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DETERMINANTS OF ACCESS TO MICROCREDIT AND ITS IMPACT ON COCOA YIELD IN OSUN STATE, NIGERIA

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Abstract

Microcredit is crucial to the reduction of poverty in underdeveloped nations. Smallholder farmers benefit from having access to microcredit by raising their standard of living. However, lack of access to microcredit is still the fundamental barrier to the economic progress of farmers. Current studies have been unable to fully comprehend the connection between productivity and microcredit. Therefore, this study investigated the impact of access to microcredit on cocoa yield in Osun State. A multi-stage sampling procedure was employed to select 120 cocoa farmers for the study. Data collected were analyzed using descriptive statistics, binary probit regression, and fractional probit regression models. The results for the entire respondents showed average values of 44 years for age, 22 years for years of experience, 6 persons for household size, and 2.8 hectares for farm size. Binary probit estimates show that off-farm income, years of formal education, marital status and membership of an association were statistically significant factors influencing access to microcredit. Fractional probit estimates show that access to microcredit, formal education, primary occupation, farm size and membership of associations were statistically significant factors influencing cocoa yield. This study concluded that access to microcredit is an important variable affecting cocoa yield. This suggests that policy strategies aimed at improving cocoa productivity must consider access to microcredit. It is therefore recommended that financial institutions should focus on the provision of timely and sustainable microcredit to smallholder farmers to improve their cocoa yield.

Keyword: Access to microcredit, Cocoa yield, Osun State, Smallholder farmers

INTRODUCTION

Perennial crops such as cocoa, coffee, cashew and oil palm have been an important component of smallholder farming systems across the humid tropics of West Africa including Nigeria. Up to the 1970s, these perennial crops led agricultural exports and provided sustainable pathways for economic development in Nigeria. Among the perennial tree crops, cocoa continues in this role (Kehinde *et al.*, 2021; Kehinde, 2022; Akande *et al.*, 2023). The cocoa crop (*Theobroma cacao*) thrives in tropical climates and production is therefore dominated by countries in those regions, while consumption is mostly by countries in temperate regions of the world. Cocoa earns more foreign exchange than other crops, and offers employment to many people, both directly and indirectly, more than 20 million people depend directly on cocoa for their livelihood and serves as an important source of raw materials and revenue to governments of cocoa-producing States (Amao *et al.*, 2015; Kolawole *et al.*, 2020; Faloni *et al.*, 2022). Cocoa is a high-value cash crop among farmers in the major producing areas in Nigeria (Taphee *et al.,* 2015; Kehinde and Tijani, 2021). In Nigeria,

cocoa-producing States include Ondo, Oyo, Osun Ogun and Ekiti where farmers either operate on inherited fields or operate a sharecropping system in which two-thirds of the produce accrues to the land owner who also contributes to the purchase of farming input. Nevertheless, the States that produce cocoa saw rapid socioeconomic development as a result of cocoa exports (Ogunleye *et al.*, 2020). The proceeds from the export of cocoa served as the main source of income for the government to pay for important services including education, healthcare, and pipe-borne water supply. In addition to its economic impact, cocoa has exceptional nutritional value, having up to 20% protein, 40% carbs, and 40% good fats which have numerous health advantages (Kehinde, 2021).

Despite these huge benefits, cocoa farmers have always remained impoverished due to the high capital requirement and risk involved in cocoa production (Kehinde and Ogundeji, 2022a). The farmers are faced with many problems such as lack of credit, farm inputs, machinery, and uncertain weather patterns (Kongor *et al.*, 2018; Kehinde *et al.*, 2024). These problems are further compounded by the ageing of trees, the occurrences of pests and diseases and low cocoa yield. The Cocoa sub-sector is currently not performing well and this is manifesting in the successive decline of cocoa annual output (Sowunmi *et al.*, 2019; Ige and Ojo, 2023). The cocoa yield has declined tremendously over recent years (FAO, 2011; FAOSTAT, 2016; ICCO, 2018). For example, cocoa output has decreased from 399,200 tonnes to 195 000 tonnes between the periods 2010–2015 (FAOSTAT, 2016). Also, cocoa production decreased by 10,000 metric tonnes (MT) to 245,000 MT in 2018/2019, down from 255,000 MT in 2017/2018. (ICCO, 2019). Furthermore, the number of cocoa beans exported was 226,634 tonnes in 2010 and declined to 76,197 tonnes in 2015 (FAO, 2016), consequently, resulting in a huge loss of revenue amounting to $1 billion yearly (Eze *et al.*, 2018). Presently, cocoa yield in Nigeria is estimated to be 200 kg/ha on average (Kolawole *et al.*, 2020; Ige and Ojo, 2023) and is much lower than other major producing countries like Ghana with an average yield of 400 kg/ha, Malaysia with an average yield of 1,600 kg/ha and Cote d'Ivoire's 700 kg/ha (Attipoe *et al.*, 2020). As a result, living conditions of many cocoa farmers have been worse over the years due to reduced cocoa farming returns, making them poorer and forcing them to leave their fields in pursuit of better job opportunities to survive (Tuninetti *et al.*, 2022). The failure of the government to provide young cocoa farmers with funding for farming inputs also lowers the amount of cocoa produced in Nigeria (Adebayo, 2019).

