
MODELING ACCESS TO FORMAL AGRICULTURAL CREDIT FOR SMALLHOLDER RICE FARMERS IN THE SANTA LUCÍA CANTON – ECUADOR

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SUMMARY

Smallholder rice farmers in Ecuador face persistent poverty conditions. As a result, rural development policies have increasingly promoted formal agricultural credit, which provides more favorable financing conditions for rice-growing cycles. This study was carried out in Santa Lucía Canton, one of the principal rice-producing areas in the country. A problem tree analysis and a logit model were applied to identify the socioeconomic factors that limit access to formal agricultural credit among smallholder farmers affiliated with a local irrigation association. Data were collected through a participatory workshop and a survey of 220 farmers conducted in 2019. The problem tree indicated that limited access to

formal credit contributes to elevated poverty levels, as many farmers resort to informal lenders who offer loans under unfavorable financial conditions. The logit model identified that educational attainment, rice hectares, household size, access to government-subsidized agricultural kits, and the ability to negotiate the selling price of rice significantly increase the likelihood of obtaining formal credit. These findings highlight key factors influencing financial access and can inform the design of more inclusive rural credit programs. The study contributes to improving the targeting and impact of financial inclusion initiatives by identifying farmer profiles with limited access opportunities.

Introduction

Agriculture has historically played a fundamental role in Ecuador's economy, providing

food and generating rural employment opportunities (Acosta, 2012; MAG, 2019). Despite the significant contributions of agricultural activities to rural

development, these areas continue to experience elevated poverty levels. For instance, rural income poverty reached approximately 41%, and extreme

poverty 17.4% (INEC, 2022). These conditions primarily affect smallholder farmers cultivating less than 10 hectares of land (FAO, 2013), underscoring

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MODELIZACIÓN DEL ACCESO AL CRÉDITO AGRÍCOLA DE LOS PEQUEÑOS PRODUCTORES DE ARROZ DEL CANTÓN SANTA LUCÍA - ECUADOR

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RESUMEN

Los pequeños productores de arroz en Ecuador enfrentan condiciones persistentes de pobreza. Como respuesta, las políticas de desarrollo rural han promovido cada vez más el crédito agrícola formal, el cual ofrece condiciones de financiamiento más favorables para los ciclos de cultivo del arroz. Este estudio fue realizado en el cantón Santa Lucía, una de las principales zonas productoras de arroz del país. Se emplearon la herramienta del árbol de problemas y un modelo logit para identificar los factores socioeconómicos que limitan el acceso al crédito agrícola formal entre pequeños productores miembros de una asociación local de riego. Los datos se recopilaron mediante un taller participativo y una encuesta aplicada a 220 agricultores en 2019. El árbol de problemas mostró que el acceso limitado al crédito

formal contribuye a altos niveles de pobreza, ya que muchos productores recurren a prestamistas informales que otorgan préstamos en condiciones financieras desfavorables. El modelo logit identificó que el nivel educativo, la cantidad de hectáreas de arroz, el tamaño del hogar, el acceso a kits agrícolas subsidiados por el Estado y la capacidad de negociar el precio de venta del arroz aumentan significativamente la probabilidad de acceder al crédito formal. Estos hallazgos destacan los factores clave que influyen en el acceso financiero y pueden orientar el diseño de programas de crédito rural más inclusivos. El estudio contribuye a mejorar la focalización y el impacto de las iniciativas de inclusión financiera al identificar los perfiles de agricultores con menores oportunidades de acceso.

MODELAGEM DO ACESSO AO CRÉDITO AGRÍCOLA FORMAL POR PEQUENOS PRODUTORES DE ARROZ NO CANTÃO SANTA LUCÍA – EQUADOR

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RESUMO

Pequenos produtores de arroz no Equador enfrentam condições persistentes de pobreza. Como resposta, políticas de desenvolvimento rural têm promovido, de forma crescente, o crédito agrícola formal, que oferece condições mais favoráveis de financiamento para os ciclos de cultivo do arroz. Este estudo foi realizado no cantão de Santa Lucía, uma das principais regiões produtoras de arroz do país. Foram utilizados a ferramenta da árvore de problemas e um modelo logit para identificar os fatores socioeconômicos que limitam o acesso ao crédito agrícola formal entre pequenos produtores vinculados a uma associação local de irrigação. Os dados foram coletados por meio de um workshop participativo e de uma pesquisa aplicada a 220 produtores, em 2019. A árvore de problemas indicou que o acesso limitado ao crédito for-

