COGENT ECONOMICS & FINANCE
2024, VOL. 12, NO. 1, 2402035
https://doi.org/10.1080/23322039.2024.2402035

GENERAL & APPLIED ECONOMICS | RESEARCH ARTICLE
OPEN ACCESS
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Impact of agricultural credit on productivity, cost and returns from cocoa production in Ghana

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ABSTRACT
This study identified the determinants of cocoa farmers' access to credit in Ghana and estimated the impact of credit access on yield, yield gap, gross income, cost of production, and net income using propensity score matching. A total of 384 cocoa-farming households were included in the analysis. Only 33.3% of cocoa farmers accessed credit for production and cooperative unions were the main source of credit accessed by the farmers. The study finds significant positive impacts of agricultural credit on yield, gross income, and net income, while yield gap decreases significantly (by 12.2–16.7%) with access to credit. Policy efforts to improve cocoa farmers' access to credit could therefore enhance the productivity and profitability of cocoa production. It was found that male-headed households with access to credit derive greater benefits than their female counterparts. This may be attributed to differences in resource endowments and marginalization (between male and female heads). In addition, it was found that with access to credit, cultivating more than one cocoa farm could make cocoa production more productive and profitable. This indicates more efficient and profitable use of credit on fragmented farms, than on non-fragmented farms. However, under credit constraint, the practice of land fragmentation could be counterproductive.

ARTICLE HISTORY
Received 24 April 2024
Revised 10 August 2024
Accepted 3 September 2024

KEYWORDS
Credit access; determinants; impact; farm performance; propensity score matching

SUBJECTS
Economics; Economics and Development; Development Policy; Microeconomics; Development Economics

IMPACT STATEMENT
Through the generation of foreign exchange, creation of employment, and the provision of other environmental and health related benefits, cocoa can be classified as a gem among the major export commodities from Ghana. Despite the benefits the commodity offers to the Ghanaian economy, the cocoa subsector has been subjected to myriads of production related challenges (including aging trees, low soil fertility, low or limited adoption of productivity-enhancing inputs, challenges with post-harvest management, etc.), which have led to declining trend in cocoa production, rising production costs and decreasing farm income. Majority of these challenges have in recent research efforts been linked to credit constraints. While efforts have been made by previous and current governments to improve cocoa farmers access to credit and enhance the performance of the subsector, credit remains insufficient for cocoa farmers, and very little has so far been documented empirically on the impact of agricultural credit on cocoa production, especially in Ghana. This study addresses this gap by analyzing the determinants of cocoa farmers access to agricultural credit and the impact of agricultural credit on productivity (yield, yield gap, and gross income), cost and returns from cocoa production. The study also identifies and documents potential heterogeneity in impacts of agricultural credit on male and female headed households, and between farmers who operate on fragmented and non-fragmented lands, stressing on the need to consider the differences in impact between these two groups when implementing measures to enhance farmers access to credit and the impact on farm performance. Findings from this study could guide policy formulation, especially

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in targeting of farmers for agricultural credit and in the implementation of measures to address challenges in cocoa production. To farmers, this study could enlighten them on the benefits of operating on fragmented lands with improved access to credit, and the risk of operating on fragmented lands under credit constraint

1. Introduction

Cocoa (*Theobroma cacao*) production, processing, and marketing serve as a livelihood for about 30% of Ghana's population (Artavia Oreamuno & Croppenstedt, 2023). The cocoa sector is a major engine to the growth of the Ghanaian economy, generating about 30% of the country's export earnings, and contributing about US$2.71 billion to government revenues in the year 2017 (Artavia Oreamuno & Croppenstedt, 2023). While it generates about 10% of agricultural GDP in Ghana (AsokoInsight, 2022; Vigneri & Kolavalli, 2018), a total of about 850,000 farm families are reported to make a living from cocoa production and marketing (Artavia Oreamuno & Croppenstedt, 2023; Vigneri & Kolavalli, 2018). For the year 2022, cocoa generated about US$2 billion in foreign exchange for Ghana and contributed about US$533 million to GDP in 2021 (in real terms) (Ghana Commercial Bank (GCB), 2022). The crop is reported to have generated annual sales revenue of approximately GH₵2500 (about US$556) for over 500,000 producing households in 2017 (Ghana Statistical Service (GSS),), 2019; Tsiboe, 2021). Cocoa plays a crucial role in the generation of employment opportunities, especially for the youthful population in Ghana. As reported by Vigneri and Kolavalli (2018), the cocoa industry in Ghana contributes approximately 11.9% of the total value-added in agriculture, maintaining its position as the largest export-based crop. This prominence not only emphasizes its economic significance but also emphasizes its vital role in earning optimum foreign exchange for Ghana. Beyond its economic benefits, cocoa tree coverage contributes to environmental protection, and its medicinal value has been recognized. Moreover, revenue generated from the cocoa sector has facilitated infrastructural developments, including the construction of hospitals and roads in regions cultivating cocoa (Obuobisa-Darko, 2015).

Despite the considerable potential of cocoa to contribute to Ghana's economy, there is a declining trend in cocoa production (Gneiting & Arhin, 2023; Oke et al., 2019), rising production costs, and decreasing farm income (Gneiting & Arhin, 2023). In an Oxfam report by Gneiting and Arhin (2023), cocoa farmers' net income in Ghana was reported to have decreased by an estimated 16.38% between the 2019/20 and 2021/22 harvesting seasons. The observed declines in the yield and income of cocoa farmers have been linked to aging trees, low soil fertility, and low or limited use of productivity-enhancing inputs (Wessel & Quist-Wessel, 2015), all of which are deeply connected to credit constraints (Balana et al., 2022; Martey et al., 2019). Research by Nwachukwu et al. (2010) and Ike and Umuedafe (2013) accentuates the prevalence of insufficient access to credit by cocoa farmers, which keeps cocoa cultivation at a basic survival level and has severe repercussions for production outcomes (Oke et al., 2019). In response, successive governments have made efforts to provide credit assistance to cocoa farmers through various programmes (Ugbajah & Ugwumba, 2013). However, despite these initiatives, credit remains insufficient for cocoa farmers, as has been highlighted by several researchers (Assouto & Houngbeme, 2023; Balana et al., 2022; Martey et al., 2019; Ogundeji et al., 2018; Wessel & Quist-Wessel, 2015).

Credit serves as the essential foundation for businesses, particularly agriculture, which has historically been a non-monetary pursuit for rural communities (Nzomo & Muturi, 2014). In the context of agriculture, credit is described as the immediate and deferred transfer of purchasing ability from an individual who possesses it to someone in need, granting the latter the ability to utilize another person's capital for agricultural endeavours. This arrangement is based on trust in the borrower's inclination and capacity to settle on an agreed future date (Kuwornu et al., 2013). Agricultural credit is considered a strategic resource that plays a crucial role in pushing crop productivity to its limits, ultimately improving the quality of life of many impoverished farmers. Therefore, the availability of farm credit is expected to empower farmers to effectively utilize their resources (Kehinde & Ogundeji, 2022). In developing countries, where smallholder farms often face financial constraints, farm credit plays a crucial role in facilitating the acquisition of modern technology and farm inputs. This in turn contributes to the enhancement of farm productivity and growth rates (Attipoe et al., 2020; Chandio et al., 2016; Dziwornu et al., 2023). According to Attipoe et al. (2020), access to credit is essential for the acceptance and spread of innovative and influential farming technologies, thereby fostering agricultural growth. The embracing of improved farming technologies is closely linked to heightened demand for both fixed and working capital, highlighting the central role of finance in boosting agricultural productivity in developing countries.

In Ghana, agricultural credit is provided in various forms, including kind, cash, or a combination of both, and can be sourced from either informal or formal channels. In the realm of farm credit, in-kind support primarily originates from informal channels such as pesticides, chemicals, fertilizers, mechanization services, and seeds. Conversely, cash-based credit predominantly stems from formal sources. Informal credit sources include friends, moneylenders, relatives, agricultural output, and input dealers. In contrast, formal sources include banks, credit unions, microfinance institutions, and formal sector employers, who extend credit through salary loans (Akudugu, 2016; Abdallah et al., 2019). While informal divisions tend to operate without a formal framework, the formal sector follows structured frameworks (Abdallah et al., 2019). It is noteworthy that credit obtained from formal sectors has adverse effects on rural communities, and its accessibility is significantly limited, as indicated by the research findings of Oke et al. (2019). This is evident from the excessively high interest rates associated with formal credit sources (Moahid et al., 2021). This results in constrained access to credit, which directly hampers farmers' productivity (Mukasa et al., 2017) and leads to a reduction in income and agricultural investment (Amanullah et al., 2019). Consequently, this situation exacerbates rural poverty (Ige & Adeyemo, 2019; Masaood & Maharjan, 2020). Farmers find themselves ensnared in a cycle of poverty, with limited opportunities or means to enhance their living standards. Without external positive intervention, rural farmers may remain trapped in their current predicaments. Hence, both increased agricultural productivity and access to credit remain pivotal factors in the ongoing battle against rural poverty (Adeyonu, 2015). Credit access is crucial for smallholder farmers as it empowers them to invest in the restoration and enhancement of their farms, facilitates market access, improves post-harvest practices, ensures quality, and promotes smoother household cash flow (Bonnieux, 2019). Through pre-harvest financing, growers can obtain quality inputs that enhance crop quality and productivity, leading to increased income and a more dependable supply for purchasers (Balana et al., 2022; Wessel & Quist-Wessel, 2015). Additionally, postharvest finance plays a vital role in the cost-efficient aggregation of crops (Bonnieux, 2019; Wessel & Quist-Wessel, 2015). To enhance the productivity of smallholder farmers, timely access to finance is crucial for acquiring inputs such as seeds, pesticides, fertilizers, herbicides, transport, machine services, fuel, and labor.

Numerous scholars have delved into the realm of agricultural credit, as evidenced by studies such as Nzomo and Muturi (2014), Akudugu (2016), Abdallah et al. (2019), and Kehinde and Ogundeji (2022). For instance, Akudugu (2016) conducted a study on the relationship between agricultural productivity, farm size, and credit access in Ghana, revealing that both informal and formal credit access lead to increased agricultural productivity among farm households. Nzomo and Muturi (2014), in their research on the effects of different agricultural credit programs on productivity, found that development credit had the most significant and enduring impact compared with seasonal and agribusiness credit. However, seasonal credit was the most accessible and sought after, whereas the response to agribusiness credit was notably low. Thus, they conclude that credit has an impact on output. Regarding the effect of credit on farm income, Abdallah et al. (2019) reported that credit access contributes to an increase in households' farm income. In a recent and relevant study by Kehinde and Ogundeji (2022), the investigation focused on the influence of access to credit and cooperative services on cocoa productivity. Their findings indicated that farmers who have simultaneous access to both cooperative services and credit exhibit higher productivity than those with access to either cooperative services or credit, as well as those with no access to either.

However, none of these studies concurrently evaluated the impact of agricultural credit on the productivity (yield, yield gap, and gross income), cost, and income of cocoa farmers. Again, the complexities of credit dynamics in Ghana's cocoa sector demand nuanced investigation to guide effective policy interventions. Therefore, this study aims to provide empirical insights into the simultaneous effects of agricultural credit on productivity, cost, and income from cocoa production, using propensity score matching. Specifically, the study

i. identifies the key determinants of cocoa farmers' access to agricultural credit and
ii. estimates the impact of access to agricultural credit on three measures of productivity (yield, yield gap, and gross income), cost of production, and net income from production.