However, to achieve higher cocoa yields, there is a need for adequate farming inputs. Input financing is an important factor needed to improve cocoa yields (Meludu *et al.*, 2017; Ladigbolu *et al.*, 2020). However, most cocoa farmers rarely have access to credit which has made it impossible for them to invest in cocoa businesses. Additionally, certain types of credit provided to cocoa farmers do not always lead to the intended increase in cocoa production (FAO, 2021). Nevertheless, Girabi and Mwakaje (2013), Baffoe *et al.* (2014), Amao *et al.* (2015) and Kehinde and Ogundeji (2022b) separately noted that poor access to credit by small-scale farmers is the major cause of low productivity as these farmers are unable to purchase the necessary inputs for production. This was further emphasized by Adewuyi *et al.* (2017) that many cocoa farmers have neglected their farms and moved to other sectors of the economy due to the problem of credit insufficiency. The problem was made worse by the reluctance of banks to lend money for agricultural production because of the risky nature of agriculture, which is highly dependent on the weather, the failure of farmers to repay loans, and the lack of necessary collateral to obtain bank credit (Lawal *et al.*, 2009; Okojie *et al.*, 2010; Asogwa *et al.*, 2014). For cocoa farmers to carry out their farming activities, such as the timely application of chemicals for the control of pests and diseases, they need to have access to cash throughout the cropping season, according to Vigneri and Santos (2009) and Oke *et al.* (2019), who highlighted the crucial role access to credit plays in cocoa production. With access to sufficient credit, this may become promising. Unfortunately, as explained above, most cocoa farmers face serious liquidity constraints to access credit which invariably affect their yield.

Governmental and non-governmental organizations launched a number of credit programs to promote loan availability among cocoa farmers. These initiatives, though, had little to no positive impact on cocoa productivity. Smallholder cocoa farmers in Nigeria face a number of obstacles that prevent them from accessing institutional financing, including the need for a minimum deposit, thorough farm records, and collateral security. Due to high rates of default and illiteracy among farmers, major commercial banks are also reluctant to extend credit to them (Oke *et al.*, 2019). The failure of small-scale farmers to provide the necessary collateral, however, is the most worrying problem (World Bank, 2020). Consequently, a number of alternatives to bank credit have emerged. Microcredit is an extension of small loans to smallholder farmers who typically lack collateral and allows the farmers to purchase the necessary inputs such as seeds, fertilizers, and other inputs for improved productivity. According to Muogbo and Tomola (2018), microcredit institutions are those authorized to offer small, medium, and micro firms financial services including loans, home transfers, and other financial services to help them operate and grow their businesses. According to Kibas (2017), there are four categories of lenders for microcredit: non-governmental organizations (NGOs), banks,

community-based organizations (CBOs), and savings and credit cooperatives (SACCOs). They offer minor loans to businesses as a sort of financial services including savings, loans, and insurance. According to Ouma and Ogaga, (2015), Sulemana and Adjei (2015) and Ogunleye *et al.* (2024), microcredit facilities include micro-credit loans, inputs, micro-savings, micro-insurance, and money transfers been attributed to enabling micro-entrepreneurs to build businesses and increase their income, as well as improving the general economic wellbeing of the poor. In some ways, microcredit has given small-scale farmers hope that they will be able to obtain credit and go above the subsistence level. Therefore, microcredit offers a greater range of financial services, particularly to the poor, which directly or indirectly improves their socioeconomic standing and farm output.

Given this background, it is expected that a lot of research efforts should be directed towards using microcredit to solve the problems of cocoa yield in Nigeria. Unfortunately, many studies stressed the impact of microcredit on the adoption of innovations, household food security, poverty alleviation and farmers' income. For example, Lawin *et al.* (2018) investigated the causal effects of microcredits on the adoption of innovations, investments, farm incomes and profits. Vishwanatha and Mutamuliza (2017) investigated the impact of Microcredit on Small Farmers' Livelihoods in Rwanda. Nakano and Magezi (2020) examined the impact of microcredit on the adoption of technology and productivity of rice cultivation in Tanzania. Namayengo *et al.* (2023) conducted a study on a comparative study on the role of microcredit on agricultural production improvement among resource-poor rural women. However, there has been little empirical research on access to microcredit and the yield of farmers. Although Ogunleye (2018) investigated the effect of access to microcredit on cassava productivity, very little work has been done on the effect of microcredit on cocoa yield, none to the best of our knowledge exists. This study is therefore a response to filling this knowledge gap as well as providing some policy impetus in the cocoa industry. This study, therefore, investigates the impact of access to microcredit on cocoa yield. Specifically, the objectives of this study are threefolds:

1) describe the socio-economic characteristics of cocoa farmers;
2) determine the factors influencing the access to microcredit among cocoa farmers;
3) determine the effect of access to microcredit on cocoa yield.

Policies improving cocoa yield at the farm level would be built on the findings of this study. With increased yields, the article hopes to contribute to the larger discussion on the importance of microcredit in assisting households engaged in cocoa production to escape poverty and food insecurity. Additionally, this research would provide policymakers with a tool to aid them in creating efficient policies that can facilitate the functioning of microcredit organizations. This manuscript is organized as follows:

- Section 2 provides a literature review;
- Section 3 gives in-depth information about both the methodology used and data sources;
- Section 4 shows the discussion of the results obtained in the study; and finally;
- Section 5 provides the conclusion and policy implications.

Literature Review

Peasant farmers, who have poor incomes and limited savings ability, predominate in Nigeria's agricultural industry. According to research by Manyong *et al.* (2004), the inability of farmers to obtain timely loans has been a significant barrier to making sound investments and increasing their agricultural productivity. Due to the clear understanding of the time-sensitive nature of particular farm operations, providing farmers with timely and targeted accessible loans to increase production and income is one method to improve their capital investment. One element of financial services that is seen as essential in all production units is credit (Dicken, 2007). The importance of credit as a tool for agricultural development has gained widespread recognition (Omonona *et al.*, 2008). The bane of agricultural productivity, revenue generation, and household welfare, however, had been the inability of poor rural households to get credit. Poor credit availability makes it impossible to get production inputs, much alone to maximize output from available resources or to reduce the amount of resources needed to produce a given level of output. Growing empirical research reveals that loan restrictions significantly reduce farm output in rural developing countries (Kehinde and Olatidoye, 2019; Nakano and Magezi, 2020). Low farm productivity in Nigeria is a result of the pervasiveness of financial restrictions and their effects on the effectiveness of production. The pecking order hypothesis was utilized in this study to assess whether cocoa producers had access to credit facilities or could independently finance their production without outside funding. The argument holds that agricultural businesses prefer to obtain their funding internally rather than through outside sources. When internal resources run dry, businesses might turn to debt and equity as a final resort. This theory asserts that there is a preferred source of funding pecking order and outlines two strategic sources of funding that an investor might employ to advance his or her investment project. When it comes to cocoa producers, legal or informal external credit can be investigated if retained revenues or savings from prior proceeds are insufficient to increase production in the current period. The

sources, accessibility, and cost of required credit will all affect the ability of farmers to secure it. In Nigeria, farmers typically have access to three different sources of financing. These are the formal sources, which are also called institutional sources (commercial banks, micro-finance banks), the semi-formal sources (NGOs, cooperative societies) and the informal sources also referred to as non-institutional sources(money lenders, contributions, family and friends) (Orimogunje *et al.*, 2020).