mal contribui para elevados níveis de pobreza, uma vez que muitos produtores recorrem a credores informais que oferecem empréstimos em condições financeiras desfavoráveis. O modelo logit identificou que o nível de escolaridade, a quantidade de hectares cultivados com arroz, o tamanho do domicílio, o acesso a kits agrícolas subsidiados pelo governo e a capacidade de negociar o preço de venda do arroz aumentam significativamente a probabilidade de obter crédito formal. Esses achados evidenciam fatores-chave que influenciam o acesso ao financiamento e podem orientar o desenho de programas de crédito rural mais inclusivos. O estudo contribui para aprimorar a focalização e a efetividade das iniciativas de inclusão financeira ao identificar perfis de produtores com menores oportunidades de acesso.

the urgent need for targeted interventions to improve their living standards.

Actors across agricultural value chains, including farmers, are continually exposed to multiple overlapping risks—climatic, natural, biological, market-related, managerial, political, and institutional—resulting in varying degrees of vulnerability (IFAD, 2023; Jaffee *et al.*, 2010). In this context, agricultural financial services play

a critical role in poverty alleviation and in enhancing rural welfare (Assouto and Houngbeme, 2023; Phan *et al.*, 2023), particularly in developing countries such as Ecuador.

Financial inclusion, defined as individuals' access to formal financial products (World Bank, 2018), facilitates access to productive capital markets, allowing for the acquisition of modern technologies and high-quality inputs. This, in

turn, supports the adoption of sustainable agricultural practices and increases smallholder income (Donkoh, 2019; Mushtaq and Bruneau, 2019). Agricultural credit enables access to financial capital for innovation at the farm level and can originate from formal or informal sources (Chandio *et al.*, 2018). Formal sources include banks, microcredit institutions, and NGOs, whereas informal sources

comprise loans from neighbors, relatives, vendors, or private individuals.

In Ecuador, rural financial inclusion reaches only 17% (RFD, 2017), suggesting limited access to agricultural credit among smallholders (Chagerben *et al.*, 2019). In 2022, 25.48% of public credit was directed toward land and building purchases, 2.13% to agricultural fertilizers, and merely 0.65% to rice crops.

For private credit, 20% went to bananas and plantains, and 8% to maize and rice (SIPA, 2022). Short-cycle crops such as rice and maize can be highly productive and profitable under favorable conditions, adequate irrigation, and proper management. However, substantial investment is required to ensure productive cycles (Deras, 2020). Public banks, such as BanEcuador, have mainly allocated credit to land acquisition and chemical fertilizer inputs. The provinces with the highest credit circulation include Guayas, Pichincha, Tungurahua, Los Ríos, and Cotopaxi. Furthermore, a disparity exceeding USD 230 million was recorded between credit allocations to men versus women, across both public and private sectors. In crops like rice, credit is disproportionately directed toward male producers (SIPA, 2022).

Several factors may hinder farmers' access to credit, including financial market imperfections, institutional limitations, and individual sociodemographic characteristics (Chandio *et al.*, 2018). Farmers in lower socioeconomic brackets face numerous barriers to accessing credit, impeding broader financial inclusion (Ali and Awade, 2019). According to Simon (2013), household head gender, household size, education, and farming experience significantly influence credit access. Studies by Baiyegunhi and Fraser (2014) and Kramer *et al.* (2021) indicate that male farmers are more likely to receive credit than their female counterparts. Yet, agricultural credit is vital for women's economic empowerment, supporting their participation and leadership in decision-making (Saavedra *et al.*, 2020). During the COVID-19 pandemic, women's participation decreased, largely due to increased domestic responsibilities (Paredes *et al.*, 2020).

Household size is identified in the literature as a dual-effect variable (Dong *et al.*, 2020). On one hand, larger households may reduce the likelihood of credit access, as

resources are redirected to household consumption (Oboh and Ekpebu, 2011). On the other, larger families may improve access, as more household members can actively seek financial resources (Carranza, 2007; Urago and Bozoglou, 2022).

