



Analysis of Determinants of Access to Credit for Cotton Producers in Mali

Touré Lassana^{1*} and Diop Ibrahima Thione²

¹University of Ségou, Mali.

²Cheikh Anta Diop University, Sénégal.

Authors' contributions

This work was carried out in collaboration between both authors. Author TL designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author DIT edited the entire work and made all the corrections. Both authors read and approved the final manuscript.

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ABSTRACT

This research analyzed the determinants of cotton producers' access to credit for in the areas of the Malian Textile Development Company (CMDT). Primary data collection was carried out using questionnaires submitted to 400 producers through multistage stratified sampling procedure (zones and types of farms constituting the strata). The data were analyzed using descriptive statistics and logit model. The values measuring the overall significance of the model are of the order of: Wald's test statistic $\chi^2 = 68.98$, Area under the ROC curve = 0.68 and Model good prediction rate = 71.03%. The binomial logit model showed that the significant variables (at the 15% level) affecting cotton producers' access to credit are age, marital status, level of education, income, interest rate, existence of material collateral and type of farm. It is therefore recommended that the financial institutions, CMDT and the Producers' Cooperatives be enhanced working together for an interest rate set at levels that take into account the sustainability of the credit institutions and managing communication around a fixed interest rate in order to avoid confusion for employees and cotton producers; making less restrictive the conditions for cotton producers to obtain credit for, so that those who do not have access can benefit from credit; revitalizing producers' training level to enable better management of farm credit by the beneficiaries; setting up an insurance mechanism

*Corresponding author: Email: l.t65@mesrs.ml, lassana.toure@mesrs.ml;

for cotton producers to cover unpaid debts due to natural climatic hazards and encouraging the population to grow cotton since the increase in active members on the farm has a positive influence on the chances of having access to credit.

Keywords: Farm credit; cotton producers; financial inclusion; logit model.

ABBREVIATIONS

BNDA : National Agricultural Development Bank
CI : Credit Institutions
CM : Farm manager
CMDT : Malian Textile Development Company
SCPC : Cotton Producers' Cooperative Society
ROC curve : Receiver Operating Characteristic curve

1. INTRODUCTION

Farm credit is important for sustainable agricultural development in all countries of the world. Farm credit has been proven to be a powerful instrument for poverty reduction and the development of rural areas. Producers have great need for credit, due to the seasonal structure of their activities and great uncertainty they face [1].

Farm credit improves productivity and raises living standards by breaking the vicious circle of poverty among small-scale farmers. Adegeye & Dittoh [2] described farm credit as the process of controlling the use of money, goods and services currently in return for a promise to repay at a later date. Imoudu and Onaksaponome [3] argued that farm credit is an essential input in smallholders' agriculture, as it enables small-scale farmers to establish and expand their farms, and increases their income and their ability to repay the loan.

In consumer economic theory, credit plays the role of budgetary equilibrium as it enables acquiring goods without having any means of payment (purchase on credit). According to Schumpeter [4], "credit is essentially a creation of purchasing power with a view to its concession to the entrepreneur". Hence credit makes it possible to acquire production factors on credit. He goes on to say: "Any kind of credit granted for innovations, improvements, etc., seems by definition to be a granting of credit to the entrepreneur, and constitutes an element of economic development".

One of the reasons for the decreasing contributions of agriculture to the economy is the

lack of a formal national credit policy and the lack of Credit Institutions (CI) that can assist farmers [5].

In line with this, granting farm credit has become one of the most important activities of the Malian Textile Development Company (CMDT) in promoting the development of the cotton sector in partnership with the National Agricultural Development Bank (BNDA) and Kafo Jiguineu (a microcredit agency). Consequently, in the Malian cotton production zone there are two types of credit that are defined through their duration: short-term credit is set up to finance the needs of the agricultural season in terms of agricultural inputs (seeds, fertilizers, pesticides, treatment equipment, etc.) and medium or long-term credit that is granted to farmers, installed in a Cotton Producers' Cooperative Society (SCPC), intended to:

- Equipping farmers with means of production (ox, donkey plow, cart, seed drill, tractor, etc.);
- Acquiring collective equipment for the SCPC (scales, shopping canvas, compass, tape, calculator, "GPS", means of locomotion, storage stores, literacy centers, etc.).

However, a large number of producers have difficulty to access medium- and long-term credit [6,7], with the extended banking rate (TBE) being estimated at less than 26% in Mali in 2017 [8]. *This is why it is relevant to ask the central question: what may be the determinants of access to medium-long-term credit?*

The general objective of this paper is to analyze the determinants of access to medium to long term credit. This topic is more relevant at a point

it helps to inform policies on the factors that determine access to credit in general and among cotton producers in particular, and the variables to be influenced if this type of financing are to be developed.

2. LITERATURE REVIEW

2.1 Notion of Credit

The word "credit" is defined differently depending on whether one looks at it from the debtor's or the creditor's point of view. From the debtor's point of view, it is the development of savings not used for own investment purposes and available for a period of time more or less long. For the creditor, it is essentially a gain of time, it is the possibility of immediate enjoyment of an asset with a deferred cost, the interest rate then being the cost of time saved (Yves B. et al. (1975) cited in Désiré [9]).