Formal financial institutions are organizations with licenses to offer financial services and are governed by the laws and regulations of the Central Bank of Nigeria. However, such financial organizations require collateral and levy high-interest rates on loans issued, and the process of acquiring credit is quite onerous (Miah *et al.*, 2006). The government does, however, occasionally subsidize interest rates. The informal credit institutions offer loans and deposits that take place outside of the monetary system; this necessitates the involvement of intermediaries like acquaintances, money lenders, and relatives (Kashuliza *et al.*, 1998), however, the application process is less onerous. Despite their exploitative methods of charging high interest rates and their offering of a small amount of credit that is insufficient to meet the cash requirements of the farmers for the agricultural production process, informal sources are essentially the top providers of agricultural credit in Nigeria (Komicha, 2007). These are necessary because putting up collateral is not one of the requirements for getting credit. In actuality, the World Bank (2000) stated that the three most significant informal sources of credit in Nigeria are as follows: The rotating savings and credit associations (RoSCAs), also known as “Esusu” or “Ajo” locally, family, and friends round out the list. Semi-formal credit institutions are licensed to offer financial products like loans, but they are not under the supervision of a central bank (Steel and Andah, 2004). Ijioma *et al.* (2015) found that personal savings, friends and family, and cooperative organizations were the main sources of credit available to the respondents in an area of Nigeria. Because there is little to no market for collateral securities, it was found that farmers preferred credit from non-institutional sources. Mgbakor *et al.* (2014) confirmed that farmers prefer to receive credit through informal sources, such as family, neighbours, and moneylenders, in a study undertaken to determine the key sources of credit available to the farmers in a specific region of Nigeria. The simple availability of the sources, the lack of extensive requirements to obtain credit, and the prompt loan payout are the main factors influencing their preference. In a separate study by Olatinwo *et al.* (2012) on the investigation of rural farming households' access to credit in Kwara state, Nigeria, it was discovered that farmers there have access to credit from cooperative societies, personal savings, and rotating loan schemes. The report suggests that farmers have trouble getting loans from formal banks since there isn't enough collateral and the interest rates are too high. A similar conclusion is reached by Adebayo and Adeola (2008), however, they discovered that the cooperative society was the most common source of credit in the area they were observing. The same conclusion was reached by Matthew and Uchechukwu (2014), but they also discovered that more than half of the respondents lacked access to credit.

In conclusion, the numerous researchers who examined the credit options available to Nigerian farmers found that informal loan sources are essential for farmers in all the places they looked at. Dependence on informal sources was mostly caused by collateral and interest rates. In other words, microcredit is a method wherein low-income families borrow money all at once and pay it back over a short period through a series of tiny, manageable payments made with the help of social security in the short-term and institutional credit history over the long run (Fayyaz *et al.*, 2016; Gan *et al.*, 2017). In the literature, there has been considerable discussion over how microcredit affects households. Numerous studies have demonstrated the beneficial effects of microcredit on both the elimination of poverty and the living standards of households. According to Quibria (2012), microcredit has increased borrowers' income and raised family well-being. According to Asmamaw (2014), practically all microloan clients have increased their standard of living, which has led to their empowerment. According to Ashaolu *et al.* (2011), farmers who used loans had greater overall costs and profits per hectare than farmers who did not. Owuor (2009) assessed the effect of financing programs on the productivity of small farmers using the Propensity Score Matching Score approach. However, other research has found that microcredit has a negative effect on those who live in households. For instance, the study conducted by Afrin *et al.* (2008) found that the impact of microloans on low-income household borrowers was lessened, and their consequences were unfavourable for all participants. According to Banerjee *et al.* (2009), the accessibility of microcredit programs has not affected the decrease of poverty among non-participants.