In terms of education, farmers with higher formal education levels are more likely to adopt advanced farming techniques and access government resources than those who are illiterate (Ali and Awade, 2019; Osobohien *et al.*, 2020). According to Dzadze *et al.* (2012) and Balana *et al.* (2022), education is one of the primary determinants of access to formal credit, as it enhances understanding of loan conditions and application procedures. Farming experience also plays a significant role, as more experienced farmers typically possess greater management skills and bargaining power, which facilitates credit access (Osobohien *et al.*, 2020; Anang and Asante, 2020; Ali and Awade, 2019).

Adoption of conventional technology packages is another determining factor. The Ecuadorian Ministry of Agriculture subsidizes these packages to boost productivity (MAG, 2018). Farmers benefiting from these programs are more likely to access formal credit, owing to the institutional trust generated by public support. However, some studies (e.g., Satama *et al.*, 2022) argue that these packages can marginalize environmentally sustainable farming alternatives.

Productivity factors such as plot size and yield levels also facilitate credit access (Balana and Oyeyemi, 2022; Nasereldin *et al.*, 2023). While productivity can contribute to poverty reduction through crop sales, its benefits are constrained by the soil's yield potential, limiting long-term financial gains. Additionally, the distance between the farm and the credit institution influences access, with proximity increasing the likelihood of engagement with financial services (Chandio *et al.*, 2021; Pal and Laha, 2015).

Improving access to formal agricultural credit in rural areas is essential, as it enables farmers to obtain complementary services such as agricultural insurance and technical assistance. Identifying the socioeconomic factors that determine credit access is therefore crucial to defining the profiles of underserved producers. The results of this research are expected to inform policymakers and non-governmental organizations in the design of programs aimed at expanding access to productive capital. This study was conducted to identify the socioeconomic determinants of credit access among smallholder rice farmers affiliated with the El Mate Irrigation Association (MIA) in Santa Lucía Canton. Furthermore, the study aligns with Ecuador's National Development Plan 2017–2021, by contributing to policies that promote credit access and financial inclusion within a sustainability framework.

Materials and Methods

Study area

The study area comprises rural communities within the El Mate Irrigation Association (MIA), located in Santa Lucía Canton, Guayas Province, Ecuador. The MIA is one of eight irrigation systems in the province, three of which serve rice cultivation areas in the canton. Irrigation systems such as El Mate, Higuaron, and América Lomas are co-managed by farmers' associations and the Guayas Prefecture—a provincial-level public institution. These associations collectively include 2,266 members, with El Mate accounting for approximately 23% of total membership (Prefectura del Guayas, 2021).

Farmers are directly involved in the administration and operational management of these systems, including fee collection, infrastructure maintenance, social engagement, institutional capacity building, and other activities necessary for the proper functioning of

the associations (Prefectura del Guayas, 2021).

The MIA irrigation project is organized into four sectors spanning 14 rural communities (Figure 1), and supports approximately 1,416 hectares of rice cultivation (Prefectura del Guayas, 2021). In 2019, 516 farmers were actively engaged in the MIA, relying primarily on rice production under a monoculture system based on conventional practices as their main source of income.

In the same year, 72.27% of MIA farmers were classified as poor under the consumption-based poverty measure. These producers face heightened vulnerability due to price volatility, flooding, frost, rising agrochemical costs, and soil degradation. Moreover, they possess limited risk management strategies; only 7.73% had access to agricultural insurance, and 94.09% reported lacking savings to respond to adverse events (Ramírez *et al.*, 2023).

An additional factor exacerbating their vulnerability is the critical sustainability status of their production system. Limited access to formal credit and the intensive use of agrochemicals contribute significantly to the low sustainability levels observed in this context (Ramírez *et al.*, 2020).