According to Dutailis [10], "to give credit is to trust, to give freely the effective and immediate disposal of a real good, of a purchasing power, against the promise that the same good will be returned within a certain time, most often with remuneration for the service rendered and the danger incurred, the danger of partial or total loss that the very nature of this service entails". Pruchaud [11], for his part, says that "bank credit is generally the operation whereby the bank makes a given sum available to a third party called the borrower in return for the latter's undertaking to pay the banker the agreed interest and to return to him at the time fixed for repayment a sum equivalent to that provided to him".

For Bernard & Colli [12], "credit is an act of trust involving the exchange of two services dissociated in time, goods or means of payment against a promise or prospect of payment or reimbursement".

From the above definitions, we deduce mainly three inseparable notions in term of granting credits. These include the trust that must exist between the contracting parties and the time factor, which is extremely important in this type of operation. Finally, credit cannot be separated from risk.

The agricultural producer is affected by access to credit, both as a household (consumer) and as a farmer (entrepreneur).

2.2 Literature Review on Determinants of Access to Credit

In line with discussions on the credit market and the informational malfunctions, a number of characteristics specific to farmers and their activities that are relevant to the decision of financial institutions whether or not to finance the required credit.

There is a wide range of studies in the literature on the determinants of access to credit, we can classify them into three groups of factors. These factors are the financial environment, the loan terms and conditions imposed by lending institutions, and the social and economic characteristics of borrowers [13,14].

First group of factors: market imperfections are a major contributor to the non-participation of many potential borrowers in the credit market. These imperfections include the interest rate caps often imposed by governments [15], monopoly power in credit markets often exercised by informal lenders [16], the high transaction costs incurred by borrowers to express their demands, the adverse incentive and selection effects combined with discrimination against vulnerable holdings, with customer morality sometimes constituting a barrier to accessing [15,17]. On the farmers' side, financial institutions are often perceived as a rapacious sector applying prohibitive interest rates, marked by bankruptcies or misappropriations that have led to the disappearance of people's savings [18,19].

Second group of factors: According to Schmidt and Kropp [20], the type of financial institution and its policies often determine access or not to credit. The duration of credit, the payment terms and the required security measures, when they do not correspond to the target groups, lead the latter not to express a request or to the systematic rejection by the institution if the request is made. According to Mayoukou and Kertous [21], the rise in individual credit leads to customer selectivity on the part of CI. The study of the 2 authors showed that loan applicants are subject to two barriers. The first concerns self-exclusion. Conscious of the fact that they do not present sufficient guarantees to obtain loans, customers give up applying for them for fear of having their applications rejected. The second is the one imposed by microfinance institutions that require a minimum collateral for loans. In addition, according to Hossain [22], the

experience of the Grameen Bank has shown that conditions imposed by CI such as collateral requirements should not be imposed on small-scale producers and the poorest in obtaining credit. The latter can use the loans and repay them if effective supervision and repayment conditions are put in place through a thorough understanding of the socio-economic environment.

Third group of factors: the majority of empirical studies have shown that farm yield, age, farm income level, sources of income, farm assets, farm size, gender, education level, distance between the borrower and potential sources of credit, history of the relationship between the institution and the individual, group membership, and collateral are all variables that influence access to credit. In this line, Sossou, Dogot et al. [23] studied the determinants of access to credit for farmers in Benin. The results showed that factors such as household size, proximity to Credit Institutions (CI), membership in a financial solidarity group and income are the factors that

strongly influence access to credit for farmers in the study area. Also in Nigeria, Ololade & Olagunju [1] analyzed the determinants of farmers' access to credit. The study found that marital status, gender, guarantor and high interest rate are the main determinants of farmers' access to credit in the Study Area.

In summary, the determinants of access to credit include:

According to Diamouténé [24], the level of education has a positive effect on access to credit. Educated producers easily assimilate and collaborate with partners [24,25].

The variable "Age" affects the probability of access to credit through the number of years of experience in agricultural production and cotton in particular. Age is often used as an indicator of producers' wisdom in decision-making processes. Hence, the age, experience and level of education are statistically significant factors

Table 1. Determinants of access to credit

Group	Determinants
Group 1	- Market imperfections - Interest rates - The monopoly situation - Transaction costs - The morality of the client
Group 2	- The type of financial institution and its policy - The duration of the credit, the terms of payment - Security measures - Conditions imposed by formal Credit Institutions (CI)
Group 3	- Age of the farm manager (CM) - Income level - Sources of income - Household size - The kind - The level of education - The history of the relationship between the institution and the individual - Group membership - The distance separating the borrower from potential sources of credit - Collateral - The area under cultivation - Number of years in cotton growing (farming experience) - Farm yield - Existence of off-farm activities - Marital status

Source: Authors based on the literature review

in access to credit. In other words, experience and education help to better understand the credit system, its working and the rules of procedure. They also help to better control risks and opportunities and to take advantage of them. Indeed, these two factors are considered everywhere as elements that reinforce progress or innovation [26]. As far as collaterals are concerned, according to Diallo [27], they can be analyzed at two levels. On one hand, guarantees are seen as mitigating elements of the adverse selection problem faced by the lender (Stiglitz and Weiss, 1981; Bester, 1985; Chan & Kanatas, 1985; Besanko & Thakor, 1987; Chan & Thakor, 1987; cited in Diallo [27]). In this case, collateral acts as a signal for the lender to reduce or eliminate the problem of adverse selection caused by the existence of informational asymmetry between lenders and borrowers. On the other hand, in a context of information asymmetry, lenders develop a contract to distinguish between different types of borrowers: high-risk borrowers choose high interest rates and do not put up collateral, while low risk borrowers commit collateral and obtain low interest rates. Collaterals help reduce the problem of moral hazard once credit is granted.