MATERIALS AND METHODS

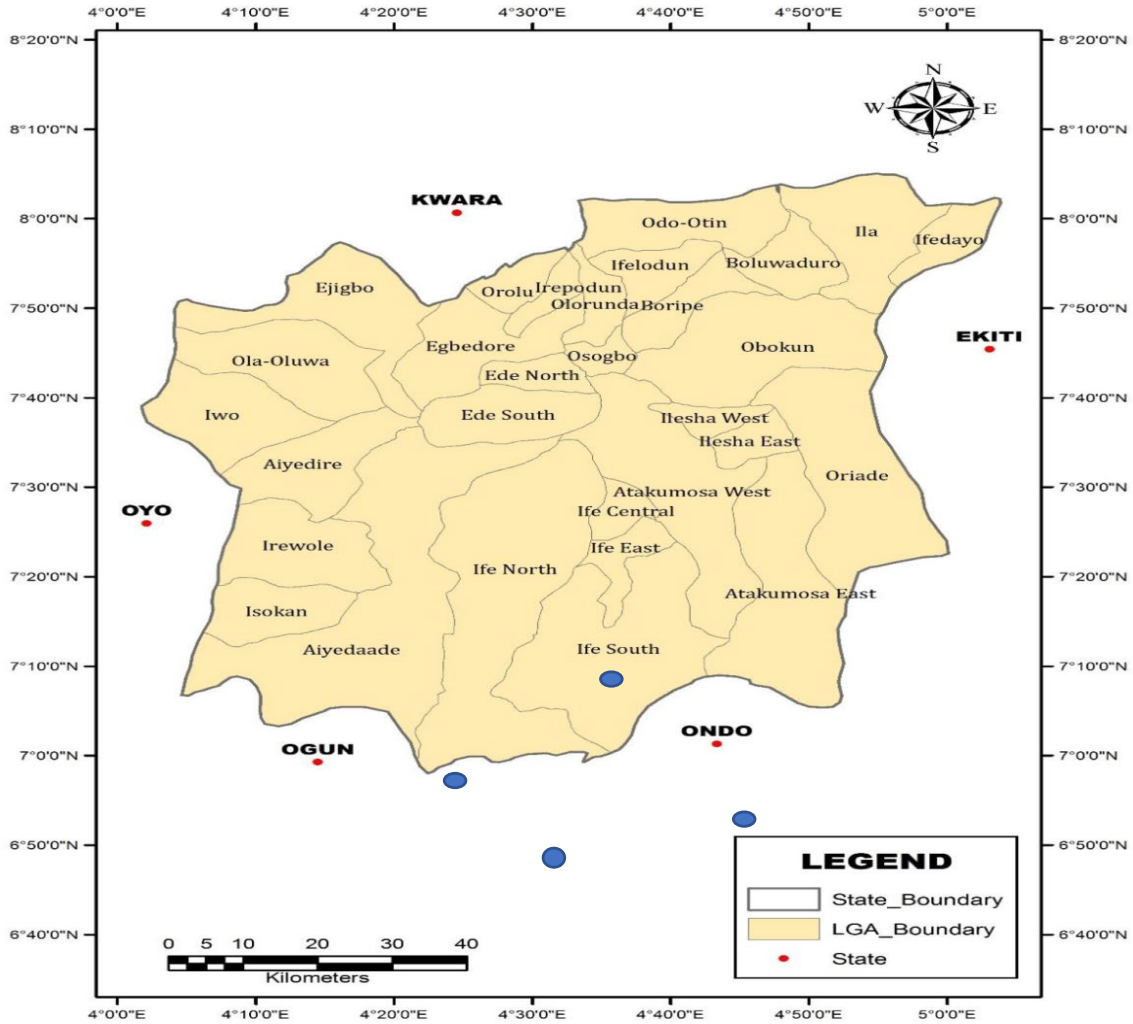
Study Area

The study was carried out in Osun State, Nigeria. Osun State has boundaries with Ogun State to the South, Kwara State to the North, Oyo State to the West, and Ekiti and Ondo State to the East. The State is within the tropical rainforest with an abundance of resources and is situated in the tropical rainforest zone. It covers an area of approximately 14,875 sq km and lies between latitude 7° 30′ 0″ N

and longitude 4° 30′ 0″ E. The State covers an area of about 8,602 km^2 of land (World Bank, 2015). The State consists of three agro-ecological zones: derived savannah (Osogbo), savannah (Iwo), and rain forest (Ife/Ijesa) zone under the Osun State Agricultural Development Programme (OSSADEP) as shown in Fig. 1. Though a landlocked State, it is blessed with the presence of many rivers and streams which serve the water needs of the State. This supports the cultivation of a large variety of crops, including cocoa. Osun State is predominantly an agricultural state with over 65% of the labour force deriving their source of income from farming. The number of people residing in the state is 3,423, 535 people (NPC, 2007), which has 30 Local Government Areas (LGAs). The State of Osun is home to a large number of rural areas that provide the cocoa that is either exported or used for other purposes. There are no banks in these places. Due to the favourable climatic and soil conditions in the area, around 70% of the residents choose to engage in agricultural activities. The extremely ferruginous tropical red soil subterranean rocks are the classification for the soil in the area. The finest soils for cocoa farming in the region are the well-drained clay soils of the hillcrest and slopes (Sofoluwe *et al.*, 2013). The cultivation of both annual and perennial crops is a typical practice in the State. Numerous crops, including millet, maize, rice, cashew, yam, cassava, plantain, and cocoa, may grow and develop well in this State.

Sampling Procedure and Sample Size

According to Faloni *et al.* (2022) and Oyenpemi *et al.* (2023), a multistage sampling procedure was employed to select the respondents for the study. The first stage involved the purposive selection of six Local Government Areas (LGAs) which include Ilesa West, Ife East, Ife South, Ayedaade, Ejigbo, and Irewole. The choice of these Local Government Areas was based on the predominance of cocoa farmers in LGAs. The second stage involved a simple random



1: *Map of Osun State, Nigeria showing the Local Government Areas of Osun State*
Source: Geospatial Analysis Mapping and Environmental Research Solutions (GAMERS) (2018)

selection of two villages in each of the LGAs. In the last stage, a simple random sampling technique was used to select 10 respondents from each of the villages. In total, 120 respondents were selected for the study. The research followed a deductive method and collected primary data. An organized interview schedule was the data collection tool for this investigation. To collect quantitative data from the respondents based on predetermined objectives, the questionnaire featured both open-ended and closed-ended questions. The socioeconomic details of the respondents (farmers including their ages, genders, educational levels, farming backgrounds, and household sizes and their farms, the sources of accessible financing, the yield of cocoa, and other inputs) are among the information gathered. In-person interviews were used to gather the data during October and November 2019. The questionnaire was created using a review of the relevant literature, a conceptual framework, and the exploratory data gathered by the researcher. Each question was carefully examined for clarity and relevance.

Analytical Framework

Data collected were analyzed using descriptive statistics, binary probit regression, and fractional probit regression models.

Descriptive Statistics

Descriptive statistics such as mean and percentages were used to describe the socio-economic characteristics of cocoa farmers.

Binary Probit Regression Model

According to Greene (2000), a binary probit regression model was used to examine the determinants of access to microcredit. Binary probit regression is usually functional in modelling dichotomous outcome variables (Long and Freese, 2014). The Probit regression is well suited for describing the relationships between a categorical outcome variable. The probit model is preferred as binary and takes a value of 1 if a cocoa farmer has access to microcredit and a value of 0 if cocoa farmers do not have access to microcredit. The probit model assumes a normal distribution of error terms. The statistical technique under consideration does not entail any presumptions concerning the independent variables' normality, homogeneity, and linearity of variance. Thus, the present research utilizes a probit regression model. The variable that is being studied is considered dependent and dichotomous, with a value of one indicating cocoa farmers having access to microcredit, and a value of zero indicating non-access to microcredit.