Sampling and data collection

This study was conducted between May and July 2019 using a mixed-methods approach that combined qualitative and quantitative techniques to analyze the limited access to formal agricultural credit in the study area. A participatory workshop and a structured survey were conducted. The workshop involved 15 active members of the El Mate Irrigation Association (MIA) and applied the problem tree tool to assess farmers' perceptions. This tool was used to identify variables representing barriers to formal credit access, which were subsequently incorporated into the econometric model. A problem tree enables analytical decomposition, identifying causes and

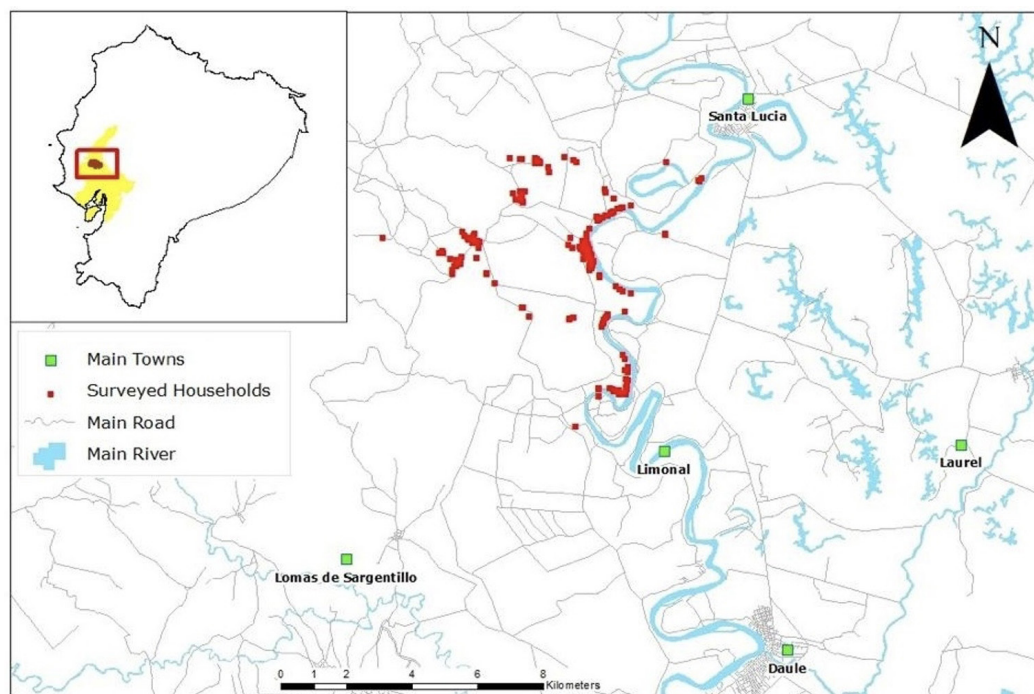


Figure 1. Territory under study and surveyed households. Source: Authors' own elaboration.

effects and organizing them by their direct or indirect relationship to the core issue (Aldunate and Córdoba, 2011; Brouwer *et al.*, 2019; Geilfus, 2002).

The questionnaire was adapted from Orrego *et al.* (2016). Its original purpose was to evaluate the sustainability of the MIA rice production system, and included sections on access to formal agricultural credit, general respondent information, geographic location, household composition, agricultural production, assets, farm management, support services, and production financing.

The sampling unit consisted of farmers residing in the area and cultivating less than 10 hectares of rice under the MIA irrigation system. MIA leaders and project team members updated the sampling frame to allow for random selection. Based on association records, 512 rice farmers were identified as eligible. Sector 1 included 110 males and 46 females; Sector 2 included 130 males and 72 females; Sector 3 included 64 males and 24 females; and Sector 4 included 46 males and 20 females.

A two-stage stratified random sampling technique was implemented. In the first stage, the sector in which land was owned served as the stratification variable. In the second stage, the farmer's sex was used to ensure a balanced sample, allowing for an analysis of gender differences in credit access. A total of 220 farmers were surveyed: 47 males and 20 females in Sector 1; 56

males and 31 females in Sector 2; 27 males and 10 females in Sector 3; and 20 males and 9 females in Sector 4.

Data analysis

Data from the participatory workshop were analyzed using a problem tree framework to understand the root causes and consequences of limited access to formal credit. Descriptive

statistics were then applied to the survey data, with results disaggregated by farmer sex (Table I). Differences in means between male and female farmers for quantitative variables were tested using the Wilcoxon rank-sum test and the T-test. Associations between qualitative variables were assessed using the Chi-square test, with p-values calculated for statistical significance.