The findings from this research could serve as an essential guide for policy formulation to enhance farmers' access to credit and the role that credit plays in the cocoa subsector. This comprehensive analysis is crucial for advancing both academic knowledge and practical interventions in the ongoing battle between declining cocoa production and rural poverty. The rest of this manuscript is organized as follows. Section 2 of the manuscript is on literature review, while methods used for the study (including data, sampling, analytical framework, and descriptive statistics) are covered in section 3. Results are presented and discussed in section 4, while section 5 concludes the study.

2. Literature review

2.1. Agricultural credit and farm performance

Credit constraint is well documented in the literature as one of the dominating constraints to agricultural production in the developing world (Balana et al., 2022; Diamoutene & Jatoe, 2020) and a major hindrance to efforts to alleviate poverty and hunger in Sub-Saharan Africa (SSA) (Balana et al., 2022; Burchi et al., 2016; Rapsomanikis, 2015). While most households in rural SSA depend on agriculture for their livelihood, challenges such as high cost of inputs, poor climatic conditions, limited access to markets, and most importantly, limited access to credit have for over two decades now led to low productivity of crop fields, high yield gaps, risk of farm income losses, food insecurity, and reduced incentive for the youth to venture into the agriculture sector (Chandio et al., 2017; Daudu et al., 2023; FAO, 2014; Ogundeji et al., 2018). Evidence shows that enhancing farmers' access to credit could improve their access to and adoption of yield-enhancing innovations in a timely manner and ensure the allocation of factors of production in a more efficient way (Diamoutene & Jatoe, 2020; Martey et al., 2019; Ogundeji et al., 2018), thereby leading to yield and income gains (Assouto & Houngbeme, 2023). In addition, access to credit is presumed to offer farmers the possibility of hiring sufficient and high-quality labor on their farms, which consequently enables them to produce under optimal conditions (Otsuka & Larson, 2016). For example, a study by Assouto and Houngbeme (2023) in Benin found that enhancing maize farmers' access to credit could lead to yield and income gains of 40.07 and 31.97%, respectively. Using a stochastic frontier analysis (SFA) of a sample of 216 rice producers from Senegal, Diallo et al. (2020) found that farmers with access to credit have 37.32% yield gains. Martey et al. (2019) also reported a positive effect of credit on maize production in Northern Ghana. In Nigeria, Wole-Alo et al. (2022) reported that cocoa growers with access to credit earn higher net farm income than those who have no access to credit. In a general farm level analysis in Lesotho, Ogundeji et al. (2018) report that access to credit increases net farm revenues by US$116.6 to US$136.9.

Numerous investment and policy efforts have been made globally to enhance the productivity of crop fields and farmers' incomes, particularly in developing countries (Mason-D'Croz et al., 2019; Ruane & Ramasamy, 2023). Despite these efforts, low yields, high yield gaps, high production costs, and low incomes have been typical attributes of cropping systems in the developing world. The root causes of these production challenges include the low adoption of productivity-enhancing innovations, untimely implementation of relevant cultural practices, high incidence of crop pests and diseases, low use of fertilizer, old age of cocoa farms, and resource bottlenecks from a broader perspective (Artavia Oreamuno & Croppenstedt, 2023; Assouto & Houngbeme, 2023; Balana et al., 2022; Chandio et al., 2017; Wessel & Quist-Wessel, 2015). While these challenges have mostly been linked to farmers' limited access to credit for production (Assouto & Houngbeme, 2023; Martey et al., 2019; Ogundeji et al., 2018), information on the channels through which credit affects farm performance is scant, with emphasis placed in research on the impact of credit on fertilizer use (Nakano & Magezi, 2020), productivity (Diallo et al., 2020; Haryanto et al., 2023; Martey et al., 2019; Seck, 2021) and farm income (Ogundeji et al., 2018; Assouto & Houngbeme, 2023). This study contributes to bridging the knowledge gap in this regard by analyzing the determinants of farmers' access to credit and the impact on yield and yield gap, gross income, cost of production, and net income from cocoa production. Assuming potential heterogeneity in the impact of credit access on farmers, a disaggregate analysis is also performed based on the sex of the respondents, and the status of land fragmentation. This study used cocoa as the primary crop of interest for the analysis because of the importance of the crop to the Ghanaian economy (the study area) and the limited access of cocoa farmers to credit in Ghana (Löwe, 2017; Obuobisa-Darko, 2015).

The agricultural finance literature extensively addresses the correlation between credit accessibility and agricultural output; however, a consensus on the nature of this impact, as well as the impact pathways, remains elusive (Ogundeji et al., 2018; Assouto & Houngbeme, 2023). This absence of agreement in the scholarly literature concerning the effect of credit access may be attributed to the socioeconomic conditions and initial farming resources that distinguish producers in one country from another (Seck, 2021). Furthermore, the absence of an agreement might be rationalized by the diverse approaches used by public establishments across countries to fund the agricultural industry (Assouto & Houngbeme, 2023). Three discernible trends in the effects of credit on agricultural productivity and profitability have been identified (Assouto & Houngbeme, 2023). First, there is a school of thought highlighting the positive influence of credit on farmers' productivity and profitability, as evidenced by the studies conducted by Akudugu (2016), Diallo et al. (2020), and Assouto and Houngbeme (2023). Second, certain studies suggest that credit has a neutral or limited effect on productivity and net returns, as seen in Wiredu et al. (2011), Khan et al. (2013), and Njeru et al. (2016). Third, Agbodji and Johnson, (2021) contended that credit can have a negative impact on the yield and income of farmers. A point well noted, and supported by economic theory; however, is the fact that farmers who face binding capital constraints are more likely to use lower levels and non-optimal combinations of yield-enhancing inputs than non-capital/credit constrained farmers (Awotide et al., 2015; Freeman et al., 1998). This could lead to lower yields and profits among the credit constrained farmers (Awotide et al., 2015). Based on this, it is hypothesized that access to agricultural credit could lead to higher yields and gross income, lower yield gaps, and higher net income. The effect of agricultural credit on cost can, however, be positive or negative depending on the time of access and use of agricultural credit.

2.2. Decision on credit access, determinants, and channels of impact

As with many other cash crops in Ghana, cocoa is primarily produced on a commercial basis. In this context, it is assumed that farmers can increase or maintain profits by increasing yields (van Vliet et al., 2021), attracting higher prices (van Vliet et al., 2021) and/or lowering the cost of production (Tabe-Ojong et al., 2022). In the Ghanaian context, where the prices received by farmers are set by the government, increasing profits can primarily be achieved by increasing cocoa yields and reducing the cost of production. The achievement of either or both, however, hinges on farmers' timely and adequate access to credit for production. A well-documented fact in the literature is that having access to credit enables farmers to purchase yield-enhancing inputs over time, which enables them to allocate farming inputs efficiently, leading to maximum possible output (Chandio et al., 2017; Martey et al., 2019; Wessel & Quist-Wessel, 2015). It is presumed that credit can affect the performance of cocoa farmers by enhancing their yields and gross income and minimizing costs if accessed in a timely manner for optimal resource allocation. This reveals the important role of credit in agriculture. Due, however, to seasonal financial constraints faced by most farmers, especially in rural Africa, which leads to payment challenges in the purchase of yield-enhancing inputs, most farmers end up making suboptimal production decisions under financial constraints, and this leads to low productivity and returns from production (Kumar et al., 2013). The access of farmers to credit when faced with such financial constraints can provide strong incentive for farmers to invest in production factors to enhance performance. This is in line with a proposition by Schultz (1964) that farmers in traditional agriculture act rationally within the context of resources and technologies available and accessible to them. By this, farmers decision to access credit is assumed to be guided by expected utility maximization, whenever they are confronted with a dilemma on whether to borrow for production or not. A farmer would access credit for agricultural production when the expected benefits from the use of credit outweighs the benefits of foregoing borrowing. Thus, each cocoa farmer in the country is assumed to be a profit maximiser (Samuelson & Nordhaus, 2005) whose primary objective is to increase net returns from production by increasing income from the sales of cocoa and minimizing the cost of production through timely purchase and efficient allocation of inputs. The ability of farmers to increase returns from production is assumed to be influenced by their access to credit, the latter of which is believed to enhance farmers' capacity to make profitable investments by acquiring vital production inputs and financing relevant operating expenses over time (Conning & Udry, 2007).

Having access to adequate credit can ease the liquidity/financial constraints of cocoa producers and enable farmers to purchase productive inputs such as fertilizer, pesticides, labor, irrigation facilities, and practice mechanization (Akudugu, 2016; Houensou et al., 2021). It also encourages the appropriate and efficient allocation of these inputs when accessed on time, thereby promoting intensification, enhancing yield, and reducing production costs. Based on economic theory, documented evidence in literature, and the institutional settings in Ghana, it is assumed that farmers access to credit for cocoa production is affected by diverse household characteristics, farm/plot characteristics, and distance and/or institutional factors (Assouto & Houngbeme, 2023; Chandio & Jiang, 2018; Diallo et al., 2020; Houensou et al., 2021; Kehinde & Ogundeji, 2022; Martey et al., 2019). These factors include the sex of the farmer, age, educational status, household size and distribution (child ratio or dependency ratio), marital status, farm size, experience in cocoa production, number of cocoa farms cultivated (land fragmentation), access to government extension services, membership in a farmer-based organization (FBO), distance to the nearest marketplace, and distance to the nearest district capital.

3. Methodology

3.1. Study area

The Birim Central Municipal District (with Akim Oda as its capital) in the southwestern corner of the Eastern Region of Ghana, a major cocoa-producing location, serves as the study area for this research. It has a total population of 76,302 (and a population density of 626.9 people/km^2), with 47.8% being male and 52.2% female (Ghana Statistical Service (GSS), 2021). The climate of the study area is semi-equatorial and wet, with a bimodal rainfall regime. The major rainy season is from April to June and the minor season is from September to November. Most of the inhabitants depend on agriculture for their livelihood, with the sector employing about 51% of the municipality's active labour force. In this location, crops such as maize, cassava, cocoyam, rice, yam, and plantain are the major food crops produced, whereas cocoa, citrus, and oil palm are the major cash crops. The major livestock reared by farmers in the area are cattle, sheep, goats, pigs, and poultry, which are produced mostly on a small scale.

3.2. Data and sampling

This study used primary data gathered from cocoa-producing households in the study area. Data were gathered after a pretest using structured questionnaires. Among the areas covered during the survey are the socio-demographic characteristics of the respondents, their access to credit, farm/plot-level characteristics, data on geographic/locational factors such as distance to markets and district capital, institutional factors such as access to extension services, and data on crop production (inputs, output, prices, and challenges) for the year 2021 (see questionnaire in the supplementary materials/files for details). Regarding farmers' access to agricultural credit, farmers were asked if they accessed credit in the year 2021 for cocoa/agricultural production or not. Those who accessed credit for cocoa/agricultural production were considered farmers with access to agricultural credit, while those who did not access credit for cocoa/agricultural production were classified as farmers without access to agricultural credit. The survey was conducted between January and April 2022 and included smallholder cocoa farmers in the Birim Central Municipality of Ghana as its population. The study area has 7,500 smallholder cocoa farmers (COCOBOD 2021). Based on Yamane's (1967) formula, a sample size of 380 farmers was estimated; however, 384 farmers were interviewed for the study. A multistage sampling procedure was used to select the sample for this study. The first of the three stages involved a purposive selection of one of the operational areas (the Oda Nwanta operational area) out of the three (3) in the municipality. This selection was based on the intensity of cocoa production in this area. In the second stage, a total of ten of the 16 communities in the operational area were randomly selected, from each of which the researchers randomly selected 38/39 households for interviews based on a list of smallholder cocoa farmers supplied by the Cocoa Health and Extension Division of COCOBOD in Akim Oda.

