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