To identify the determinants of access to formal agricultural credit, a logit regression model was estimated. The underlying assumption was that access is influenced by socio-demographic characteristics, farm attributes, and bargaining capacity. The dependent variable indicated whether a farmer had accessed formal credit in the past five years, and was modeled as a function of a vector of independent variables (Table II).

The dependent variable is expressed as $f(X) = \text{credit access}$, where X_i is the vector of farmers' socio-demographic characteristics of the farmers, farm conditions, and their bargaining power, β is a vector of the parameters to be estimated (Equation 1). Access to credit implies a probability that is satisfied if $Pr(y=1)$ (Wooldridge, 2010). ϵ_i represents the stochastic error, and W represents the logistic function (Equation 2), which

TABLE I
DESCRIPTIVE STATISTICS FOR MALE AND FEMALE FARMERS

Variables	Male farmers (n = 148 or 67%)	Female farmers (n= 72 or 33%)	p-value
Dependent variable Credit	33.43%	25.00%	0.259
Independent variables			
Education	2	2	-
Rice hectares	2.68 (2.27)	1.81 (1.85)	0.003
Household size	4.21 (2.13)	4.67 (2.19)	0.173
Kit	22.30%	16.67%	0.331
Distance	6.99 (1.78)	6.97 (1.85)	0.883
Experience	19.98 (11.45)	13.39 (8.69)	0.000
Yield	57.86 (18.35)	58.76 (17.78)	0.732
Bargaining	31.76%	26.39%	0.415

Standard deviations in parenthesis. Source: Authors' own elaboration.

TABLE II
DESCRIPTION OF THE VARIABLES USED IN THE MODEL

Variables	Definition	Unit of measure (n= 72 or 33%)
Dependent variable Credit	Access to agricultural formal credit in the last 5 years	1: Access 0: No access
Independent variables		
Education	Farm manager education level	0: Illiterate 1: Literate 2: Elementary school 3: High school 4: University
Rice hectares	Productive hectares for rice cultivation	Number of hectares
Household size	Farm manager family size	Number of persons
Kit	Access to State-subsidized agricultural input kit	1: Access 0: No access
Distance	Km from the farm to nearest BanEcuador office (public bank)	Distance (kilometers)
Experience	Years of experience in rice production	Years
Yield	Sacks of 210 pounds of rice in husk /per hectare in the last cycle	Number of rice sacks
Bargaining	Bargaining power of rice price in the last cycle	1: Could negotiate 0: Could not negotiate

Source: Authors' own elaboration.

takes values between $\langle W(z) \rangle$ where z corresponds to real numbers, so that the probability values can be bounded between 0 and 1.

$$Pr(y = 1|X) = W(\beta_k X_j + \varepsilon_i) \quad [1]$$

$$W(z) = \frac{\exp(z)}{[1 + \exp(z)]} \quad [2]$$

The Hosmer-Lemeshow test was used to assess model fit. Likewise, the area under the ROC (Receiver Operating Characteristic) curve was used to determine the discriminatory power, following the criteria of Hosmer and Lemeshow (2000). All statistical analyses were performed in RStudio (version 4.3.1), and the map was developed using ArcGIS (version 10.8). The dataset is available upon request from the authors.

Results

The results of the problem tree are presented in Figure 2. The analysis indicates that farmers perceive low access to formal credit in the area, as less than half report having access. Factors identified as contributing to limited access

include high interest rates charged by public and private institutions, socioeconomic constraints, and low credit-worthiness associated with unpaid loans due to crop losses. The lack of collateral—such as agricultural land,

vehicles, or machinery with clear property titles—is another barrier, particularly for farmers with less productive plots. Furthermore, many farmers are unfamiliar with the loan application process, a situation worsened by the

limited presence of financial institutions and the absence of outreach programs for financial services in the area.

Due to these limitations, farmers frequently turn to informal lenders, who typically require no paperwork and disburse funds more quickly. However, these lenders often charge exorbitant interest rates, and in some cases, both principal and interest are collected in sacks of rice, which reduces farmers' autonomy over their sales and results in diminished profits. These credit-related challenges are compounded by restricted access to agricultural technologies, further limiting yields and overall economic improvement.