The data for this study was gather by one of the co-authors of this manuscript for his MSc work in Agribusiness Management at the Kwame Nkrumah University of Science and Technology (Ghana) (under the supervision of the corresponding author). The work was first approved by the Research Ethics Office of the University in 2021 before the data collection began to ensure adherence to approved ethics considered in research that involves human participants. Besides this, respondents voluntarily participated in the interviews conducted for this data, and none was forced to provide confidential information. The respondents gave written consent (signature/thumbprint) before each data collection began.

3.3. Analytical framework

Estimating the impact of credit access on farm performance poses two methodological challenges: unobserved heterogeneity and endogenous sample selection (Mukasa et al., 2017). First, there is some heterogeneity between farmers with and without access to credit in terms of socio-demographic characteristics, farm/plot characteristics, access to institutional support, and geographic/locational measures and the consequent impacts on productivity, cost, and net returns. Some farmers may not have accessed credit for production because they had sufficient capital and resources to self-finance their activities (Balana et al., 2022), while others did not access credit because there were no lenders (formally or informally) to access credit. It could also be that they did not access credit because of the high transaction costs (Balana et al., 2022). Regarding endogenous sample selection bias, farmers with access to credit can separate consumption decisions from farm production decisions and make efforts to choose optimal levels of productive inputs, independent of the consumption constraints they face (Foltz, 2004; Mukasa et al., 2017). In contrast, liquidity-constrained farmers may use suboptimal levels of productive inputs due to the allocation of such limited resources between production and consumption expenditures. In addition, it is assumed that a farmer would try to access credit only if the benefits derived from the decision exceed the benefits of not accessing credit, a situation that could induce selection bias. To control for these biases, we estimated the productivity, cost, and income effects of access to agricultural credit using propensity score matching. Propensity score matching (PSM) is a non-parametric technique used in impact evaluation studies to estimate the effect of a treatment on outcome variables. In the current context, the propensity score $p(X_i)$ refers to the conditional probability of accessing credit for cocoa production given characteristics of the subjects before they accessed credit for production (Owusu et al., 2011). This is defined as follows (Owusu et al., 2011):

$$p(X_i) = Pr\left[T_i = |X_i\right] = E\left[T_i|X_i\right]; p(X_i) = F\left\{h(X_i)\right\} \tag{1}$$

From Eq. (1), $T_i = (0, 1)$ represents status of credit access, and X_i is a vector of the characteristics of farmers before they accessed credit for cocoa production, and $F(*)$ is a normal or logistic cumulative distribution. The propensity score in Eq. (1) can be predicted with either a probit or logit model (Faltermeier & Abdulai, 2009), and the predicted scores used to estimate treatment effects. This technique is based on three main pillars, namely individuals, treatment and potential outcomes (Caliendo & Kopeinig, 2005). In the case of a binary treatment, as in the current study, T_i equals to 1 if a farmer i accessed credit for cocoa production, and 0 otherwise. The potential outcomes (productivity, cost, and net returns) are defined as, $Q_i(T_i)$ for each individual i, where $i = 1, \ldots .N$. N represents the total population. For an individual i, the treatment effect can be written as:

$$\theta_i = Q_i(1) - Q_i(0) \tag{2}$$

However, a major evaluation problem arises from the estimation of Eq. (2) because only one of the potential outcomes is observed for each of the farmers i, and this makes the estimation of the treatment effect θ_i impossible, permitting the estimation of only average treatment effects. The estimation of the latter however requires a counterfactual outcome, which refers to the unobserved outcome for each of the subjects (Caliendo & Kopeinig, 2005). While emphasis is placed in the literature on three basic treatment effects, namely the Average Treatment Effect (ATE), the Average Treatment Effect on the Untreated (ATU), and the Average Treatment Effect on the Treated (ATT), the latter has received the most attention in impact evaluation literature. Emphasis is as well placed in this study on the ATT, which is defined as

$$\theta_{ATT} = E(\theta|T = 1) = E[Q(1)|T = 1] - E[Q(0)|T = 1] \tag{3}$$

where $E[Q(0)|T = 1]$ is the counterfactual mean for the treated. The study assumes that selection of respondents into the respective statuses of credit access is solely based on observable characteristics and that all the variables that are assumed to influence treatment assignment and the potential outcomes simultaneously are observed by the researcher (Caliendo & Kopeinig, 2005). The justification of this assumption is however based on the quality of the data and the quality of matching. In estimating the propensity scores and the treatment effects, several matching algorithms have been used in literature, and the most used algorithms are the Kernel matching, nearest neighbour matching, and caliper/ radius matching. While all three have their strengths and weaknesses, this study employs the Kernel matching technique as the base model and checks for robustness in estimated impacts using the other two matching algorithms. In addition to these, the study checks for robustness and reliability of the results using a balancing property. This property implies that conditional on the estimated propensity scores, everyone should have the same probability of accessing credit as in a randomized experiment (Caliendo & Kopeinig, 2005). The distribution of X_i in Eq. (1) is expected to be balanced between the treated and control groups if the balancing property is satisfied (Hujer et al., 2004).

This study assumes that farmers' access to credit (T_i) is influenced by a set of household characteristics (H_i), farm/plot characteristics (F_i), and distance/institutional factors (D_I_i). Based on this information, the probit model employed for the estimation of the propensity scores is defined as follows:

$$T_i = \beta_0 + \beta_1 H_i + \beta_2 F_i + \beta_3 D\_I_{ii} + u \tag{4}$$

The variables considered under the symbol H_i are the sex of the household head interviewed, age, educational level, household size, child ratio, and marital status. For symbol F_i, the variables considered were farm size, experience in cocoa production, and number of cocoa farms cultivated. The variables considered under the distance/institutional factors (D_I_{ii}) are access to government extension services, distance to the nearest daily marketplace, and distance to the nearest district capital.

With an a priori expectation of a differential impact of credit access among the respondents based on some key attributes, a disaggregate analysis of the impact was also performed based on the gender of the respondents, and status of land fragmentation.

3.4. Definition of the performance indicators

Three performance indicators were considered in the analysis: productivity (measured using yield, yield gap, and gross income), cost of production, and net income from production. Yield refers to the observed output per acre of cocoa farms, and the yield gap is defined as follows:

$$Yield\ gap = \left[1 - \left(\frac{Y_a}{Y_w}\right)\right] \times 100 \tag{5}$$

where Y_a is the observed yield from the survey data, and Y_w is the maximum possible yield under rainfed conditions, the latter of which is reported to be 1000 kg/ha or 404.69 kg/acre (Ministry of Food and Agriculture (MoFA), 2018). For the analysis, yield was measured in kg/acre, while gross income (a product of yield and price) was measured in GH₵/acre. The cost of production includes the cost of land rent, cost of land preparation and maintenance, cost of pesticides and herbicides, fertilizer costs, hired labor costs, charges on fertilizer, herbicide, and pesticide application, charges for other relevant cultural practices (including pruning), cost of transportation, and expenses related to harvesting and post-harvest management of the beans. Net income (returns) from cocoa production is defined as the gross income minus the cost of production.

3.5. Characteristics of cocoa farms and farmers in the study area

In this section, we present some brief information on the characteristics of cocoa farms and farmers in the study area.

Low yield was found to be a major attribute of cocoa farms in the study area. As shown in Table 1, we estimated an average yield of 176.86 kg/acre (437 kg/ha), equivalent to 2.76 bags/acre. This figure is well below the achievable yield of 1000 kg/ha (404.7 kg/acre) under rainfed conditions reported by the Ministry of Food and Agriculture (MoFA), (2018). This estimate implies a yield gap of 56.3% for cocoa in the study area. Cocoa farmers in the study area earn an average gross income of GH₵1823.8/acre (US$303.7/acre). The annual cost of production is estimated at GH₵275.1/acre (US$45.81/acre), while the average cocoa farmer records a return of GH₵1,548.7/acre (US$257.8/acre). While access to credit is believed to ease liquidity constraints among farmers and enhance investment in yield-enhancing innovations, most of the farmers have no access to formal or informal credit. The proportion of cocoa farmers with access to credit was estimated to be 33.3%. Approximately 70% of the cocoa farmers in the study area are males, and the average farmer has approximately 11 years of schooling and is approximately 46 years old. The estimate for the mean age is close to the estimate of 50.4 years reported by Yahaya et al. (2015) for the Eastern Region. The figures indicate that the cocoa farmers in the study area are mostly economically active. While we estimate an average household size of six people, it is found that about 14.0% of the members of the respective households are below 18 years of age. Half of the sample is married, and the average cocoa farmer cultivates 6.906 acres (2.79 ha) of cocoa farmland. The average farmer lives about 2.0 km from the nearest daily marketplace, and about 8.7 km from the nearest district capital. Approximately 96% of the respondents accessed government extension services in 2021. The average farmer in the study area cultivates approximately two cocoa farms and has been cultivating the crop for approximately 19 years. This latter estimate is in line with a report by Yahaya et al. (2015) for the Eastern Region, where the authors report a mean farming experience of 19.4 for cocoa farmers.

In addition to presenting the general characteristics of cocoa farmers and farms in the study area, we also assessed differences in these characteristics among farmers who accessed credit for cocoa

Table 1. Characteristics of the cocoa farms and farm households in the study area.

$N = 384$	Units of measurement	Mean	Std Dev
Outcome variables			
Measures of productivity			
Yield of cocoa in kg	Output per acre of cocoa farm (Kg/acre)	176.86	92.79
Yield gap	Deviation of observed cocoa yield from achievable, %	56.30	22.93
Gross income from cocoa	Gross income per acre of cocoa (GH₵/acre)	1823.8	956.9
Cost indicator			
Annual cost of production per acre	Variable cost for cocoa production (GH₵/acre)	275.13	473.43
Income (returns) indicator			
Net income from cocoa	Net income per acre of cocoa (GH₵/acre)	1548.7	945.82
Treatment variable			
Credit access for agricultural production	Dummy = 1 if farmer accessed credit for cocoa production, 0 otherwise	0.333	0.472
Explanatory variables			
Household characteristics			
Gender	Dummy = 1 if household head is a male, 0 otherwise	0.698	0.460
Age	Age of household head in years	45.90	13.87
Education	Years of schooling	10.60	5.925
Household size	Number of people in household	6.219	3.328
Child-ratio	% of household members < 18years	14.01	15.45
Marital status	Dummy = 1 if household head is married, 0 otherwise	0.50	0.501
Farm/plot characteristics			
Farm size	Total size of cocoa farm in acres	6.906	3.703
Experience in cocoa production	Number of years farmer has been producing cocoa	19.24	9.568
Number of cocoa farms	Count of the number of cocoa farms cultivated/owned	2.508	1.999
Distance/institutional factors			
Access to gov, extension services	Dummy = 1 if farmer has access to extension services, 0 otherwise	0.958	0.200
Distance to nearest market	Distance from residence to nearest market place in km	2.017	0.603
Distance to nearest district capital	Distance from residence to the nearest district capital in km	8.667	1.843

Note. Exchange rate for the year 2021 - GH₵/US$ = 6.0061; FBO membership was not considered because all the farmers interviewed were members of a farmer-based organization.
Source: Authors.

Table 2. Test of mean difference in characteristics.