At the level of household size, for Gnounanfoly [28], increasing household size increases the chances of having more assets participating in the activity and increases access to sources of finance. The head of a larger household can also be considered a responsible person who can be trusted by lenders to provide credit. This result differs from those of Chemin (2008) and Imai et al. (2010) cited in Gnounanfoly [28] who observe a negative effect of household size on participation in the credit program.

3. METHODOLOGY

3.1 Study Area and Farms

In Mali, the cotton zone remains larger and each locality has its own reality. Our survey in 2019 took into account two CMDT zones Koutiala and Fana for being respectively the oldest and the most accessible zones. The reason for the second case is close to the capital city (Bamako) and has more Credit Institutions (CI). We used the typology still in use in the study area by CMDT. This typology divides farmers' into 5 categories [29]: the motorized type refers to farms with a functioning tractor; type A refers to farms with two coupled crop units, each with at least one pair of oxen, a plough, a seed drill, and

a cart; type B refers to farms with only one coupled crop unit; type C refers to farms with incomplete coupling, and type D refers to those farms with only tools are manual. We have selected 3 types (Well-equipped= type A and Motorized type, Equipped= type B and Less equipped= type C+D). This can be explained by the low representativeness of the motorized type and a tendency for type D to disappear [30]. This work uses 2019 survey data collected from 400 family farms in the CMDT zones of Fana and Koutiala through stratified sampling procedure with two stages (zones and types of farms forming the strata). This primary data was used.

3.2 Data Analysis Techniques

3.2.1 Choice of model

Dichotomous models are used to explain phenomena whose manifestations (modalities or realizations) take discrete values. They are models where the dependent variable (or the studied phenomenon) can only take two possible values 0 and 1, if we consider the following linear probabilistic model:

$$Y_i = \alpha_i + \beta X_i + u_i \text{ with } E(u_i) = 0 \quad (1)$$

Where:

$Y_i = 1$ If the producer has access to credit
 $Y_i = 0$ If the producer does not have access to credit
 X_i represents the vector of variables of operator characteristics
 u_i is the residual term

Y_i can only take two possible values. Therefore Y_i follows a binomial process; as a binomial process, the probability of occurrence of the event is equal to the expectation of the random variable. Let it be:

$$P[Y_i = 1 / X_i = x_i] = E[Y_i = 1 / X_i = x_i] = \beta x_i \text{ car } E(u_i) = 0 \quad (2)$$

The regression equation gives with $\hat{Y}_i = \hat{\beta} x_i$ where $\hat{\beta}$ is the estimator of the vector of parameters of β . But note that the estimation of the parameters depends on the law of the residual term and its stochastic properties. The efficiency conditions of ordinary least squares are no longer realized due to the existence of heteroskedasticity in the residuals because:

$$\text{Var}(u_i) = E(y_i)[1 - E(y_i)] \quad \text{with} \quad E(y_i) = E[Y_i = 1 / X_i = x_i] \quad (3)$$

$\text{Var}(u_i) \neq \text{Var}(u_j)$ if $i \neq j \Rightarrow$ Heteroskedasticity

Since the u_i terms are not normally distributed, the least-squares method is generally not effective because if they were, Y_i would be so. But Y_i being a discrete variable, therefore with a non normal distribution, there are more efficient non-linear estimation procedures. As a reminder, if the u_i are normally distributed, the appropriate method is the Maximum Likelihood method.

An alternative approach to linear probabilistic models has been probit/logit models.

The probit model assumes a normally distributed random variable, so the probability of this random variable can be determined from the distribution function of the normal distribution. On the other hand the logit model uses the distribution function of the logistic distribution for simplicity. These non-linear models are used for the estimation of quantitative and/or qualitative variables reflecting a choice between two possibilities. The focus here is on whether or not producers in the sample have access to farm credit. Since the probability that these producers have access to credit is a number between 0 and 1, the specification of the logit model is compatible with this constraint [31].

In terms of analyzing access to credit, binary choice models in general and the logit model in particular are becoming increasingly important since most of the characteristic variables are qualitative.

This model is estimated by maximizing the likelihood function. Maximization requires iterative methods. The interpretation of the results of this model is similar to the interpretation of the results of a classical regression. The approximate or estimated values are the probabilities assigned by the model to the occurrence of an event [32,33].

3.2.2 Model specification

The model can be specified as follows

$$P_i = P[Y_i = 1 / 0] = \alpha_i + \beta X_i + u_i \quad (4)$$

Where:

P_i is the dependent variable, i.e. the probability of individual i having access to farm credits.

$Y_i = 1$ If the producer has access to credit;
 $Y_i = 0$ If the producer does not have access to credit;
 X_i is the vector of explanatory variables
 β is the associated vector of the parameters to be estimated;
 u_i is the randomness that we suppose to follow a logistic law;

α_i is the individual parameters to be estimated, specific to each producer i that we assume here constant for all i (the constant).