Descriptive statistics indicate that 33.43% of male farmers and 25.00% of female farmers accessed formal credit. However, the difference was not statistically significant (Table I). Regarding education, both male and female respondents generally reported primary-level schooling. The average household size was four for male respondents and five for female respondents, with no statistically significant difference. However, years of

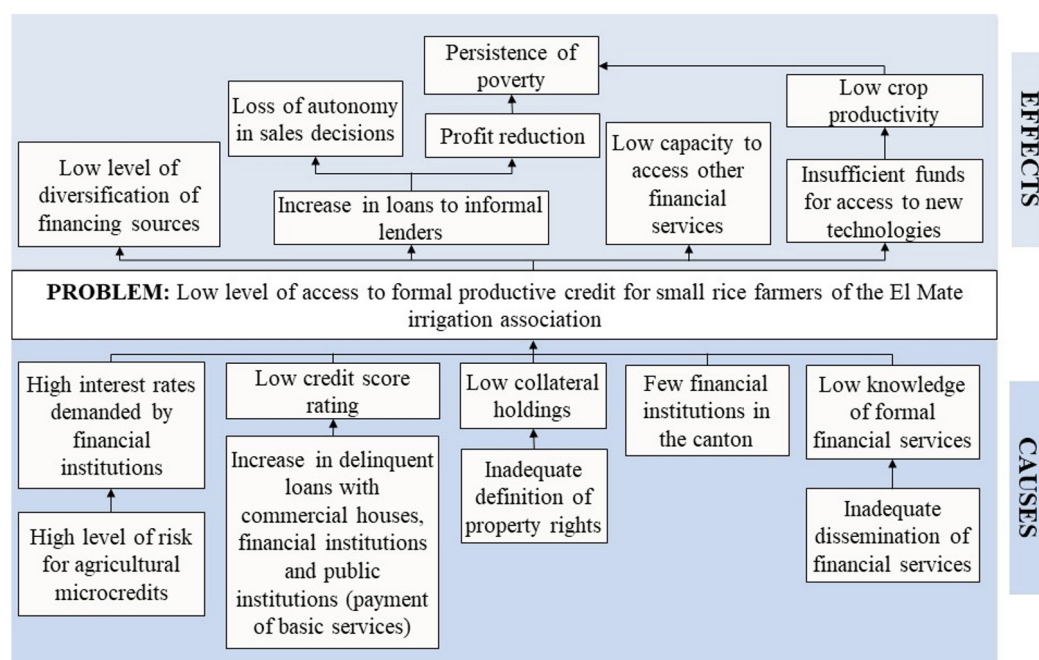


Figure 2. Problem tree of low access to formal credit. Source: Authors' own elaboration.

TABLE III
LOGIT MODEL RESULTS

Variables	Estimate	Standard error	Z	Pr(> Z)	Odds Ratios	Marginal Effect
Intercept	-4,46637	1,31955	-3,385	0,000712 ***	0,01149	-0,67824
Education	0,84218	0,26593	3,167	0,001541 **	2,32141	0,12789
Rice hectares	0,28572	0,08542	3,345	0,000823 ***	1,33072	0,04339
Household size	0,20889	0,08438	2,476	0,013300 *	1,23231	0,03172
Sex	0,16062	0,41066	0,391	0,695709	1,17423	0,02439
Kit	1,05622	0,42735	2,472	0,013453 *	2,87549	0,16039
Distance	-0,05592	0,10357	-0,540	0,589221	0,94561	-0,00849
Experience	0,01314	0,01217	1,080	0,280174	1,01322	0,00200
Yield	-0,00365	0,01029	-0,355	0,722668	0,99636	-0,00055
Bargaining	0,67008	0,37647	1,780	0,075097+	1,95439	0,10175
Significance:	0 '***' 0,001 '**' 0,01 '*' 0,05 '+' 0,1 ' ' 1					
Hosmer-Lemeshow	0,8869					
Area under ROC Curve	81.14					

Source: Authors' own elaboration.

experience in rice production were significantly different, with males averaging 19.98 years and females 13.39 years.

In terms of bargaining power, only 26.39% of females and 31.76% of males reported being able to negotiate the selling price of rice in the last production cycle. This is noteworthy, as many MIA farmers unable to access formal credit rely on informal financing, which constrains their ability to negotiate rice prices.