	No credit accessed ($N = 256$)	Credit accessed ($N = 128$)	Mean diff	*t*-value
Outcome variables				
Yield of cocoa	170.18 (91.75)	190.22 (93.77)	−20.04**	−2.00
Yield gap	57.95 (22.67)	53.00 (23.17)	4.95**	2.00
Gross income from cocoa	1754.97 (946.18)	1961.60 (966.98)	−206.63**	−2.00
Cost of production per acre	291.88 (534.80)	241.63 (316.15)	50.25	0.98
Net income from cocoa	1463.09 (887.56)	1719.97 (1035.24)	−256.88**	−2.53
Household characteristics				
Gender	0.672 (0.470)	0.750 (0.435)	−0.078	−1.57
Age	44.44 (13.80)	48.81 (13.58)	−4.38***	−2.94
Education	10.81 (6.828)	10.19 (3.464)	0.625	0.97
Household size	6.859 (3.355)	4.938 (2.883)	1.922***	5.54
Child-ratio	13.72 (15.47)	14.58 (15.45)	−0.861	−0.51
Marital status	0.578 (0.495)	0.344 (0.477)	0.234***	4.43
Farm/plot characteristics				
Farm size	6.828 (3.885)	7.063 (3.320)	−0.234	−0.58
Experience in cocoa production	19.64 (10.55)	18.44 (7.174)	1.203	1.16
Number of cocoa farms	2.637 (2.314)	2.25 (1.094)	0.375*	1.73
Distance/institutional factors				
Access to gov, extension services	0.984 (0.124)	0.906 (0.293)	0.078	3.66
Distance to nearest market	1.90 (0.313)	2.25 (0.905)	−0.35***	−5.56
Distance to nearest district capital	8.719 (2.092)	8.563 (1.202)	0.156	0.783

NB: (*) standard deviation; NB: ***1%, **5%, *10%.
Source: Authors.

Table 3. Status and sources of credit access among cocoa farmers in the study area.

Did farmer access credit for cocoa production in the year 2021?	Percent of respondents ($N = 384$)	Sources of credit accessed for cocoa production	Percent of farmers with access to credit ($N = 128$)
Yes	33.33	Bank	12.50
No	66.67	Credit Union	9.38
		Cooperative union	75.0
		Family/friends/relatives	3.13

Source: Authors.

production in 2021 and those who did not access credit. This is a first step in the identification of potential selection bias in the analysis. The results are presented in Table 2. Farmers who accessed credit for production had significantly higher yields, lower yield gaps, higher gross income, and higher net income than those who did not access credit during the reference period. However, this does not indicate causality.

In addition, farmers with access to credit were found to be relatively older, had lower household size, were mostly single, cultivated fewer farms, and lived farther from the nearest marketplace than those who did not access credit for production. Living farther from the nearest marketplace may limit farmers' access to off-farm employment to generate extra income, and this could induce liquidity constraints and consequently force them to search for credit for production. For a deeper insight into cocoa farmers' access to credit, this study also identified the sources from which the farmers accessed credit for production. The results, as shown in Table 3, indicate that most of the farmers who accessed credit did so from cooperative unions (75%), banks (12.50%), and Credit Unions (9.38%).

Only 3.13% accessed credit from their family, friends, or relatives. This result is in line with reports by Agbo et al. (2015) and Haryanto et al. (2023), who found that the majority of farmers access credit from cooperative unions or farmer unions to which they belong. The high access to credit from informal sources by cocoa farmers may be attributed to lower interest rates, lower transaction costs, and less demand for collateral associated with lending from informal sources (Haryanto et al., 2023).

4. Results

In this section, we present the results for the respective analyses, starting with an analysis of the determinants of farmers' access to credit, impact of credit access on farm performance, and then to a disaggregate analysis of the impact of credit access based on gender (sex) and status of land fragmentation.

4.1. Determinants of cocoa farmers access to credit

Having estimated a probit model for prediction of the propensity scores, we present the outcome in this section. From Table 4, the results show that the statistically significant determinants of cocoa farmers' access to credit are age, age squared, household size, child ratio, marital status, farm size, experience in cocoa production, number of cocoa farms cultivated, access to government extension services, distance to the nearest marketplace, and distance to the nearest district capital. There is a non-linear association between credit access and the age of the household head. We find a significant positive effect of age and a significant negative effect of age squared. This implies that middle-aged farmers are more likely to access credit for cocoa production than aged farmers. This could be due to the possibility that older farmers are more risk averse (Nielsen et al., 2013), considered high-risk clients by lenders and hence not given loans as compared to younger farmers (Sekyi et al., 2017, 2020), have less need for credit due to their usual engagement in low-input production (Acheampong et al., 2021), or may have high resource endowment and hence have less need for credit (Balana et al., 2022; Chamberlin & Sumberg, 2021; Chen et al., 2024).

While a negative association was found between farmers' access to credit and their household size, households with higher child ratios were more likely to access credit for production. The former relationship is in line with the work of Li et al. (2011) and Hananu et al. (2015), whereas the latter association is in line with the findings of Okurut et al. (2005) and Li et al. (2011). The former relationship may be attributed to the possibility of collective efforts by members of the household towards the upkeep of the household and to meet the cost of production of cocoa, thereby leading to a reduced incentive for them to apply for and access credit. However, this observation contrasts with reports by Barslund and Tarp (2008) and Tang and Guo (2017), who found that larger households have a greater demand for credit. A higher child ratio means that households are likely to access financial support from fewer members, have a greater burden of meeting the needs of the children, and hence are more likely to be constrained financially, thereby increasing the chance for such households to apply for and access credit to meet production expenditures. Married household heads are less likely to have access to credit for production. This may be attributed to the fact that married household heads, owing to the possibility of pooling resources with their spouses, are less likely to face cash constraints and have a reduced incentive to apply for and access credit for production. From Table 4, it is found that married household heads are 29.96% less likely to access credit for cocoa production compared to their single counterparts.

Additionally, a positive association was found between farm size and farmers' access to credit. The marginal effects in Table 4 indicate that an acre increase in the farm size increases the probability of credit access by 3.80%. This observation agrees with the reports of Awotide et al. (2015), Ullah et al. (2020), and Haryanto et al. (2023). This can be attributed to several possibilities. First, land represents a measure of wealth, assets, and social status (Ullah et al., 2020). The larger the farm size, the more likely the farmer is to have access to credit from both formal and informal sources (Awotide et al., 2015), as the land could serve as collateral to access credit (Haryanto et al., 2023). Second, cultivation on a larger farm implies a need for investment in relatively higher amounts of inputs for high productivity (Chandio et al., 2020) and

Table 4. Determinants of cocoa farmers' credit access (probit from kernel matching).

Variables	Coefficient	Std. Error	*z*	*p*-value	Marginal effects (DF/dx)	Std. Error
Household characteristics						
Gender	0.1575	0.1870	0.84	0.400	0.0505	0.0587
Age	0.1811***	0.0464	3.94	0.000	0.0593***	0.0154
Age squared	−0.0014***	0.0005	−2.90	0.004	−0.00046***	0.00016
Education	−0.0073	0.0243	−0.30	0.763	−0.0024	0.0079
Household size	−0.2405***	0.0457	−5.27	0.000	−0.0787***	0.0139
Child-ratio	0.0225***	0.0064	3.50	0.000	0.0074***	0.0020
Marital status	−0.9356***	0.1858	−5.03	0.000	−0.2996***	0.0576
Farm/plot characteristics						
Farm size	0.1160***	0.0328	3.54	0.000	0.0380***	0.0106
Experience in cocoa production	−0.0538***	0.0179	−3.00	0.003	−0.0176***	0.0058
Number of cocoa farms	−0.1109*	0.0565	−1.96	0.050	−0.0363*	0.0183
Distance/institutional factors						
Access to gov, extension services	−1.0546**	0.4280	−2.46	0.014	−0.3981**	0.1579
Distance to nearest market	1.1420***	0.2443	4.67	0.000	0.3738***	0.0827
Distance to nearest district capital	−0.1702*	0.0967	−1.76	0.078	−0.0557*	0.0311
Intercept	−3.4004*	1.7525	−1.94	0.052		

NB: ***1%, **5%, *10%; Obs. $p = 0.3333$, pred. $p = 0.2647$ (at x-bar).

economies of scale. However, owing to liquidity constraints faced by most farmers in the study area, increasing farm size may force most farmers to go in for credit for their operations. In addition, most informal and formal lenders regard large-scale producers as creditworthy and are more likely to grant them credit for production (Sekyi et al., 2019).

In line with a report by Ullah et al. (2020), it was found that more experienced farmers are less likely to access credit for production. Due to the generally risk-averse nature of most experienced producers compared to younger farmers (Senapati, 2020; Ullah et al., 2015), uncertainties and risks in cocoa production, and experiences from loan default and repercussions from the past, more experienced farmers may prefer to produce with the resources at hand rather than access credit to invest in their production. Access of cocoa farmers to credit is also found to decrease with the number of cocoa farms cultivated and access to government extension services but increases with distance to the nearest marketplace. This implies that farmers who cultivate more cocoa farms are less likely to apply for and/or access credit for production.

Producing on different crop fields serves as a risk management strategy and could reduce incentives for farmers to access credit for production due to a low possibility of total crop failure. Although the association between credit access and access to extension services contrasts with reports by Anang et al. (2015) and Anang and Asante (2020), the observed relationship could be deemed logical. While extension agents can link farmer groups to credit sources and provide farmers with vital production-related information (Anang et al., 2015), most farmers, especially cocoa producers, also receive production-related support (including inputs) from the government through extension agents. This reduces production-related costs and the need to access production credit. Farmers with access to extension services are found to be 39.81% less likely to access credit for cocoa production. Living closer to markets improves income and off-farm employment, both of which reduce liquidity constraints and the need to access production credit. Living farther from the nearest marketplace, however, reduces farmers' access to off-farm employment, increases liquidity constraints and transaction costs (including cost of transportation and accessing inputs), and increases the need for credit to cover production expenditures. A km increase in the distance to the nearest marketplace increases the probability of agricultural credit access by 37.38%. A km increase in the distance to the nearest district capital however decreases the probability of access to agricultural credit by 5.57%. This indicates that farmers leaving in more remote locations are less likely to have access to credit compared to those closer to the district capitals where most financial institutions and cooperative bodies/farmer unions are located.

4.2. Impact of access to credit on cocoa production

This section presents the results for the estimated impacts of credit access on cocoa production using a kernel-based propensity score matching algorithm (Kernel Matching with a bandwidth of 0.09), a nearest neighbour matching, and a caliper matching (with a caliper of 0.05). A balancing test is performed based on kernel matching, and the results are presented in Table AP 1 in the appendix, alongside a common support graph (Figure AP1 in the appendix). According to the estimated impacts in Table 5, access of cocoa farmers to credit leads to significant increases in yield, decreases in yield gap, and increases in

Table 5. Impact of access to credit on cocoa production.