Therefore, Y can be expressed as:

$$Y_i = \beta X_i + \varepsilon_i , \quad (1)$$

Y_i.....is the access to micro-credit by i^{th} cocoa farmer. The model assumes values of 0 and 1. Y = 1, if the cocoa farmers have access to credit; Y = 0, if the cocoa farmers don't have access to credit.
β.....represents a vector of parameters to be estimated,
X_i.....is a set of explanatory variables used for i^{th} cocoa farmer; and
ε_i.....represents the error term.

Furthermore, marginal effects are computed to gauge the immediate impacts of changes in an explanatory variable on the anticipated access to microcredit, while keeping all other variables constant. Marginal effects indicate the percentage change in the probability of the dependent variable taking a certain outcome given a one-unit change in the independent variable.

The marginal effects are computed as

$$\beta_m = Pr\left[\frac{\delta(\beta_i x_i) + \varepsilon_i}{\delta \beta x_i}\right]\beta_i . \quad (2)$$

For continuous explanatory variables

Or β_m = Pr[γ_i = 1] - Pr[γ_i = 0] for dummy variables (3)

β_m is the vector of marginal parameters to be estimated; the marginal dependent variable, denoted as "γ_i" which takes on a value of 1 if an individual responded to have access to microcredit, and 0 otherwise.

The empirical model is specified as follows:

$$Y^* = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 \ldots \beta_9 X_9 , \quad (4)$$

Y^*.....the cocoa farmers' Access to credit (1 = yes, 0 = otherwise).
The explanatory variables are:
X_1 .....gender of the farmer (male = 1, female = 0);
X_2 .....age of farmers (years);
X_3 .....household size (actual number);
X_4 .....Marital status (1 = married, 0 = otherwise);
X_5 .....education (years spent in formal education);
X_6 .....farm experience (years);
X_7 .....income from farming (naira);
X_8 .....income from other source (naira);
X_9 .....membership in association (1 = member, 0 = otherwise).

The inclusion of these independent variables in the model was based on a previous expectation of the variable used and a review of the literature. These independent variables are expected to influence the access to microcredit (Tab. I).

Total Factor Productivity

Total factor productivity was used to determine the cocoa yield among the respondents. Productivity is the ratio of the value of total farm output to the value of total inputs used in farm production.

I: *The prior expectation for the explanatory variables for the Probit model*

Variables	Unit	Expected sign	References
Age	Year	±	Orimogunje *et al.*, 2020; Bakare *et al.*, 2023; Kehinde and Bamire, 2023
Gender	Dummy	±	Shahriar *et al.*, 2020
Household size	Number of persons	±	Orimogunje *et al.*, 2020
Marital Status	Dummy	±	Olateju, 2018
Farming experience	Years spent in farming	±	Orimogunje *et al.*, 2020
Formal education	Years spent in school	±	Kolapo *et al.*, 2021; Bakare *et al.*, 2023
Income from farm	Naira	±	Offor *et al.*, 2021
Income from non-farm	Naira	±	Agyapong *et al.*, 2015
Membership of association	Dummy	±	Orimogunje *et al.*, 2020; Kolapo *et al.*, 2021

The total factor productivity was calculated using the formulas below:

$$TFP_i = \frac{Y_i}{\sum P_i X_i}. \quad (5)$$

where
TFP_i..total factor productivity (kg/Naira);
Y_i.....quantity produced (kg);
P_i.....unit price of variables input (Naira);
X_i.....quantity of variables inputs used.

Fractional Response Model

Fractional probit regression analysis was used to determine the effects of access to microcredit on cocoa yield. This model was proposed by Papke and Wooldridge (1996) to deal with dependent variables defined on the unit interval, irrespective of whether boundary values are observed. This study used a fractional response model because the outcome variables take values in the [0, 1] – interval. Because fractional response variables are bounded, assuming a linear model pertaining to a fractional response variable in a collection of explanatory factors (which can be estimated using ordinary least squares) may not be acceptable, as predictions may fall outside of the [0, 1] – interval. The conditional mean of the fractional response was calculated to maintain the projected values within the unit interval. To generate robust estimators of the conditional mean parameters with appropriate efficiency qualities, the quasi-maximum likelihood estimation (QMLE) method was used.

Let y represent the fractional response variable and x represent the collection of explanatory variables with a conformable parameter vector β. The conditional mean is then defined as follows:

$$E[y/x] = G(x'\beta). \quad (6)$$

where $G(x'\beta)$ signifies a function with a range of zero to one, usually a cumulative distribution function like the logistic (fractional logit model) or the normal (fractional probit model). This link function guarantees that the model's predictions are between zero and one, which is appropriate with the fractional response variable's nature.

$$y_i^* = \Phi(x'_i\beta + u_i) \quad (7)$$

$$z_i = 1(w_i'\gamma + \varepsilon_i > 0) \quad (8)$$

$$y_i = z_i y_i^* \quad (9)$$

where
$i = 1,\ldots, n$.... indexes the individuals,
y^*_i ....latent dependent variable whose data generation process is characterized by a fractional probit model; The cumulative probability distribution is represented by the symbol "ϕ".
z_i .....an observed binary variable indicating whether an individual has a "missing" outcome ($z_i = 0$) or not ($z_i = 1$), and y_i is the observed dependent variable.

The vectors x_i and w_i contain observed explanatory variables, while β and γ are corresponding vectors of parameters. Finally, u_i and ε_i denote error terms, which capture the aggregated effects of unobserved variables. These error terms are assumed to follow a (conditional) bivariate normal distribution,

i.e.,

$$\begin{pmatrix} u_i \\ \varepsilon_i \end{pmatrix} |xi, wi \sim \mathrm{N}\left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix}\right) \quad (10)$$

where $\rho \in (-1, 1)$ denotes the correlation parameter. Because the parameters are only identifiable up to scale, the variances of one were chosen owing to normalization. It's worth noting that because ε_i has a (conditional) normal distribution, Zi's data production process is characterized by a probit model.