The average cultivated area for rice was significantly different between genders: 2.68 hectares for males and 1.81 hectares for females. This variable is critical, as land ownership serves as primary collateral when applying for credit. The average distance to the nearest BanEcuador office did not differ significantly between male and female respondents. Regarding access to the government-subsidized agricultural input kit, 22.30% of males and 16.67% of females reported participation in the last cycle. Rice yield per hectare did not differ significantly between groups.

The Hosmer–Lemeshow test returned a p-value of 0.89, confirming that the logit model had an adequate fit. The area under the ROC curve was 81.14, indicating acceptable discriminatory power,

according to the scale proposed by Hosmer and Lemeshow (2000). The Wald test revealed that the variables education, rice hectares, household size, access to the agricultural kit, and bargaining power were statistically significant and positively associated with the probability of accessing formal credit (Table III).

The average marginal effects (Table III) indicate that: one additional level of education increases the likelihood of access by 12.79%; one additional hectare of rice increases it by 4.34%; one additional household member increases it by 3.17%; Access to the input kit increases the likelihood by 16.04%.

The ability to negotiate the selling price increases the probability by 10.18%.

Discussion

Access to credit is widely recognized as a key instrument for rural development in poverty contexts (Amanullah *et al.*, 2020; Assouto and Hounbeme, 2023; Phan *et al.*, 2023). In this case study, approximately 72.27% of farmers in the MIA live in poverty (Ramírez *et al.*, 2023), which remains one of the primary challenges faced by this population. Through the problem tree workshop, farmers

associated limited access to formal credit with high poverty levels. According to participants, the lack of credit access restricts the adoption of agricultural technologies that could improve productivity. Indeed, existing evidence confirms a positive correlation between access to financial capital and the use of high-yielding seeds and fertilizers (Girma, 2022; Kehinde and Ogundeji, 2022). However, the inadequate or excessive use of conventional technologies may exacerbate the environmental unsustainability of the production system (Ramírez *et al.*, 2020).

The logit model identified education, rice area, household size, access to subsidized agricultural kits, and bargaining power as the main determinants influencing the probability of accessing formal agricultural credit. Previous studies have found that gender may significantly affect credit access, often reflecting structural inequalities between male and female farmers (Baiyegunhi and Fraser, 2014; Kramer *et al.*, 2021; Simon, 2013). However, this pattern was not observed in the current study. Neither the econometric analysis nor the problem tree findings indicated that gender was a limiting factor in the study area. This aligns with the credit access

rates—33.43% for men and 25.00% for women—and with statistical tests showing no significant association between gender and access to credit.

From a policy standpoint, however, it remains critical to promote credit access among female farmers as a strategy for reducing rural poverty. National data indicate that, although women represent a higher proportion of credit recipients, the total loan amounts allocated to female farmers are consistently lower than those received by their male counterparts (MAG, 2025). This underscores the need to implement gender-sensitive financial inclusion strategies that ensure equity not only in access numbers but also in the volume of credit distributed.

Regarding education, the analysis revealed that farmers with formal education opportunities were more likely to access credit. As noted by Ali and Awade (2019), Osabohien *et al.* (2020), and Sekyi *et al.* (2020), education and credit access are interrelated and contribute significantly to rural economic development. Formal education equips farmers with the knowledge, skills, and competencies necessary to engage more effectively in financial decision-making.

In the problem tree analysis, participants linked limited

formal education levels to farmers' reduced ability to obtain the information required to apply for credit through formal channels. This constraint is compounded by the scarcity of financial education programs offered by local banks or cooperatives. The limited dissemination of credit-related information and the low presence of financial institutions in rural areas are additional barriers that explain the low credit coverage among smallholder farmers (Mulume *et al.*, 2022). To overcome these limitations, digital financial tools have been proposed as a mechanism to expand financial inclusion (Sarfo *et al.*, 2021). According to Chen and Zhao (2021), digital platforms enhance communication networks among farmers and reduce credit access barriers by facilitating information flows.

In the logit model, bargaining variable was also found to be positively associated with access to formal credit. In the participatory workshop, farmers indicated that those who were able to negotiate the selling price of rice were typically not tied to conditional sales imposed by informal lenders, and thus could seek better financing opportunities in the formal system. In many rural settings, the limited availability of price and credit information weakens farmers' bargaining position relative to intermediaries (Courtois and Subervie, 2014). This limited bargaining capacity restricts smallholders' ability to benefit from stronger linkages to value chains, which in turn negatively affects access to credit, extension services, and efficient marketing channels (Mwangi *et al.*, 2021).