Outcome variable	Estimator	Treated	Control	ATT	*t/z*-value	% Change
Yield (kg/acre)	Kernel matching	198.18	169.42	28.76**	2.07	16.98
	Nearest neighbor	198.18	162.84	35.35**	2.06	21.71
	Caliper/radius	198.18	156.96	41.22**	2.42	26.26
Yield gap, %	Kernel matching	51.029	58.136	−7.107**	−2.07	−12.22
	Nearest neighbor	51.029	59.763	−8.734**	−2.06	−14.61
	Caliper/radius	51.029	61.215	−10.19**	−2.42	−16.65
Gross income (GH₵/acre)	Kernel matching	2043.75	1747.12	296.62**	2.07	16.98
	Nearest neighbor	2043.75	1679.25	364.50**	2.06	21.71
	Caliper/radius	2043.75	1618.63	425.11**	2.42	26.26
Cost of production (GH₵/acre)	Kernel matching	249.36	255.47	−6.107	−0.10	−2.39
	Nearest neighbor	249.36	242.58	6.784	0.13	2.80
	Caliper/radius	249.36	236.61	12.75	0.25	5.39
Net income (GH₵/acre)	Kernel matching	1794.38	1491.65	302.73**	2.05	20.29
	Nearest neighbor	1794.38	1436.67	357.72**	2.07	24.90
	Caliper/radius	1794.38	1382.02	412.36**	2.41	29.84

NB: ***1%, **5%, *10%.

gross income. For yield, the estimated increase ranges between 16.98 and 26.26% (28.76–41.22 kg/acre), while the estimated decreases in yield gap ranges between 12.22 and 16.65%. The observed positive effect of agricultural credit access on yield implies that improving cocoa farmers' access to credit could significantly help to reduce the current yield gap for cocoa and enhance the productivity of cocoa farms in the study area. Since cocoa prices are set by the government (thus, farmers take prices as given), we estimate the same percentage change in gross income with access to credit. From the results, it is found that access to agricultural credit has no significant impact on the cost of production. A significant positive impact is however found for net income, indicating that the positive impact of agricultural credit on income from cocoa production could be due to the positive impact on yield.

The impact estimates in Table 5 indicate that access to agricultural credit is associated with 20.29–29.84% increases in net income from cocoa production. This finding implies that improving cocoa farmers' access to credit could enhance the profitability of cocoa production in Ghana. These observations are in line with those of Wole-Alo et al. (2022), Assouto and Houngbeme (2023), Diallo et al. (2020), and Ogundeji et al. (2018), who reported that access to credit increases yields and incomes from crop (cocoa and maize) production.

For a deeper insight into the potential heterogeneity in impacts across various categories of cocoa farmers, a disaggregate analysis of the impact was performed based on gender of the household head, and the status of land fragmentation. All the three matching algorithms are used for this analysis, and the results are presented in the subsequent subsection.

4.3. A disaggregate analysis of the impact of access to credit on cocoa production

In line with an a priori expectation of differential impacts of credit access on males and females, and on farmers who operate on fragmented and non-fragmented lands, we find different directions and magnitudes of impacts for these categories of farmers.

Based on the gender of the household head, and as shown in Table 6, it was found that male-headed households are better off in their use of credit for cocoa production than their female counterparts. While the males observed significant increases in yield (56.39–94.20%), gross income, and net income (64.45–118.95%), as well as significant decreases in the yield gap (−27.35 to −36.05%), none of the estimated impacts for female-headed households were found to be significant. These differences in the estimated impacts could be attributed to differences in the challenges faced by men and women in cocoa production, such as differences in access to inputs, liquidity constraints, resource endowment, marginalization, access to information, decision-making power, and managerial skills (Bessa et al., 2021; Danso-Abbeam et al., 2020; Dery & Dongzagla, 2020; Kuhn et al., 2023).

Considering the impact of credit use for cocoa production on fragmented and non-fragmented lands, it was found that it could be more beneficial to access credit for production on fragmented lands than on non-fragmented lands. While farmers who operate on fragmented lands observe 41.82–53.08% increases in yield, 24.20–27.28% decreases in yield gap, and 46.83–59.51% increases in net income, farmers who operate on non-fragmented lands observe 23.33–33.14% decreases in yield, 26.52–35.79% increases in yield gap, and 31.15–47.30% decreases in income. This implies that the use of credit for production on fragmented lands increases the productivity and profitability of cocoa production by enhancing farmers' financial ability to meet the costs across fields, purchase sufficient inputs on time, and allocate them efficiently. The use of credit on non-fragmented lands could lead to inefficient use of inputs, possibly because of the small-scale nature of cocoa farms in the study area. With sufficient resources, it may be more profitable to use credit for production on fragmented lands.

5. Conclusion

A fact well established in literature is that the behaviour of farmers in the allocation of resources is consistent with the neo-classical profit maximization model (Schultz, 1964), and farmers decision to access credit when faced with liquidity constraint is based on expected utility maximization. In effort to maximize profit/returns from production, a farmer may access credit for production only if the benefits from credit access and utilization outweighs the benefits of foregoing borrowing and operating within the context of available resources and technology. It is assumed that a farmer will access credit for

Table 6. Heterogeneity/disaggregated analyses of the impact of agricultural credit access.

Variables	Outcomes	Treated	Control	ATT	t-stat	% change
Kernel matching						
Gender						
Male (N = 268)	Yield (kg/acre)	206.72	132.18	74.54***	3.57	56.39
	Yield gap (%)	48.92	67.34	−18.42***	−3.57	−27.35
	Gross income (GH₵/acre)	2131.8	1363.10	768.71***	3.57	56.39
	Cost of production (GH₵/acre)	191.78	183.43	8.350	0.28	4.55
	Net income (GH₵/acre)	1940.02	1179.7	760.36***	3.49	64.45
Female (N = 116)	Yield (kg/acre)	188.72	158.76	29.96	1.10	18.87
	Yield gap (%)	53.37	60.77	−7.40	−1.10	−12.18
	Gross income (GH₵/acre)	1946.1	1637.2	308.94	1.10	18.87
	Cost of production (GH₵/acre)	372.11	261.36	110.75	0.57	42.37
	Net income (GH₵/acre)	1574.04	1375.85	198.19	0.65	14.40
Land fragmentation						
Operation of fragmented land (247)	Yield (kg/acre)	210.31	137.39	72.92***	4.05	53.08
	Yield gap (%)	48.03	66.05	−18.02***	4.05	−27.28
	Gross income (GH₵/acre)	2168.82	1416.82	752.00***	4.05	53.08
	Cost of production (GH₵/acre)	188.45	175.32	13.13	0.43	7.49
	Net income (GH₵/acre)	1980.37	1241.50	738.87***	3.92	59.51
Operation of single cocoa farm (N = 137)	Yield (kg/acre)	165.08	215.29	−50.22**	−2.12	−23.33
	Yield gap (%)	59.21	46.80	12.41**	2.12	26.52
	Gross income (GH₵/acre)	1702.38	2220.23	−517.85**	−2.12	−23.33
	Cost of production (GH₵/acre)	418.36	355.15	63.22	0.47	17.80
	Net income (GH₵/acre)	1284.02	1865.08	−581.06**	−2.21	−31.15
Nearest neighbour matching						
Gender						
Male (N = 268)	Yield (kg/acre)	206.72	113.6	93.12***	4.45	81.97
	Yield gap (%)	48.92	71.93	−23.01***	−4.45	−31.99
	Gross income (GH₵/acre)	2131.80	1171.5	960.3***	4.45	81.97
	Cost of production (GH₵/acre)	191.78	217.6	−25.82	−0.73	−11.87
	Net income (GH₵/acre)	1940.02	953.90	986.12***	4.46	103.4
Female (N = 116)	Yield (kg/acre)	188.72	172.0	16.72	0.55	9.72
	Yield gap (%)	53.37	57.50	−4.131	−0.55	−7.18
	Gross income (GH₵/acre)	1946.1	1773.75	172.4	0.55	9.72
	Cost of production (GH₵/acre)	372.11	291.37	80.74	0.67	27.71
	Net income (GH₵/acre)	1574.0	1482.4	91.66	0.30	6.18
Land fragmentation						
Operation of fragmented land (247)	Yield (kg/acre)	210.31	148.3	62.02***	2.97	41.82
	Yield gap (%)	48.03	63.36	−15.33***	−2.97	−24.20
	Gross income (GH₵/acre)	2168.8	1529.2	639.6***	2.97	41.83
	Cost of production (GH₵/acre)	188.45	180.47	7.983	0.23	4.42
	Net income (GH₵/acre)	1980.4	1348.7	631.6***	2.95	46.83
Operation of single cocoa farm (N = 137)	Yield (kg/acre)	165.08	217.78	−52.70***	−2.73	−24.20
	Yield gap (%)	59.21	46.19	13.02***	2.73	28.19
	Gross income (GH₵/acre)	1702.38	2245.8	−543.5***	−2.73	−24.20
	Cost of production (GH₵/acre)	418.36	327.71	90.65	0.63	27.66
	Net income (GH₵/acre)	1284.0	1918.1	−634.1***	−2.68	−33.06
Caliper matching						
Gender						
Male (N = 268)	Yield (kg/acre)	217.50	112.0	105.5***	4.75	94.20
	Yield gap (%)	46.26	72.32	−26.07***	−4.75	−36.05
	Gross income (GH₵/acre)	2243.0	1155.0	1088.0***	4.75	94.20
	Cost of production (GH₵/acre)	187.70	216.32	−28.62	−0.83	−13.23
	Net income (GH₵/acre)	2055.3	938.68	1116.6***	4.77	118.95
Female (N = 116)	Yield (kg/acre)	185.27	186.67	−1.397	−0.04	−0.75
	Yield gap (%)	54.22	53.87	0.345	0.04	0.64
	Gross income (GH₵/acre)	1910.6	1925.0	−14.40	−0.04	−0.75
	Cost of production (GH₵/acre)	410.0	315.78	94.23	0.65	29.84
	Net income (GH₵/acre)	1500.6	1609.2	−108.6	−0.33	−6.75
Land fragmentation						
Operation of fragmented land (247)	Yield (kg/acre)	210.31	148.29	62.02***	2.97	41.82
	Yield gap (%)	48.03	63.36	−15.33***	−2.97	−24.20
	Gross income (GH₵/acre)	2168.82	1529.2	639.6***	2.97	41.82
	Cost of production (GH₵/acre)	188.45	180.47	7.983	0.23	4.42
	Net income (GH₵/acre)	1980.37	1348.7	631.64***	2.95	46.83
Operation of single cocoa farm (N = 137)	Yield (kg/acre)	140.50	210.13	−69.64***	−3.94	−33.14
	Yield gap (%)	65.28	48.08	17.21***	3.94	35.79
	Gross income (GH₵/acre)	1448.9	2167	−718.1***	−3.94	−33.14
	Cost of production (GH₵/acre)	466.16	302.25	163.9	1.00	54.23
	Net income (GH₵/acre)	982.7	1864.8	−882.05***	−4.03	−47.30

NB: ***1%, **5%, *10% significance level.

production only if that would enhance his productivity and help to maximize his profit from production. Given limited access of most cocoa farmers to agricultural credit in Ghana, this study sought to ascertain the role agricultural credit plays in cocoa production in Ghana, placing emphasis on productivity, costs, and profitability implications/impacts.

This study identified the determinants of cocoa farmers' access to agricultural credit and estimated the impact of credit on productivity, cost, and net income from cocoa production using survey data from 384 cocoa farming households in the Eastern Region of Ghana. The study employed propensity score matching for the analysis, using Kernel matching, nearest neighbour matching, and caliper matching. The study found that cocoa yields in the region are well below the achievable water-limited potential, with a yield gap of 56.30% estimated for cocoa. This indicates that there is room for improvement. The study finds that improving farmers' access to credit could help to significantly reduce this gap, enhance their yields, and increase their income from production. Despite the merits of agricultural credit in cocoa production, only 33.3% of farmers accessed credit for production in 2021, and most of these farmers did so from cooperative unions. Policy and stakeholder efforts to enhance farmers' access to credit as a hunger and poverty alleviation tool should consider the important role that cooperative unions play in the process. Interestingly, it was found that all interviewed household heads were members of farmer-based organizations/cooperative unions. A significant positive association was found between access to credit and age, child ratio, farm size, and distance to the nearest marketplace, but a significant negative association was found between credit access and age squared, household size, marital status, experience in cocoa production, number of cocoa farms cultivated, access to government extension services, and distance to the nearest district capital. These differences in the direction and magnitude of effects should be taken into consideration whenever policy efforts are made to enhance cocoa farmers access to agricultural credit.