To be able to estimate this model by maximum likelihood, we need to write the law of the latent (or unobservable) variable conditionally to the explanatory variables. This latent or unobservable variable is defined by:

$$P(Y_i = 1) \propto Y_i \begin{cases} 1 & \text{where } y_i^* > 0 \\ 0 & \text{otherwise } y_i^* \leq 0 \end{cases} \quad (5)$$

We therefore specify a logit model in the following form:

$$P(\text{Access to credit}=1) = \alpha + \beta_1 \text{ age of the farm manager} + \beta_2 \text{ age of the farm manager square root} + \beta_3 \text{ marital status} + \beta_4 \text{ household size} + \beta_5 \text{ presence of collateral} + \beta_6 \text{ schooled} + \beta_7 \text{ type of exploitation} + \beta_8 \text{ interest rate} + \beta_9 \text{ secondary assets binary} + \beta_{10} \text{ cotton microproject training} + \beta_{11} \text{ presence of CI in the village} + \beta_{12} \text{ total available farm size} + \beta_{13} \text{ regular payment of credit} + \beta_{14} \text{ years of experience in cotton} + \beta_{15} \text{ cotton yield in 2019} + \beta_{16} \text{ household income} \quad (6)$$

The following provides a rationale for introducing these explanatory variables into the model.

3.2.3 Choice of explanatory variables

Based on the literature and available data, the following variables were chosen for the logistic regression:

Access to credit (ACCESS2019): This is the dependent variable in the model.

Age (age_cm): This is the age of the farm manager. We expect it to have a positive effect of the variable Age on access to credit. We have introduced the variable age_cm_carré the square

root of the variable Age to test whether there is an optimal age at which the chance of having access to farm credit is low.

Marital status (situation_matri): For banks, marital status is generally used as an indicator of wisdom in credit management. In the literature, it is believed that a married, mostly polygamous producer is more responsible than a single one. We consider a positive effect of this variable on access to credit. The modalities are (monogamous married, polygamous married, single).

Household size (taille_menage): In the literature, the household members measure the availability of farm's labor input, hence having a positive influence on access to credit.

Existence of guarantee (existence_garanti_nouveau): This refers to material collateral or equipment (plough, draught ox, cattle, square plot, permanent building, plantation, vehicles) owned by producers. The variable is binary coded (0 not owned and 1 owned). These collaterals are required for almost all credits. Possession of collateral is assumed to increase the chance of accessing credit.

Level of training (scolarisé2): The variable explains the level of education via three modalities (no level, primary, secondary, higher). We expect a positive influence of the education on the CI's decision to grant or not a credit to the producer. The variable *scolarisé1* is somewhere used for the purpose of comparison between modalities where the level of education is binary (1 in school and 0 out of school).

Type of Farm (type_exploitation2): It is assumed that better equipped farms have more access to credit compared to less equipped producers.

Interest rate (tauxinteret_applique_ic): This is the average interest rate proposed at the time of the loan application. We assume a positive effect on access to credit.

Secondary activity (activite_secondaire_binaire): It is considered that performing or not an off-farm activity is considered to have a positive effect on access to credit.

Training in microproject (formation_microprojet_coton): In the cotton areas, the actors of the sector organize trainings

on project setting up for cotton producers. Here we expect that these trainings positively influence the access to credit.

Presence of CI in the village (presence_ic_village): This binary variable tells us whether there is a CI in the surveyed village. Normally the presence of a CI in the village facilitates access to credit.

Number of years of experience in cotton production (annee_experience_coton): This variable denotes experience in cotton production. According to producers who have not had their credit applications accepted. It can be a determining factor in access to credit. We therefore seek to verify this by introducing it into the model. A positive or negative sign is expected depending on whether the number of years of experience is taken into account significantly by the CI or not.

Total area available (superficie_totale_disponible): This variable measures the total area held by the holding. It provides a physical collateral for the repayment and the producer's production capacity. A positive or negative sign is expected for the same reasons as above.

Cotton production yield (rendement_coton_2019): This variable is the ratio between the quantity of cotton produced and the area sown for cotton. A positive sign of its coefficient is expected.

Household income (revenu_menage2): This variable measures the profit from cotton production taking into account non-agricultural income. A positive sign is expected because it allows producers to have financial guarantees on its repayment capacity.

For the choice of the right model, the classical hypotheses (autocorrelation, heteroskedasticity, multi collinearity, endogeneity of the explanatory variables.) on the residuals of the logistic regression are tested and corrections are made when they are violated (see Appendices).

3.3 Descriptive Statistics for the Selected Variables

Descriptive analysis of the explanatory variables shows that in the group of producers who do not have access to credit 42% are monogamous compared to 57% of producers who are

Table 2. Descriptive statistics for the selected variables

Variables	No access to credit	Access to credit	Statistical test
Marital Status (% of Monogamous Married)	42	34	4.679
Age of the head of household	56.36 (14,36)	55.24 (15)	0,398
Level of education (% of producers with no level)	30	37	4.79***
Training in cotton micro-project (% of yes)	90	92	0.5722***
Household income (Cotton income + Non Agricultural income)	495636.1 (704825.9)	707915.7 (1342058)	1.6781**
Existence of material guarantees (% of yes)	43	33	3.7226 ***
Type of farm (% well equipped producers)	49.45	46.46	0.9079
Interest rates	11.13284 (6.415034)	14.208 (5.730923)	4.7759***

Source: Authors based on 2019 survey data
 Pearson's Chi-square test was used for the % variables
 Student's t is presented for the quantitative variables
 *** significant at the 5% level ($P < .05$)
 ** significant at the 10% level ($P < .1$)

polygamous. For producers with access to credit, only 34% are monogamous.