The Fractional regression model only requires the assumption of a functional form for y that imposes the desired constraints on the conditional mean of the dependent variable, as follows;

$Y = 1$ ($Y^* > 0$). That is, $Y = 1$ if $Y^* > 0$ i.e., ($\varepsilon < X^1\beta$), 0, otherwise.

The empirical model is specified as follows:

$$Y^* = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 \ldots \beta_7 X_7 \quad (11)$$

Y^*.....cocoa yield (kg/Naira).

The explanatory variables are:
X_1 .....Access to microcredit (yes = 1, otherwise = 0);
X_2 .....education (years spent in formal education);
X_3 .....Nature of the business (1 = Fulltime farming; 0 = Otherwise);
X_4 .....Farm size (ha);
X_5 .....membership in association (1 = member, 0 = otherwise);
X_6 .....income from farming (naira);
X_7 .....household size (actual number).

The inclusion of these independent variables in the model was based on a previous expectation of the variable used and a review of the literature. These independent variables are expected to influence the cocoa yield (Tab. II).

Fitting a Good Model

For the observation, let π be the estimated probability of the observed response. The two goodness-of-fit test criteria usually used for the goodness of fitting the explanatory variables in the probability procedure are:
1. Likelihood Test Criterion;
2. Wald Test Criterion.

Likelihood Test Criterion

The likelihood ratio test is performed to see whether the inclusion of an explanatory variable in a model tells us more about the outcome variable than a model that does not include that variable. The likelihood ratio (LR) test is based on the likelihood function. The likelihood ratio (LR) test statistic is given by the maximized value of the likelihood function for the full model (L_1)and the maximized value of the likelihood function for the reduced model (L_0).

$$-2 \log(L_0/L_1) = -2 [\log(L_0) - \text{Log}(L_1) = -2 L_0 - L_{01}) \quad (12)$$

For each model it fits, STATA calculates the statistic which is -2* log likelihood (known as - 2LL). This statistic is called the scaled deviance and it measures the degree of discrepancy between the observation values and the predicted values from the model. The STATA software provides a p-value (in the "sig" column). If this p-value is less than 0.05, then we reject the null hypothesis at 5% level of significance and conclude that the inclusion of the explanatory variable is better at predicting the outcome variable than when it is not included.

The Wald Test

This test estimates the coefficients (i.e. the β"s) in probability regression. Using the Wald test, we calculate the Wald statistic, which is the square of this ratio

$$(b_1/S_{b1})^2, \quad (13)$$

where b_1 denotes the coefficient of parameters that were estimated; and S_{b1} is the estimate of standard error. This is performed in STATA using the method of Maximum Likelihood Estimation (MLE). The standard errors are also computed by STATA, and their estimation also relies on MLE theory. If the null hypothesis that = 0 is true, then this statistic has a chi-squared distribution with "p" degrees of freedom. The STATA calculates this statistic and displays it in the "Variables in the Equation" along with an associated p-value. The p-value less than 0.05 indicates that the coefficient is significant at a 5% level in predicting the outcome variable. In most cases, the likelihood ratio test and Wald test lead to the same conclusion.

RESULTS AND DISCUSSION

Socio-economic Characteristics of Cocoa Farmers

The socio-economic characteristics of cocoa farmers are presented in Tab. III. The average age of the cocoa farmers is approximately 44 years. This implies that the farmers are young and still in their productive years. This implies that most of the farmers were getting too old and might find it difficult to meet the demands that the intensive care of cocoa farms required. In addition, young and energetic people were scarce in the industry. This unfortunate trend,

II: *The prior expectation for the explanatory variables for the Fractional Probit model*

Variables	Unit	Expected sign	References
Access to microcredit	Dummy	±	Nakano and Magezi, 2020; Bakare *et al.*, 2023
Formal education	Years spent in school	±	Paltasingh and Goyari, 2018; Van Hon andNinh, 2020
Nature of Business	Dummy	±	Faloni *et al.*, 2022
Farm size	Hectares	±	Suh and Molua, 2022
Membership of association	Dummy	±	Kehinde *et al.*, 2021
Income from farm	Naira	±	Van Vliet *et al.*, 2021
Household size	Number of persons	±	Kehinde *et al.*, 2021

if not checked, might pose a danger of extinction to cocoa farmers in the near future. This study corroborates the findings of Kehinde (2022). Male farmers dominate cocoa production as about 78% of the sample farmers are male. This is because the cocoa industry is time-consuming and requires a lot of work. The predominance of male farmers in the survey may be due to the fact that, like other crop production processes, cocoa cultivation requires a lot of energy and labor, particularly in remote areas. Women are constrained in this manner because it is conventional wisdom in the study area that they must work inside and only in the kitchen. This result agrees with the result of Abidogun *et al.* (2019) and Kehinde (2021) that male farmers dominate cocoa production. The average household size is approximately 6 persons. This indicates a small household size which reveals the need for hired labour. This could also mean that the households had an adequate number of helping hands available to help with the processing of the cocoa beans (such as cracking the pod, fermenting, and drying) during the height of farming activity, which, coincidentally, fell around the school summer vacation of the children. This is explained by the fact that numerous family members can live together and participate in the economic activities of the household due to the communal nature of African culture. The outcome is consistent with Alao *et al.* (2020). The result also agreed with the findings of Osarenren *et al.* (2016) and Awoyemi and Aderinoye (2019). The majority (93.33%) of the respondents are married. This implies that the farmers are expected to be responsible because they would be more committed to enhancing the standard of living. This could also imply that the farmers are married due to the fact that in the presence of constraints in the supply of farm labour, married farmers make use of family labour and this reduces the money spent on labour. This result is in agreement with the findings of Muhammad-Lawal *et al.* (2009) and Osondu (2014). The majority of the respondents (92.50%) are formally educated. This is an indication that literate farmers are involved in cocoa production. This suggests that educated people who migrate to the towns and cities in search of 'white- and blue-collar jobs', are now returning to villages to venture into cocoa farming. This could further motivate the farmers to adopt new technologies that could improve the farm yield. This result is in agreement with the findings of Kehinde (2021). The average farm size of the respondents is 2.70 hectares. This shows that the farmers are smallholders. The finding reaffirms that cocoa production takes place on smallholdings and a large number of cocoa farmers in the Southwest are smallholders. This finding relates to the study of Adeyemo *et al.* (2020) and Kehinde and Tijani (2021) that cocoa production in Southwestern Nigeria takes place in smallholdings. The average years of farming experience is approximately 22 years. This is a strong indication that the farmers have many years of farming experience. This demonstrates that the farming households have been involved in the cocoa business for a considerable number of years, which could help them to develop a better understanding of the crop and a mastery of effective farming techniques that might increase their output (Kehinde and Adeyemo, 2017; Adeyemo *et al.*, 2020).