The study finds a significant positive impact of credit access on yield, gross income, and net income from cocoa production and a significant decrease in the yield gap with improved access to credit. The implementation of policy measures to improve cocoa farmers' access to credit is important. These measures include enhancing the financial capacity of agricultural cooperatives (farmer-based organizations), providing farmers with credit at lower interest rates, and carefully considering the different effects of the considered explanatory variables on farmers' access to credit. However, we found heterogeneity in the impact of credit access on male- and female-headed households, and between farmers who operate on fragmented and non-fragmented lands. The study finds that male-headed households with credit access derive greater benefits than their female counterparts who access credit. These observations may be attributed to the possibility that most of the male-headed households may be more resource endowed, have better access to information, and are often less marginalized than their female counterparts, and hence are in a better position to efficiently and effectively utilize agricultural credit to enhance their productivity and profitability. On the other hand, most female-heads in the study country, especially in agriculture-dominated areas are known to be relatively more marginalized, less endowed in resources, and have limited access to relevant production related information among other factors, and this could hinder their performance, even if they have access to credit. This outcome implies that enhancing female farmers access to credit may not be enough to enhance their farm performance. There may be a need to first address other constraints faced by the female heads beside liquidity constraints for them to realize the benefits of agricultural credit in cocoa production. The use of agricultural credit for cocoa production is more beneficial among farmers who produce on fragmented lands than among those who produce on a single cocoa farm. While producing on fragmented lands may lead to a higher absolute cost than on non-fragmented lands, input cost per land may be lower on fragmented farms if inputs are purchased on time (due to the division/allocation of inputs across farms), the latter of which can be enhanced by farmers access to credit. With access to credit for production on non-fragmented lands however, farmers may be inefficient in their use of inputs, and this could lead to a decrease in yield, and a possible decrease in income. Producing on fragmented lands when faced with credit constraint could however be counterproductive. Policy efforts to enhance cocoa farmers access to credit, especially for production on fragmented lands could prove beneficial in terms of enhancing productivity and profitability of cocoa production.

These differences in impact should be carefully considered in policy formulation to improve farmers' access to credit and enhance the role of agricultural credit in cocoa production as a yield- and profit-enhancing tool.

Limitations of the study

While informative, this study is not without limitations. Future research can focus on analyzing the effect of the sources of credit on the performance of the farmers to ascertain which of the sources is more beneficial to farmers in their production. In addition, while this study was based on a cross-sectional data, it is believed that the use of a panel data for future research could be more informative, especially in the provision of information on the dynamics in farmers' access to and sources from which they access credit. In addition, future research can explore some of the challenges faced by male and female farmers, and farmers who cultivate on fragmented and non-fragmented lands. This could provide better explanations for the observed outcomes in the current study.

Authors' contributions

David Boansi: Conceptualization, Literature review, Data curation, Investigation, Formal analysis, Methodology, Project administration, Resources, Supervision, Validation, Writing-original draft, Writing- review & editing. Michael Gyasi: Conceptualization, Data curation, Investigation, Project administration, Resources, Writing – review and editing. Stephen Nuamah: Literature review, Writing- review and editing. Enoch Kwame Tham-Agyekum: Literature review, Writing- review and editing. Fred Ankuyi: Literature review, Writing-original draft, Writing- review and editing. Richmond Frimpong: Literature review, Writing- review and editing. Albert Gbafah: Literature review, Writing- review and editing. Charles Bosompem Gyan: Literature review, Writing- review and editing.

Disclosure statement

In accordance with Taylor & Francis policy and our ethical obligation as researchers, we declare that we have no potential competing interests to disclose.

Funding

No funding was received

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Data availability statement

On behalf of the co-authors, the corresponding author of this manuscript agrees to make data and materials supporting the results of this study or analyses presented in this paper available upon reasonable request.

References

Abdallah, A. H., Ayamga, M., & Awuni, J. A. (2019). Impact of agricultural credit on farm income under the Savanna and Transitional zones of Ghana. *Agricultural Finance Review*, *79*(1), 60–84. https://doi.org/10.1108/AFR-02-2018-0009

Acheampong, E. O., Sayer, J., Macgregor, C. J., & Sloan, S. (2021). Factors influencing the adoption of agricultural practices in Ghana's forest-fringe communities. *Land*, *10*(3), 266. https://doi.org/10.3390/land10030266

Adeyonu, A. G. (2015). Income inequality and poverty among farming households in Southwest, Nigeria. *International Journal of Agricultural Economics and Rural Development*, *7*, 59–67.

Agbo, F. U., Iroh, I. I., & Ihemezie, E. J. (2015). Access to credit by vegetable farmers in Nigeria: A case study of Owerri Agricultural Zone of Imo State, Nigeria. *Asian Journal of Agricultural Research*, *9*(4), 155–165. https://doi.org/10.3923/ajar.2015.155.165

Agbodji, A. E., & Johnson, A. A. (2021). Agricultural credit and its impact on the productivity of certain cereals in Togo. *Emerging Markets Finance and Trade*, *57*(12), 3320–3336. https://doi.org/10.1080/1540496X.2019.1602038

Akudugu, M. A. (2016). Agricultural productivity, credit and farm size nexus in Africa: A case study of Ghana. *Agricultural Finance Review*, *76*(2), 288–308. https://doi.org/10.1108/AFR-12-2015-0058

Amanullah, W. J., Khan, I., Channa, S. A., & Magsi, H. (2019). Farm level impacts of credit constraints on agricultural investment and income. *Pakistan Journal of Agricultural Sciences*, *56*(02), 511–521. https://doi.org/10.21162/PAKJAS/19.7872

Anang, B. T., & Asante, B. O. (2020). Farm household access to agricultural services in northern Ghana. *Heliyon*, *6*(11), e05517. https://doi.org/10.1016/j.heliyon.2020.e05517

Anang, B. T., Sipilainen, T., Backman, S., & Kola, J. (2015). Factors influencing smallholder farmers' access to agricultural microcredit in Northern Ghana. *African Journal of Agricultural Research*, *10*, 2460–2469.

Artavia Oreamuno, M. A., & Croppenstedt, A. (2023). *Bottlenecks, stresses and risks in the cocoa supply chain in Ghana: recommendations to increase its resilience*. FAO Commodity and Trade Policy Research Working Paper, No. 58. https://doi.org/10.4060/cc8649en

AsokoInsight. (2022). *Ghana's cocoa value chain*. Asoko Insight.

Assouto, A. B., & Houngbeme, D. J. L. (2023). Access to credit and agricultural productivity: Evidence from maize producers in Benin. *Cogent Economics & Finance*, *11*(1), 2196856. https://doi.org/10.1080/23322039.2023.2196856

Attipoe, S. G., Jianmin, C., & Opoku-Kwanowaa, Y. (2020). Evaluating the impact of rural finance on cocoa farmers productivity: A case study of Bodi district in Ghana. *Asian Journal of Advances in Agricultural Research*, *12*, 36–45. https://doi.org/10.9734/AJAAR/2020/v12i430092

Awotide, B. A., Abdoulaye, T., Alene, A., & Manyong, V. M. (2015 *Impact of access to credit on agricultural productivity: Evidence from smallholder cassava farmers in Nigeria* [Paper presentation]. In *A Contributed Paper Prepared for Oral Presentation at the International Conference of Agricultural Economists (ICAE)*, Milan, Italy. August 9–14.

Balana, B. B., Mekonnen, D., Haile, B., Hagos, F., Yimam, S., & Ringler, C. (2022). Demand and supply constraints of credit in smallholder farming: Evidence from Ethiopia and Tanzania. *World Development*, *159*, 106033. https://doi.org/10.1016/j.worlddev.2022.106033

Barslund, M., & Tarp, F. (2008). Formal and informal rural credit in four Provinces of Vietnam. *The Journal of Development Studies*, *44*(4), 485–503. https://doi.org/10.1080/00220380801980798

Bessa, T., Mesfin, Z., & Tobbin Osei, M. (2021). *Women's land rights and economic empowerment in cocoa communities in Ghana: Gender assessment.* USAID Integrated Land and Resource Governance Task Order under the Strengthening Tenure and Resource Rights II (STARR II) IDIQ.

Bonnieux, G. (2019). *Access to finance for cocoa farmers*. Access to Finance Working Group, Swiss Platform for Sustainable Cocoa.

Burchi, F., Scarlato, M., & d'Agostino, G. (2016). Addressing food insecurity in Sub-Saharan Africa: the role of cash transfers. *Discussion Paper 17/2016*., German Development Institute. https://www.idos-research.de/uploads/media/DP_17.2016.pdf

Caliendo, M., & Kopeinig, S. (2005). *Some practical guidance for the implementation of propensity score matching. IZA DP No. 1588*, Institute for the Study of Labor.

Chamberlin, J., & Sumberg, J. (2021). *Do young farmers farm differently? Evidence from sub-Saharan Africa. Integrated Development Program Discussion Paper no. 006*. International maize and Wheat Improvement Center CIMMYT.

Chandio, A. A., & Jiang, Y. (2018). Determinants of credit constraints: Evidence from Sindh, Pakistan. *Emerging Markets Finance and Trade*, *54*(15), 3401–3410. https://doi.org/10.1080/1540496X.2018.1481743

Chandio, A. A., Jiang, Y., Wei, F., Rehman, A., & Liu, D. (2017). Famers' access to credit: Does collateral matter or cash flow matter?—Evidence from Sindh, Pakistan. *Cogent Economics & Finance*, *5*(1), 1369383. https://doi.org/10.1080/23322039.2017.1369383

Chandio, A. A., Yuansheng, J., Sahito, J. G. M., & Larik, S. A. (2016). Impact of formal credit on agricultural output: Evidence from Pakistan. *African Journal of Business Management*, *10*, 162–168. https://doi.org/10.5897/AJBM2015.8042

Chen, Y., Xiang, W., & Zhao, M. (2024). Impacts of capital endowment on farmers' choices in fertilizer-reduction and efficiency-increasing technologies (Preferences, influences, and mechanisms): A case study of apple farmers in the Provinces of Shaanxi and Gansu, China. *Agriculture*, *14*(1), 147. https://doi.org/10.3390/agriculture14010147

Conning, J., & Udry, C. (2007). Rural financial markets in developing countries. In: Evension, R., Pingali, P. (Eds.), *Handbook of agricultural economics* (vol. 3, pp. 2858–2908). Elsevier.