For the average age of farm managers, there is no significant difference between producers with access to credit and those without. For example, the average age of cotton producers with access to credit is 54, compared to 56 for those whose credit was refused.

The level of training of producers varies significantly in relation to access to credit. Indeed, in the group of cotton producers with access to credit, 37% have no level at all, compared to 10% who have a secondary level. For those who do not have access to credit, 30% have no level, compared to 6% who have secondary education. These results also show that, since CMDT disengaged from literacy training, NGOs have not been able to take over significantly in CMDT zones.

In the surveyed CMDT sectors, the majority of producers with or without access to credit have followed training with CMDT in micro-projects (more than 90% of producers).

Farm income varies significantly depending on whether or not the producer has access to credit. The average income is 495 636 FCFA for producers who do not have access to credit and around 707 916 FCFA for producers who do have access to credit.

In addition, the possession of physical collateral varies significantly between groups of those who have had their applications accepted compared

to farms who did not have access to credit. It can be noted that 43% of the producers who do not have access to credit have physical collateral against 57% who do not have physical collateral. In the group of producers who have access to credit, 33% have a physical guarantee against 67% who do not have a guarantee. These can be explained by the typology in the group of producers who do not have access to credit, 49% are well equipped and have the highest debt ratio in our database. The average interest rate charged by the BNDA and Kafo Jiguineu is 12% and varies significantly between groups.

4. RESULTS AND DISCUSSION

The purpose here is to interpret the estimation results and present the econometric tests for model fitness.

4.1 Economic Interpretation of Results

As shown in Table 3 of the estimation of the coefficients, the variables that are significant at the 15% threshold affecting access to credit for cotton producers are age, marital status, level of education, farm income, interest rate, existence of material security and type of farm.

The estimation of the coefficients of the logit model shows that the variable Age is significant at the 5% threshold but has a negative coefficient. This means that in the CMDT zones of Fana and Koutiala, CI prefer lending to younger producers compared to older ones. From a certain optimal age (with more

experience in cotton production), the effect of this variable is significantly positive.

The study reveals that equipped and less equipped producers have a higher probability of having their credit application accepted compared to well-equipped producers.

The model finds that being married to a polygamous spouse increases the probability of having access to credit compared to a monogamous spouse by 56%. This remains true for single people, with a higher chance (85%) of obtaining farm credit, but the effect is insignificant. In terms of access to credit, the variables Participation in agricultural microproject training and possession of material collateral have a negative effect on the probability of having access to credit. Thus, paradoxically, one is less likely to have access to credit if one possesses physical collateral. This is consistent with the farm type variable.

Producers who have a primary level of schooling are less likely to have credit compared to literate, Koranic school or no level. On the other hand, producers from secondary level of schooling are more likely to have access to credit compared to the latter. The income and interest rate variables have a significant positive effect on the probability of having access to credit.

In order to properly measure the effects of the explanatory variables on the odds of accessing credit, we calculated the Odds Ratio in Table 4.

Less equipped and well-equipped producers are about 1.34 times and 1.47 times more likely to have access to credit than not compared to well-equipped producers.

Moreover, producers with physical security are 0.70 times less likely to have access to credit than producers without physical security. This result is not consistent with the literature, which estimates that the existence of collateral has a considerable positive effect on access to credit [1,27]. In addition, we find that producers who have followed microproject training on cotton are about 0.96 times less likely to have access to credit than those who have not followed microproject training. All this is explained by the fact that it is the well-equipped farms that have followed the microproject training (67%) and have more material guarantees, and 70% of the well-equipped producers have not had their credit applications accepted. Indeed, the well-equipped producers are already highly indebted following the bad campaign in the sector of

Molobala in Koutiala in the last two years and also all producers are not subscribed to any form of agricultural insurance to manage agricultural damage.

The study also shows that polygamous producers are about twice as likely to have access to credit as those who are monogamous married. This is because household size has a positive influence on the chances of accessing credit. This result is not consistent with the majority of the literature, which estimates that household size has a much greater influence on the demand for credit than its satisfaction by credit institutions [13,14]. On the other hand, according to Gnoudanfoly [28], increasing household size increases access to sources of finance.

Among producers with a primary level of schooling, they are respectively 0.79 times less likely to have access to credit than those without any level, Koranic level or literacy. On the other hand, those with a secondary level of education are 1.36 times more likely to have access to credit than those with no education, Quranic or literacy levels. This is explained by the fact that education helps to better understand the credit system, how it works and the rules of procedure. It also helps to better control the risks involved and the opportunities to take advantage of them [24,26]. Also, those who have a higher level of education are 0.88 times less likely to have access to credit than those who do not have any level, Koranic or literate. This is due to the fact that higher-level farmers are not generally producers by trade. They are professional farm managers trying to seize the opportunity of cotton production in their free time¹.

Producers who accept a 1% interest rate increase are 1.08 times more likely to have access to credit than producers who do not accept it compared to producers who accept the average interest rate. The Income variable shows that if producers' income is increased by 1%, compared to producers with an average income, they are relatively more likely to have access to credit than they are not. Indeed, income is a criterion of the producer's ability to repay and a high interest rate pushes financial institutions to grant credit more quickly in order to recover the capital invested. These results are consistent with those obtained by Ololade & Olagunju [1] and Sossou [13].