Factors Influencing Access to Microcredit Among Cocoa Farmers

The factors influencing access to micro-credit among cocoa farmers are presented in Tab. IV. The factors influencing access to micro-credit among cocoa farmers were analyzed by using binary probit regression. The average marginal effect was used in this study as a useful measure to interpret the result as the coefficient of the probit model is difficult to interpret since it only shows the direction of the effect. The likelihood ratio test indicates that the overall goodness of fit of the probit model is statistically significant at a 1% probability level. This indicates that the explanatory variables included in the probit model regression jointly explain the variations in the access to micro-credit among cocoa farmers. Furthermore, a pseudo-R-squared of 0.5874 implies that about 58.74% of the changes that occur in the dependent variable (access to credit) are jointly explained by the independent variables. The log-likelihood indicated the overall significance of the model. This

III: *Socio-economic Characteristics of Cocoa Farmers*

Variables	Average	Median
Age (years)	44.27 (±12.73)	45.01
Male (%)	78.33	0.788
Married (%)	93.33	0.935
Formal education (%)	92.50	0.927
Household size (#)	5.70 (±2.29)	5.72
Farm size (ha)	2.78 (±1.25)	2.79
Years of farming experience	21.57 (±14.20)	21.59

Source: Computed from field survey, 2019 Figures in parenthesis represent standard deviation

implies that there is about 99.99% assurance that the model was not mis-specified. The probit model was fitted with nine explanatory variables and four of them were significant (Tab. IV). These are off-farm income, years of formal education, marital status and membership in the association. The coefficient of off-farm income was negative and statistically significant with a marginal effect of 0.092. This signifies that a unit increase in off-farm income decreases the probability of accessing microcredit by 0.092 units. This result can be explained on the premise that a farmer with other sources of income other than farming, may likely not access credit because the income from the other sources can be converted to be used on the farm. This can be attributed to an increase in wealth and income from off-farm activities making more money available in the household, hence less credit demand. The reason may be that money from off-farm income may serve as a substitute for credit (Auma and Mensah, 2014).

On the other hand, the coefficient of marital status was positive and statistically significant with a marginal effect of 0.565. This signifies that farmers who were married have a higher probability of accessing microcredit by 0.565 units. The implication is that farmers who are married have a higher probability of accessing microcredit. The result indicates that the probability of accessing loans from microfinance banks is higher for married customers. This can be explained by the fact that these banks base their loans on trust, which is in part believed to be higher for married people because they are seen as being responsible for their actions and are hence less likely to default on paying off the debt. Additionally, married people are viewed as being more stable and taking longer to relocate than unmarried people. Married consumers also seem to be more responsible and dread potential repercussions from loan default. This submission supports the claims made by Ololade and Olagunju (2013) and Adigun (2022) that married couples may be able to access more credit due to their decreased mobility and the possibility of joint underwriting.

Also, the coefficient of years of formal education was positive and statistically significant. The implication is that an additional year spent on formal education increases the probability of a cocoa farmer accessing microcredit by 0.028 units. This is consistent with the prior expectation. Because literate farmers are presumed to have better technical knowledge and information about the market and other government facilities, it makes sense to assume that literacy status can affect the access of farmers to microcredit institutions. This effect is also expected to be positive. Secondly, they are more familiar with the formalities related to loan application, acquisition, and payback. Additionally, educated people are more likely to increase their income and own the assets required for collateral, are better able to understand the need for credit, and have lower entry costs because they have an easier time gathering and evaluating the information required to apply for a loan (Wivine, 2012; Argaw, 2017). Similarly, the coefficient of membership in the association was positive and statistically significant with a marginal effect of 0.843. It implies that a unit increase in membership of an association increases the probability of a cocoa farmer accessing microcredit by 0.843 units. This implies that the probability of accessing credit is higher with farmers who belong to farmers' associations than his/her counterparts who do not. This is based on the assumption that the majority of financial institutions prefer to extend credit to farmers who are members of or who receive credit through associations. By doing this, the moral risks connected to credit availability are diminished. The findings of Obisesan (2013) and Anang *et al.* (2015), which demonstrate a favourable correlation between membership in an organization and access to credit, are similarly consistent with this outcome. This is pertinent, particularly in developing nations like Nigeria where one of the primary functions of farmer organizations is to assist various farmers get microcredit.