Danso-Abbeam, G., Baiyegunhi, L. J. S., & Ojo, T. O. (2020). Gender differentials in technical efficiency of Ghanaian cocoa farmers. *Heliyon*, *6*(5), e04012. https://doi.org/10.1016/j.heliyon.2020.e04012

Daudu, A. K., Abdoulaye, T., Bamba, Z., Shuaib, S. B., & Awotide, B. A. (2023). Does youth participation in the farming program impact farm productivity and household welfare? Evidence from Nigeria. *Heliyon*, *9*(4), e15313. https://doi.org/10.1016/j.heliyon.2023.e15313

Dery, I., & Dongzagla, A. (2020). Gender analysis within the cocoa supply chain in Ghana. OXFAM Research Reports. November, 2020. Accessed on March 31, 2024: https://www.cocoainitiative.org/sites/default/files/resources/Oxfam%20Gender%20analysis%20Ghana%20Nov20%20(1).pdf

Diallo, M. F., Zhou, J., Elham, H., & Zhou, D. (2020). Effect of agricultural credit access on rice productivity: Evidence from the irrigated area of Anambe Basin, Senegal. *Journal of Agricultural Science*, *12*(3), 78. https://doi.org/10.5539/jas.v12n3p78

Diamoutene, A. K., & Jatoe, J. B. D. (2020). Access to credit and maize productivity in Mali. *Agricultural Finance Review*, *81*(3), 458–477. https://doi.org/10.1108/AFR-05-2020-0066

Dziwornu, R. K., Yiadom, E. B., & Narteh-Yoe, S. B. (2023). Agricultural loan pricing by banks in Ghana: A panel data analysis. *African Journal of Economic and Management Studies*, *15*, 145–158. https://doi.org/10.1108/AJEMS-12-2022-0504

Faltermeier, L., & Abdulai, A. (2009). The impact of water conservation and intensification technologies: Empirical evidence for rice farmers in Ghana. *Agricultural Economics*, *40*(3), 365–379. https://doi.org/10.1111/j.1574-0862.2009.00383.x

FAO. (2014). *Youth and agriculture: Key challenges and concrete solutions*. Food and Agriculture Organization of the United Nations. https://www.fao.org/3/i3947e/i3947e.pdf

Foltz, J. (2004). Credit market access and profitability in Tunisian agriculture. *Agricultural Economics*, *30*(3), 229–240. https://doi.org/10.1016/S0169-5150(04)00025-8

Freeman, H. A., Simeon, K. E., & Jabar, M. A. (1998). Agricultural credit and farm performance in China. *Journal of Comparative Economics*, *13*, 508–526.

GCB. (2022). Sector industry analysis - 2022 Cocoa Sector Report. Ghana Commercial Bank (GCB). Strategy & Research Department. https://www.gcbbank.com.gh/research-reports/sector-industry-reports/120-cocoa-industry-in-ghana-2022/file#:~:text=The%20crop%20generates%20about%20%242,around%20533%20million%20U.S.%20dollars

Ghana Statistical Service (GSS). (2019). Ghana Living Standards Survey 7 (GLSS 7) Main Report. https://statsghana.gov.gh/gssmain/fileUpload/pressrelease/GLSS7%20MAIN%20REPORT_FINAL.pdf

Ghana Statistical Service (GSS). (2021). Population of regions and districts. Ghana 2021 Population and Housing Census. General Report, Volume 3A. Ghana Statistical Services.

Gneiting, U., & Arhin, A. (2023). Towards a living income for cocoa farmers in Ghana: Assessing companies' efforts to date. Oxfam International. February, 2023. https://oxfamilibrary.openrepository.com/bitstream/handle/10546/621485/rr-ghana-cocoa-farmers-living-income-140223-en.pdf

Hananu, B., Abdul-Hanan, A., & Zakaria, H. (2015). Factors influencing agricultural credit demand in Northern Ghana. *African Journal of Agricultural Research*, *10*, 645–652.

Haryanto, T., Wardana, W. W., Jamil, I. R., Brintanti, A. R. W., & Ibrahim, K. H. (2023). Impact of credit access on farm performance: Does source of credit matter? *Heliyon*, *9*(9), e19720. https://doi.org/10.1016/j.heliyon.2023.e19720

Houensou, D. A., Goudjo, G. G., & Senou, M. M. (2021). Access to finance and difference in family farm productivity in Benin: Evidence from small farms. *Scientific African*, *13*, e00940. https://doi.org/10.1016/j.sciaf.2021.e00940

Hujer, R., Caliendo, M., & Thomsen, S. L. (2004). New evidence on the job creation schemes in Germany – a matching approach with threefold heterogeneity. *Research in Economics*, *58*(4), 257–302. https://doi.org/10.1016/j.rie.2004.07.001

Ige, A. O., & Adeyemo, R. (2019). Differentials in poverty levels of cocoa farmer cooperators and non-cooperators in Southwestern Nigeria. *International Journal of Community and Cooperative Studies*, *7*, 17–29.

Ike, P. C., & Umuedafe, D. E. (2013). Determinants of savings and capital formation among rural farmers in Isoko North local government area of Delta State, Nigeria. *Asian Economic and Financial Review*, *3*, 1289.

Kehinde, A. D., & Ogundeji, A. A. (2022). The simultaneous impact of access to credit and cooperative services on cocoa productivity in South-western Nigeria. *Agriculture & Food Security*, *11*(1), 11. https://doi.org/10.1186/s40066-021-00351-4

Khan, M. N., Khan, M., Abassi, S. S., Anwar, S., Ali, M., & Naheed, S. (2013). The Effect of Zarai Taraqiati Bank in enhancing farm productivity through Agricultural Credit-A case study of district Lakki Marwat, KPK-Pakistan. *Research Journal of Agriculture and Forestry Sciences*, *1*(8), 1–4.

Kuhn, M., Tennhardt, L., & Lazzarini, G. A. (2023). Gender inequality in the cocoa supply chain: Evidence from smallholder production in Ecuador and Uganda. *World Development Sustainability*, *2*, 100034. https://doi.org/10.1016/j.wds.2022.100034

Kumar, C. S., Turvey, C. G., & Kropp, J. D. (2013). The impact of credit constraints on farm households: survey results from India and China. *Applied Economic Perspectives and Policy*, *35*(3), 508–527. https://doi.org/10.1093/aepp/ppt002

Kuwornu, J. K., Ohene-Ntow, I. D., & Asuming-Brempong, S. (2013). Agricultural credit allocation and constraint analyses of selected maize farmers in Ghana. *British Journal of Economics, Management & Trade*, *2*(4), 353–374. https://doi.org/10.9734/BJEMT/2012/2270

Li, X., Gan, C., & Hu, B. (2011). Accessibility to microcredit by Chinese rural households. *Journal of Asian Economics*, *22*(3), 235–246. https://doi.org/10.1016/j.asieco.2011.01.004

Löwe, A. (2017). *Creating opportunities for young people in Ghana's cocoa sector. Working Paper 511*. Overseas Development Institute.

Martey, E., Wiredu, A. N., Etwire, P. M., & Kuwornu, J. K. M. (2019). The impact of credit on the technical efficiency of maize-producing households in Northern Ghana. *Agricultural Finance Review*, *79*(3), 304–322. https://doi.org/10.1108/AFR-05-2018-0041

Masaood, M., & Maharjan, K. L. (2020). An exploration of the informal credit practices for agriculture in Afghanistan: reasons for availing informal and not availing formal credit. *Journal of International Development and Cooperation*, *26*, 95–108.

Mason-D'Croz, D., Sulser, T. B., Wiebe, K., Rosegrant, M. W., Lowder, S. K., Nin-Pratt, A., Willenbockel, D., Robinson, S., Zhu, T., Cenacchi, N., Dunston, S., & Robertson, R. D. (2019). Agricultural investments and hunger in Africa modelling potential contributions to SDG2- Zero Hunger. *World Development*, *116*, 38–53. https://doi.org/10.1016/j.worlddev.2018.12.006

Ministry of Food and Agriculture (MoFA). (2018). *Agriculture in Ghana: Facts and Figures (2017). Statistics, Research and Information Directorate (SRID)*. Ministry of Food and Agriculture.

Moahid, M., Khan, G. D., Yoshida, Y., Joshi, N. P., & Maharjan, K. L. (2021). Agricultural credit and extension services: Does their synergy augment farmers' economic outcomes? *Sustainability*, *13*(7), 3758. https://doi.org/10.3390/su13073758

Mukasa, A. N., Simpasa, A. M., & Salami, A. O. (2017). *Credit constraints and farm productivity: Micro-level evidence from smallholder farmers in Ethiopia*. Working Paper Series. 247, African Development Bank.

Nakano, Y., & Magezi, E. F. (2020). The impact of microcredit on agricultural technology adoption and productivity: Evidence from randomized control trial in Tanzania. *World Development*, *133*, 104997. https://doi.org/10.1016/j.worlddev.2020.104997

Nielsen, T., Keil, A., & Zeller, M. (2013). Assessing farmers' risk preferences and their determinants in a marginal upland area of Vietnam: a comparison of multiple elicitation techniques. *Agricultural Economics*, *44*(3), 255–273. https://doi.org/10.1111/agec.12009

Njeru, T. N., Mano, Y., & Otsuka, K. (2016). Role of access to credit in rice production in Sub-Saharan Africa: The case of Mwea irrigation scheme in Kenya. *Journal of African Economies*, *25*(2), 300–321. https://doi.org/10.1093/jae/ejv024

Nwachukwu, I. N., Agwu, N., Nwaru, J., & Imonikhe, G. (2010). Competitiveness and determinants of cocoa export from Nigeria. *Report and Opinion*, *2*, 51–54.

Nzomo, M., & Muturi, W. (2014). The effect of types of agricultural credit programmes on the productivity of small-scale farming businesses in Kenya: a survey of Kimilili Bungoma Sub County. *Journal of Economics and Sustainable Development*, *5*, 150–161.

Obuobisa-Darko, E. (2015). Credit access and adoption of cocoa research innovations in Ghana. *Research on Humanities and Social Sciences*, *5*, 16–29.

Ogundeji, A. A., Donkor, E., Motsoari, C., & Onakuse, S. (2018). Impact of access to credit on farm income: Policy implications for rural agricultural development in Lesotho. *Agrekon*, *57*(2), 152–166. https://doi.org/10.1080/03031853.2018.1483251

Oke, I. T. O., Kehinde, A. D., & Akindele, A. J. (2019). Determinants of access to credit by cocoa farmers in Osun state, Nigeria. *International Journal of Agricultural Research, Innovation and Technology*, *9*(2), 57–61. https://doi.org/10.3329/ijarit.v9i2.45411

Okurut, F. N., Schoombee, A., & Berg, S. (2005). Credit demand and credit rationing in the informal financial sector in Uganda. *The South African Journal of Economics*, *73*(3), 482–497. https://doi.org/10.1111/j.1813-6982.2005.00033.x