¹ It should be noted that they represent about 0.75% of the heads of operations

Table 3. Results of the logit model analysis of producer access determinants

Variables	Coefficient	Std. Err.	z	P> z 	[95% Conf. Interval]	
AGE_CM	-0.0750379***	0.0184531	-4.07	.000	-0.1112053	-0.0388705
AGE_CM_CARRE	0.0005857***	0.0001831	3.2	.001	0.0002269	0.0009445
Situation_matri						
Polygamous husband	0.5611385***	0.2490414	2.25	.02	0.0730263	1.049251
FORMATION_MICROPROJET_COTON	-0.042291	0.2290118	-0.18	.85	-0.4911458	0.4065638
REVENU_MENAGE2	2.29E-07**	1.51E-07	1.52	.08	-6.65E-08	5.25E-07
EXISTENCE_GARANTI_NOUVEAU	-0.3586351	0.2485175	-1.44	.15	-0.8457204	0.1284503
Scolarisé2						
Primary	-0.2329122	0.2920296	-0.8	.43	-0.8052796	0.3394552
Secondary	0.3058084	0.4075186	0.75	.45	-0.4929135	1.10453
Superior	-0.1240122	1.26686	-0.1	.92	-2.607013	2.358989
Type_exploitation						
Equipped	0.3857447	0.2535678	1.52	.13	-0.111239	0.8827284
Less Equipped	0.293958	0.4742589	0.62	.54	-0.6355723	1.223488
TAUXINTERET_APPLIQUE_IC	0.0800321***	0.0211539	3.78	.000	0.0385711	0.1214931
Wald chi2(15)	68.98***					
Area under the ROC curve	.6793					
Number of observations	400					
Rate of good model prediction	71,03%					

Source: Authors based on 2019 survey data

*** significant at the 5% level ($P < .05$); ** significant at the 10% level ($P < .1$)

Table 4. Odds ratio of model explanatory variables

Variables	Coefficient	Std. Err.	z	P> z	[95% Conf. Interval]	
AGE_CM	0.9277083***	0.0171191	-4.07	.000	0.894755	0.9618753
AGE_CM_CARRE	1.000586***	0.0001832	3.2	.001	1.000227	1.000945
Situation_matri						
Polygamous husband	1.752667***	0.4364865	2.25	.02	1.075759	2.85551
FORMATION_MICROPROJET_COTON	0.9585908	0.2195286	-0.18	.85	0.6119249	1.501649
REVENU_MENAGE2	1**	1.51E-07	1.52	.08	0.9999999	1.000001
EXISTENCE_GARANTI_NOUVEAU	0.6986292	0.1736216	-1.44	.15	0.429248	1.137065
Scolarisé2						
Primary	0.7922231	0.2313526	-0.8	.43	0.4469629	1.404182
Secondary	1.357722	0.5532971	0.75	.45	0.6108441	3.017806
Superior	0.8833691	1.119105	-0.1	.92	0.0737545	10.58025
Type_exploitation						
Equipped	1.470709	0.3729244	1.52	.13	0.8947249	2.417486
Less Equipped	1.341728	0.6363262	0.62	.54	0.5296323	3.399024
TAUXINTERET_APPLIQUE_IC	1.083322***	0.0229165	3.78	.000	1.039325	1.129182

Source: Authors based on 2019 survey data

*** significant at the 5% level ($P < .05$); ** significant at the 10% level ($P < .1$)

Producers who are older than the average age of one year are 0.93 times less likely to have access to credit than those who are not. On the other hand, above the optimal age, one is more than once more likely to have access to credit than not to have it. Age affects the probability of access to credit through the number of years of experience in agricultural production and cotton in particular [26].

4.2 Econometric Tests

The likelihood ratio test shows that the model is globally significant. Indeed, the statistical critical probability associated with this test is less than 5%.

With the area under the ROC curve equal to 0.6793, the sensitivity and specificity are 24% and 93% respectively with a model good ranking of 71%. This gives the model good predictive power (see details in Appendix).

5. CONCLUSION

This research analyzed the determinants of access to credit for cotton producers in the CMDT zones of Fana and Koutiala in Mali, based on a sample of 400 cotton producers, of whom 32% have access to credit, compared to 68% who did not have their credit applications accepted. The research showed that the variables that are significant at the 5% level affecting cotton producers' access to credit are age, marital status and interest rate.

Producers who are older than the average age of one year are 0.93 times less likely to have access to credit than producers who are older than the average age of 56. On the other hand, above the optimal age (with producers with more farming experience), one is once more likely to have access to credit than not to have it. The study also shows that polygamous producers are about twice as likely to have access to credit as those who are not compared to producers who are monogamously married. Producers who accept a one-point increase in the interest rate are 1.08 times more likely to have access to credit than not compared to producers who accept the average interest rate. The study also reveals that producers who are less equipped and equipped are on average 1.40 times more likely to have access to credit than not compared to producers who are well equipped. The same paradox is observed among producers with a

material guarantee or who have not followed micro-project training.

It is therefore necessary for financial institutions, CMDT and Producer Cooperatives and the state to work together to:

- Set the interest rate at levels that take into account the sustainability of the credit institutions;
- Manage communication around the interest rate set to avoid confusion for employees and cotton producers;
- Make the conditions for obtaining credit less restrictive for cotton producers, so that those who do not have access can benefit from credit;
- Revitalize the level of training of producers to enable better management of farm credit by the beneficiaries;
- To set up an insurance mechanism for farms to cover unpaid debts due to natural climatic hazards and stabilize household income (main guarantee for farm credit);
- Encourage farmers' population to grow cotton, because the increase in the number of active members on the farm or the household size has a positive influence on the chances of having access to credit. This can also be done by promoting polygamy.