IV: *Factors influencing cocoa farmers' access to microcredit*

Variables	Coefficients	Marginal effects	Standard error	P value
Formal education	0.069**	0.028	0.042	0.027
Non-farm income	-0.098**	-0.092	0.031	0.040
Membership in association	2.871***	0.843	0.415	0.000
Constant	2.973***		2.811	0.000
Number of Observations	120			
Prob > Chi^2	0.000			
L R Chi^2(9)	97.40			
Pseudo R^2	0.587			

Source: Computed from field survey, 2019, *** significant at 1%, ** significant at 5%, * significant at 10%
Note: only significant variables are reported in the Table above

Impact of Access to Microcredit on Cocoa Yield

The average cocoa productivity was observed to be 0.28 Kg/₦. The fractional Response Model was used to analyze the effect of access to microcredit on cocoa productivity as shown in Tab. V. The Wald chi-square value of 42.66, was statistically significant at 1% with a log pseudo-likelihood of -32.895 confirming the goodness of fit. The results of the fractional probit model show that access to microcredit, formal education, primary occupation, farm size and membership in associations were statistically significant factors influencing cocoa productivity. However, the coefficients of access to microcredit, formal education, Primary occupation, farm size and membership in associations had positive signs. This implies that for every unit increase in any of these variables, the cocoa productivity increases by the magnitude of their coefficients; 0.048 units for access to microcredit, year of education (0.151), primary occupation (0.043), farm size (0.196) and membership in associations (0.089) units, all other things held constant.

The coefficient of access to microcredit has a positive impact on cocoa yield. The finding of the study aligns with previous research by Chandio *et al.* (2021) and Koricho and Ahmed (2022). This is due to the fact that having access to financial services is essential for boosting agricultural output and efficiency because it allows for long-term investments. Access of farmers to new technology and inputs is further increased by the availability of microcredit (Martey *et al.*, 2019; Nkegbe, 2018). Therefore, Martey *et al.* (2019) assert that better collaborations with financial sources can help maintain agricultural yield gains. The coefficient of years of education has a positive impact on cocoa yield. This might be because cocoa growers are more open to novel approaches and technological advancements that increase productivity. Farmers with education are better able to gather, comprehend, and use information from research and extension than farmers without education. Additionally, educated farmers are probably less risk-averse and therefore more willing to experiment with cutting-edge technology. Farmers who are more educated than their less educated counterparts are better able to receive, evaluate, and react to new information and improved technology like fertilizers, herbicides, and planting materials. The conclusion supports research by Onoja and Herbert (2012) and Martey *et al.* (2019) that shows education improves the capacity of farmers for productivity.

The coefficient of primary occupation has a positive impact on cocoa yield. According to the socioeconomic characteristics, the majority of the respondents work as farmers as their primary occupation, which will encourage the adoption of conservation agricultural practices. This goes hand in hand with the implicit expectation that the yield of cocoa will increase, as noted in the literature. This is consistent with the conclusions reached by Olugbire *et al.* (2019). The coefficient of farm size has a positive impact on cocoa yield. This is because there are more options to use modernized tools and skilled labourers on a large farm, which usually increases the farmer's productivity. This is in line with the work of Osanyinlusi and Adenegan (2016), Abdallah (2016) and Ojo *et al.* (2019) who found a positive relationship between farm size and crop yield. The coefficient of membership of associations has a positive impact on cocoa yield. This might be explained by the fact that associations give a platform for disseminating information about cutting-edge technologies and offer their members input subsidies and credit services. A farmer who belongs to an association is therefore more likely to embrace new agricultural technologies and get financing. Associations also help its members by offering instruction in agricultural production. The productivity of cocoa producers may rise as a result of this intervention. This result is consistent with investigations conducted by Kehinde and Ogundeji (2022b).

V: *Effect of access to microcredit on the cocoa yield*

Variables	Coefficients	Marginal effects	Standard error	Z
Access to microcredit (0/1)	0.4169**	0.0484	0.1778	2.05
Formal education(years)	0.0529**	0.1512	0.0417	2.37
Primary occupation (0/1)	0.3383*	0.0437	0.2415	1.69
Farm size (ha)	0.2844 ***	0.1967	0.2872	3.34
Member in association (0/1)	0.6732***	0.0895	0.5193	2.68
Constant	4.7414***		0.278	3.70

Source: Computed from field survey, 2019 N = 120, Wald Chi^2 = 42.66 Prob > chi^2 = 0.0000, log pseudo–likelihood -32.895
*** significant at 1%, ** significant at 5%, * significant at 10%
Note: only significant variables are reported in the Table above

CONCLUSION AND RECOMMENDATIONS

This study investigated the effect of access to microcredit on cocoa yield in Osun State. A multi-stage sampling procedure was employed to select 120 cocoa farmers for the study. Data collected were analyzed using descriptive statistics, binary probit regression model and fractional probit regression model. The results for the entire respondents showed average values of 44 years for age, 22 years for years of experience, 6 persons for household size, and 2.8 hectares for farm size. Binary probit estimates show that off-farm income, years of formal education, marital status and membership of an association were statistically significant factors influencing access to microcredit. Fractional probit estimates show that access to microcredit, formal education, primary occupation, farm size and membership in associations were statistically significant factors influencing cocoa yield. This study concluded that the cocoa farmers were predominantly male, smallholders and at the peak of their productive age. Access to microcredit is an important variable affecting cocoa yield. This suggests that policy strategies aimed at improving cocoa yield must consider access to microcredit. Microfinance banks should ensure the early and timely disbursement of microcredit to farmers, enabling them to purchase high-quality seeds, seedlings, and fertilizers at the right time. This will enhance agricultural productivity and profitability, allowing farmers to reinvest in their businesses. Since membership in farmers' associations positively influences access to microcredit and increases cocoa yield, farmers should be encouraged to join or establish such associations. These groups offer opportunities for knowledge sharing, enhanced bargaining power, and improved access to financial resources. Non-members of cooperative societies should be motivated to join these organizations to benefit from the various services they offer. Cooperatives play a crucial role in enhancing production, boosting income, and reducing poverty among farmers by improving access to credit, market information, and agricultural inputs. Microfinance institutions should conduct public awareness campaigns each time a farmer applies for a loan. Educating farmers on loan policies, terms, and conditions will help them make informed financial decisions, improving their ability to manage credit effectively. Additionally, the government should implement policies that improve access to financial services for households without formal education. Ensuring financial inclusion for all farmers, regardless of their educational background, will enable them to secure credit and invest in their agricultural activities, ultimately improving their livelihoods.

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