Otsuka, K., & Larson, D. F. (2016). *In pursuit of an African green revolution*. Springer.
Owusu, V., Abdulai, A., & Abdul-Rahman, S. (2011). Non-farm work and food security among farm households in Northern Ghana. *Food Policy*, *36*(2), 108–118. https://doi.org/10.1016/j.foodpol.2010.09.002
Rapsomanikis, G. (2015). *The economic lives of smallholder farmers: An analysis based on household data from nine countries*. Food and Agriculture Organization of the United Nations.
Ruane, J., & Ramasamy, S. (2023). *Global investments in agricultural research: Where are we and where are we going?*. Food and Agriculture Organization of the United Nations.
Samuelson, P., & Nordhaus, W. (2005). *Economics*. Tata Mc-Graw Hill.
Schultz, T. W. (1964). *Transforming traditional agriculture*. Yale University Press.
Seck, A. (2021). Heterogeneous credit constraints and smallholder farming productivity in the Senegal River Valley. *Emerging Markets Finance and Trade*, *57*(12), 3301–3319. https://doi.org/10.1080/1540496X.2019.1601080
Sekyi, B. M., Abu, B. M., & Nkegbe, P. K. (2017). Farm credit access, credit constraint and productivity in Ghana: Empirical evidence from Northern Savanna ecological zone. *Agricultural Finance Review*, *77*(4), 446–462. https://doi.org/10.1108/AFR-10-2016-0078
Sekyi, S., Abu, B. M., & Nkegbe, P. K. (2020). Effects of farm credit access on agricultural commercialization in Ghana: Empirical evidence from the northern Savannah ecological zone. *African Development Review*, *32*(2), 150–162. https://doi.org/10.1111/1467-8268.12424
Sekyi, S., Domanban, P. B., & Honya, G. K. (2019). The impact of informal credit on rural agricultural productivity in the savannah ecological zone of Ghana. *African Journal of Economic and Management Studies*, *11*(2), 301–315. https://doi.org/10.1108/AJEMS-03-2019-0121
Senapati, A. K. (2020). Evaluation of risk preferences and coping strategies to manage with various agricultural risks: evidence from India. *Heliyon*, *6*(3), e03503. https://doi.org/10.1016/j.heliyon.2020.e03503
Tabe-Ojong, M. P. J., Ibarra, L. M., Andrade, R. S., & Labarta, R. (2022). Soil conservation and smallholder welfare under cassava-based systems in Thailand. *Land Degradation & Development*, *34*(6), 1795–1805. https://doi.org/10.1002/ldr.4569
Tang, S., & Guo, S. (2017 *Formal and informal credit markets and rural credit demand in China* [Paper presentation]. In: 2017 4th International Conference on Industrial Economics System and Industrial Security Engineering (IEIS) (pp. 1–7) https://doi.org/10.1109/IEIS.2017.8078663
Tsiboe, F. (2021). Chronic sources of low cocoa production in Ghana: New insights from meta-analysis of old survey data. *Agricultural and Resource Economics Review*, *50*, 1–26. https://doi.org/10.1017/age.2021.3
Ugbajah, M., & Ugwumba, C. (2013). Analysis of micro credit as a veritable tool for poverty reduction among rural farmers in Anambra State, Nigeria. *Discourse Journal of Agriculture and Food Sciences*, *1*, 152–159.
Ullah, A., Mahmood, N., Zeb, A., & Kächele, H. (2020). Factors determining farmers' access to and sources of credit: Evidence from the rain-fed zone of Pakistan. *Agriculture*, *10*(12), 586. https://doi.org/10.3390/agriculture10120586
Ullah, R., Shivakoti, G. P., & Ali, G. (2015). Factors effecting farmers' risk attitude and risk perceptions: The case of Khyber Pakhtunkhwa, Pakistan. *International Journal of Disaster Risk Reduction*, *13*, 151–157. https://doi.org/10.1016/j.ijdrr.2015.05.005
van Vliet, J. A., Slingerland, M. A., Waarts, Y. R., & Giller, K. E. (2021). A living income for cocoa producers in Côte d'Ivoire and Ghana? *Frontiers in Sustainable Food Systems*, *5*, 732831. https://doi.org/10.3389/fsufs.2021.732831
Vigneri, M., & Kolavalli, S. (2018). *Growth through pricing policy: The case of cocoa in Ghana. Background paper to the UNCTAD-FAO Commodities and Development Report 2017 Commodity markets, economic growth and development*. Food and Agriculture Organization. ISBN 978-92-5-130104-3
Wessel, M., & Quist-Wessel, P. M. F. (2015). Cocoa production in West Africa, a review and analysis of recent developments. *NJAS: Wageningen Journal of Life Sciences*, *74-75*(1), 1–7. https://doi.org/10.1016/j.njas.2015.09.001
Wiredu, A. N., Mensah-Bonsu, A., Andah, E. K., & Fosu, K. Y. (2011). Hybrid cocoa and land productivity of cocoa farmers in Ashanti Region of Ghana. *World Journal of Agricultural Sciences*, *7*, 172–178.
Wole-Alo, F. I., Akinwalere, B. O., & Alo, O. J. (2022). Impact of credit on farm incomes of cocoa growers in Ondo State, Nigeria. *International Journal of Applied Agricultural Sciences*, *8*, 156–161.
Yahaya, A. M., Karli, B., & Gül, M. (2015). Economic analysis of cocoa production in Ghana: The case of Eastern Region. *Custos e Agronegocio*, *11*, 336–352.
Yamane, T. (1967). *Statistics: An introductory analysis* (2nd ed.). Harper and Row.

Appendix

Table AP 1. Kernel-based balancing test after matching.

Variables	Adopters	Non-adopters	*t*-test	*p*-value
Household characteristics				
Gender	0.619	0.584	0.46	0.643
Age	45.76	47.19	−0.67	0.502
Education	10.48	10.21	0.34	0.735
Household size	5.048	5.598	−1.53	0.129
Child-ratio	14.91	15.64	−0.30	0.765
Marital status	0.429	0.416	0.17	0.865
Farm/plot characteristics				
Farm size	7.071	6.322	1.29	0.200
Experience in cocoa production	18.14	18.25	−0.08	0.937
Number of cocoa farms	2.143	2.206	−0.28	0.780
Distance/institutional factors				
Access to gov, extension services	0.952	0.928	0.66	0.512
Distance to nearest market	1.952	1.942	0.30	0.761
Distance to nearest district capital	8.810	8.604	0.96	0.327
	Ps R^2	LR chi^2(*p*-val.)	MeanBias	MedBias
Unmatched	0.334	163.79 (0.000)	26.4	21.4
Matched	0.050	11.63 (0.558)	8.5	7.8

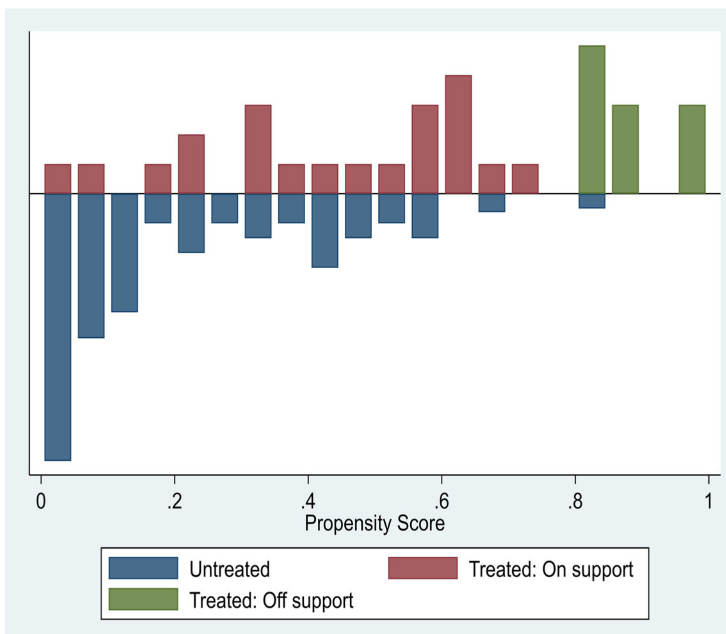

Figure AP1. Common Support Graph_new.

Questionnaire

Purpose of the survey

This questionnaire forms part of a MSc. (Agribusiness Management) research being undertaken by Michael Gyasi at Kwame Nkrumah University of Science and Technology, Ghana. The aim of this study is to analyse the determinants of access to credit and its impact on cocoa yields and net returns among cocoa farmers in Ghana. This questionnaire will take 8–10 min to answer all the questions. You will be asked to respond to statements that are related to farmers' access to credit and its impact on cocoa yields and net returns.

Voluntary participation and confidentiality

Your participation in this interview is voluntary and you can back out whenever you like (***nobody can and must force you to provide any confidential information***). Any interactions between us would be kept confidential. Thank you in advance for participating in this study.

For further questions please contact

Name: Michael Gyasi
Email: speedoucc@yahoo.com
Mobile: +233244987310
Address: COCOBOD Ghana

Participation

I agree to ***voluntarily*** participate in this interview
Signature of respondent Signature of interviewer

Section A: Demographic

Please kindly answer the following questions:
Kindly tick (✓) the appropriate box that best describes you

D1. Gender:
Male = 1 ▭ Female = 0 ▭

D2a. Age Group:
1. 20–29 ▭ 2. 30–39 ▭ 3. 40–49 ▭
4. 50–59 ▭ 5. 60–69 ▭ 6. 70 and above ▭

D2b. Actual Age: … … … … … … … … … … … … (years)

D3. Level of Education:
1. Illiterate ▭ 2. Primary School/Middle School ▭ 3. Junior Secondary School ▭
4. Secondary School ▭ 5. Tertiary level ▭

D3b. Years of schooling: … … … … … … … … … … … … (yrs)

D4. Marital Status 01. Single [ ] 02. Married [ ] 03. Divorced [ ] 04. Widowed/widower [ ]

D5a. Number of bags of cocoa harvested in year 2021: … … … … … … … … …

D5b. Number of bags of cocoa harvested in year 2021 (categorized):
1. 1–10 ▭ 2. 11–20 ▭ 3. 21–30 ▭
4. 31–40 ▭ 5. 41–50 ▭ 6. 51–60 ▭
7 .61–70 ▭ 8. 71 and above ▭

D6a. Household size: 1–5 ▭ 2. 6–10 ▭ 3. Above 10 ▭

D6b. Total number of people in the household … … … … … … … … … … … …
D6c. Total number of females in the household … … … … … … … … … … … …

D6d. Total number of males in the household … … … … … … … … … … … …

D6e. Total number of females in the household below 18yrs … … … … … … … … … … … …

D6f. Total number of males in the household below 18yrs … … … … … … … … … … … …

D6g. Total number of females in the household above 18yrs … … … … … … … … … … … …

D6h. Total number of males in the household above 18yrs … … … … … … … … … … … …

D7a. How many cocoa farms do you own/operate?
1. 1–3 ▭ 2. 4–7 ▭ 3. 7–10 ▭ 4. 11 and above ▭

D7b. Actual number of cocoa farms operated by the farmer … … … … … … … ….

D8a. What is the size of your cocoa farm (acres)
1. 1–3 ▭ 2. 4–7 ▭ 3. 8–11 ▭ 4. 12–15 ▭ 5. 16 and above ▭

D8b. Actual size of cocoa farm cultivated (in acres) … … … … … … … … … … ….

D9a. Number of years in cocoa business:
1. 1–10 ▭ 2. 11–20 ▭ 3. 21–30 ▭
4. 31 and above ▭

D9b. Actual number of years in cocoa business: … … … … … … … … … … … … … … …

D10. When was the cocoa farm established (in years ago)?
1. 1–10 ☐ 2. 11–20 ☐ 3. 21–30 ☐
4. 31 and above ☐

D11a. Do you have access to extension services? Yes ☐ No ☐

D11b. How many times in the year were you visited by an extension officer?
2. Once a season ☐ 2. Twice in a season ☐ 3. Thrice in a season ☐
4. More than thrice in a season ☐ 5. No access at all ☐

D12. Are you a member of cocoa farmers' cooperative: Yes ☐ No ☐

D13a. Distance to the nearest market from your residence (km) … … … … … … … … … … … … …

D13b. Distance to the nearest district capital from your residence (km) … … … … … … … … … …

Section B: Sources and access to credit

Did you apply for any credit last year: Yes ☐ No ☐
Did you access any credit last year? Yes ☐ No ☐
Did you access credit for cocoa production last year? Yes ☐ No ☐
Did you access credit for non-agricultural purposes last year? Yes ☐ No ☐
Did you acquire credit for both agricultural and non-agricultural purposes last year? Yes ☐ No ☐
From which of these sources have you accessed any credit last year for cocoa production?
Banks ☐ Credit Union ☐ Cooperative Union ☐ Family/Friends/Relatives ☐ Input Providers

Non-labor input use.

Input	Unit Price	Quantity used per farm per year
Fertilizer (bags)		
Hired labor input (people)		
Pesticide application (litre)		
Weedicide application (litre)		

Hired labour input use.

Input	Wages per day	Days	Number of people
Weeding			
Harvesting			
Pod-Breaking			

Other costs.

Cost items	Cost per acre (GH₵)	Cost per farm (GH₵) (Cost per acre*farm size)
Land preparation (per acre)		
Land rent (per acre)		
Charges on fertilizer, herbicide/weedicide and pesticide application (per acre)		
Charges on relevant cultural practices including pruning (per acre)		