This research has certain limitations. The data concerns only two CMDT areas with a low representativeness of the category of type D producers and motorized type producers. Our sample is a snapshot. It would therefore be interesting to carry out a broader study and if possible, to use a panel model. Concerning credit, it would be interesting, given the importance of other forms of credit (short-term credit, informal credit), to deepen our knowledge of the real determinants of all forms of credit. This would help in the elaboration of future policies on the financing of the cotton sector.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX

Choosing the Right Model (Reducing the number of explanatory variables)

After finding strong correlations between some of the explanatory variables, the phase-out method was used.

The variable Superficie_totale_disponible being correlated with variable taille_menage is removed from the model. The latter is then removed from the model because it is correlated with household income. The same is true for the variables activite_secondaire_binaire and rendement_coton_2019 correlated with household income.

The same procedure allowed to remove the variable presence_ic_village and annee_experience_coton which are respectively correlated with the variables formation_microprojet_coton and age.

	ACC-2019	AGE_CM	AGE_CM	TAILLE	ACTIV_RE	PRESEN_E	FORMA_ON	REVENU_2	EXISTE_U	SUPERF_E	REMBOU_R	ANNEE_N	REN_2019	scolar2
ACCES2019	1.0000													
AGE_CM	-0.0271	1.0000												
AGE_CM_CARRÉ	-0.0219	0.9863	1.0000											
TAILLE_MEN	-0.0215	0.2420	0.2336	1.0000										
ACTIVITE_SEC	0.0127	-0.0146	-0.0033	0.0329	1.0000									
PRESENCE_IC	0.0282	0.0505	0.0609	0.0313	0.0002	1.0000								
FORMATION_ON	0.0384	0.0085	0.0278	-0.2325	-0.0158	0.3980	1.0000							
REVENU_MEN2	0.0987	0.0922	0.0827	0.4260	0.1265	0.1063	-0.0401	1.0000						
EXISTENCE_GA	-0.1081	0.1516	0.1412	0.2273	-0.0080	0.0613	-0.1096	0.1013	1.0000					
SUPERFICIE_C	-0.0357	0.1971	0.1862	0.6362	-0.0206	0.0761	-0.2438	0.3302	0.1977	1.0000				
REMBOURSEM_R	-0.1586	-0.0113	-0.0114	-0.0803	-0.0108	0.0567	0.1193	-0.0765	-0.1040	-0.0467	1.0000			
ANNEE_EXPE	-0.0039	0.2768	0.2458	0.1084	-0.0565	0.0877	-0.0145	0.0630	0.0282	0.0924	-0.0663	1.0000		
RENDEME_2019	0.0886	0.0118	0.0162	0.1265	0.0544	0.1389	-0.0132	0.2070	0.0581	0.0940	-0.1236	0.0562	1.0000	
scolar2	-0.0243	-0.0297	-0.0252	0.0574	0.0391	0.0313	0.1180	-0.0594	0.0812	-0.0304	-0.0787	-0.1312	0.0327	1.0000

Fig. 1. Correlation matrix

Among the remaining variables, the information criteria showed that combining additional explanatory variables does not change their values too much. The variable level of education scolarisé2 was also replaced by a binary variable scolarisé1 (ENROLLED/not enrolled). In any case, the information criteria are minimal for the variable scolarisé2.

On the other hand, the area of the ROC curve is larger in the case of the model with scolarisé2.

Moreover, compared to the scolarisé1 variable whose expected sign is not obtained, the other model is richer in interpretable information (with more modalities whose signs of the coefficients are more significant). The number of significant variables at the 15% threshold for the model with scolarisé1 decreases compared to the model with scolarisé2. This is why the latter model will be the optimal model to be estimated afterwards.

Table 5. Information criteria

Criteria	AIC	BIC	Log likelihood	ROC curve
Model with scolarisé1	482.4321	534.0916	-228.216	0.6752
Model with scolarisé2	479.8035	523.5154	-228.9017	0.6796

Source: Authors based on 2019 survey data

MODEL FITNESS: If we logically take 50% as the probability beyond which the producer has access to credit, it comes as follows:

Logistic model for ACCES2019

Classified	True		Total
	D	~D	
+	22	15	37
-	102	254	356
Total	124	269	393

Classified + True D if predicted $\Pr(D) \geq .5$
defined as ACCES2019 != 0

Sensitivity	$\Pr(+ D)$	17.74%
Specificity	$\Pr(- \sim D)$	94.42%
Positive predictive value	$\Pr(D +)$	59.46%
Negative predictive value	$\Pr(\sim D -)$	71.35%

False + rate for true ~D	$\Pr(+ \sim D)$	5.58%
False - rate for true D	$\Pr(- D)$	82.26%
False + rate for classified +	$\Pr(\sim D +)$	40.54%
False - rate for classified -	$\Pr(D -)$	28.65%

Correctly classified 70.23%

Sensitivity and specificity are respectively 17.7% and 94.4% with a good model ranking of 70.23.

Therefore, the ROC curve is used to validate the model. Its optimal value is equal to 0.6796 as shown in the figure opposite:

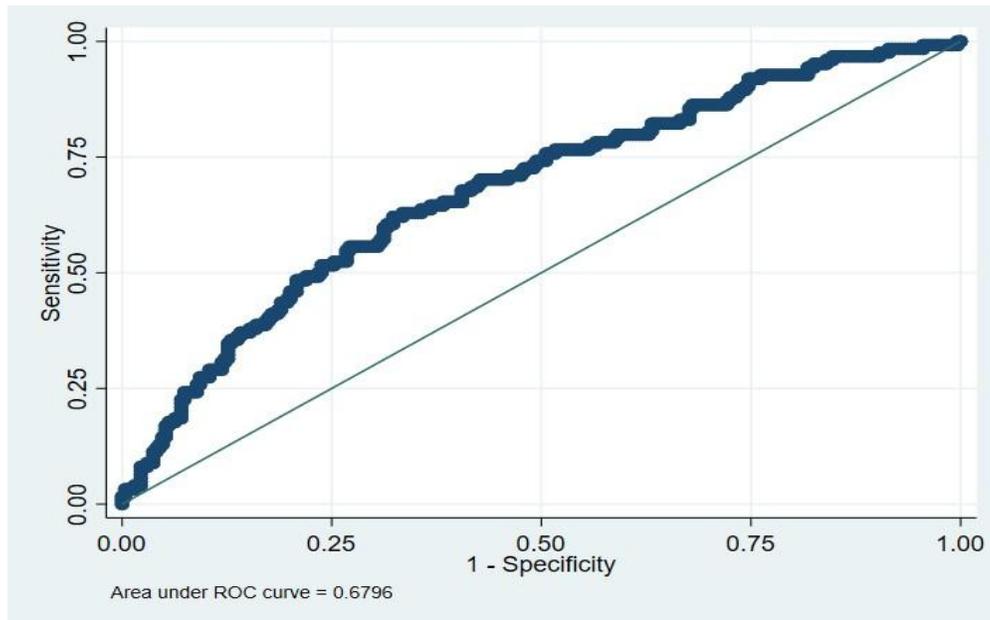


Fig. 2. Predictive quality evaluation curve of the model

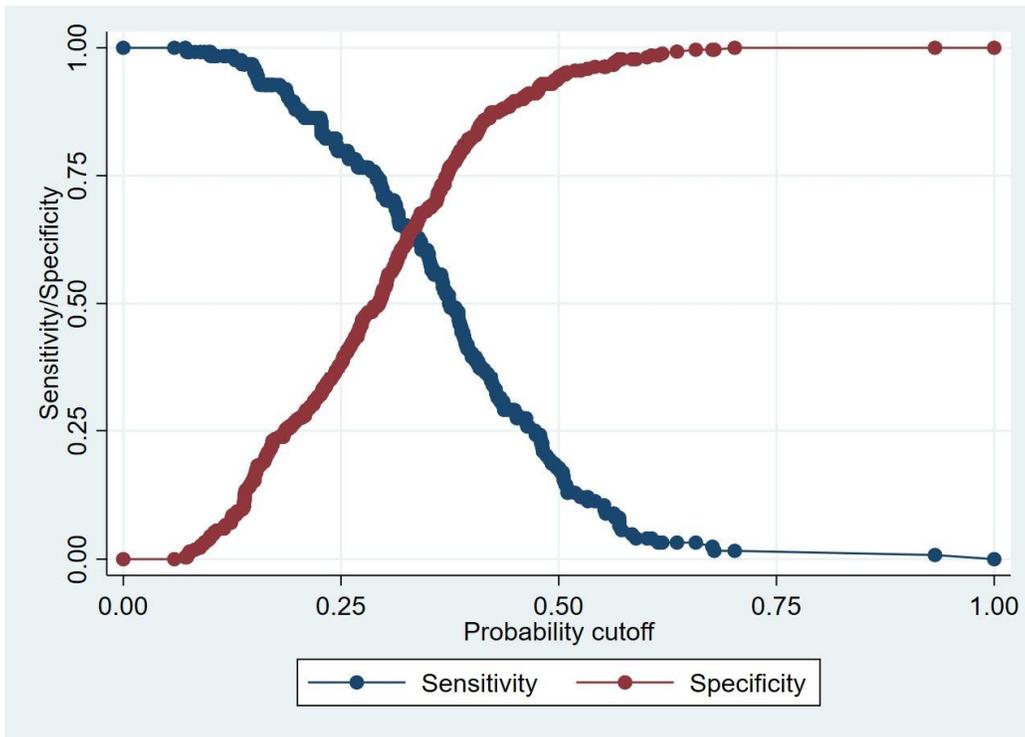


Fig. 3. Sensitivity and specificity

As shown in the graph above, the 50% level is far from being the optimal cut-off point for the probability of access to credit.

Furthermore, the distribution of the estimated probability of access to credit shows that the best cut-off point is 0.4783, which corresponds to a model predictive power of 71%, a model sensitivity of 24% and a specificity of 93%. This makes it possible to create the following predicted binary variable of access to credit:

Table 6. Predicted access to credit

Predicted access to credit	Yes	No	Total
Staff	50	343	393
Percentages	15%	85%	100%

Source: Authors based on 2019 survey data

It can be seen that 15% of producers are estimated to have access to credit, compared to 85% who do not.

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