The variable rice hectares made a positive contribution in explaining access to credit in the study area. Agricultural land is one of the primary forms of collateral required by formal financial institutions to issue loans (Raza *et al.*, 2023). However, the requirement for collateral and high interest rates often discourages the demand for agricultural credit

(Gbigbi, 2022). In this context, farmers in the area own, on average, less than three hectares of rice, meaning that mortgaging such smallholdings poses a substantial risk to their livelihoods in the event of loan default. The fear of losing land due to inability to repay loans is another factor that negatively affects credit demand (Kuhn and Bobojonov, 2023).

Access to formal credit may also be influenced by household size, as noted by Carranza (2007); larger families can have both positive and negative effects on credit access (Dong *et al.*, 2020). On the one hand, a larger household may be associated with greater labor availability and increased access to financial resources. On the other hand, larger households may experience higher living expenses and reduced disposable income, which could affect the debt-to-income ratio, making it more difficult to meet the requirements set by lending institutions. Moreover, credit scores play a key role in creditworthiness assessments; households with multiple members may possess diverse and potentially stronger credit histories, which could improve eligibility for formal loans, particularly if credit records are positive (Simon, 2013).

In Ecuador's agricultural sector, access to formal credit is closely linked to the adoption of conventional agricultural input kits. These kits typically include tools, equipment, and primarily chemical inputs aimed at enhancing field productivity. In some cases, these kits are even used as collateral to secure loans from formal institutions. Their use may contribute to improving farmers' credit profiles, as increased productivity and income enhance creditworthiness and raise eligibility for formal credit. Nevertheless, access to these kits is not uniform, and their availability and affordability vary depending on regional conditions, agricultural practices, and farmers' specific needs.

While the Ecuadorian government supports the distribution of subsidized agricultural kits, their widespread use may not fully align with the principles of sustainable agriculture, as they rely heavily on chemical inputs (Satama *et al.*, 2022). Consequently, there is a need to promote the development and accessibility of environmentally sustainable kits, emphasizing ecological practices and farmers' long-term well-being. Transitioning to sustainable input systems is essential not only for the development of Ecuador's agricultural sector but also for advancing broader global objectives aimed at fostering resilient and environmentally responsible farming systems.

Conclusions

Farmers in the study area seek both formal and informal credit due to their limited ability to finance rice production using their own resources. Access to formal credit plays a crucial role in rural development, as it enables the financing of rice production cycles under improved conditions and without conditional sales. In response to the research question, the variables that significantly and positively influenced access to formal agricultural credit were educational level, number of rice hectares, household size, access to the state-subsidized agricultural kit, and the ability to negotiate the selling price of rice. No significant gender differences were found in credit access.

The model suggests that farmers with lower education levels, smaller rice plots, smaller households, no access to agricultural kits, and limited bargaining power are less likely to obtain formal credit. Under such conditions, many farmers tend to rely on informal lenders, often facing unfavorable credit terms and constraints on marketing channels due to conditional sales, thereby negatively affecting their well-being.

In households where the surveyed farmer had a higher

level of formal education, the probability of accessing formal credit increased. Education is a critical factor in developing human capital, as it enhances farm management skills and the ability to prepare and submit credit applications to formal institutions. Household size also had a positive effect on credit access in the model; however, larger households may face economic pressure due to reduced per capita income.

The number of rice hectares cultivated is a key determinant, as landholding size is one of the primary forms of collateral evaluated by financial institutions. This limits access for farmers with smaller plots. Bargaining power also plays an important role, as it enables producers to secure better prices, avoid conditional sales to informal lenders, and thus improve their access to formal credit. Furthermore, access to government-subsidized agricultural kits was positively associated with credit access, highlighting the role of public policy interventions that integrate input provision, technical assistance, and financial services.

However, the long-term sustainability of conventional input packages promoted through credit programs has been increasingly questioned, particularly in environmentally vulnerable contexts. Evidence from Satama *et al.* (2022) and Ramírez *et al.* (2020) suggests that dependence on agrochemical-intensive packages undermines environmental sustainability. In regions like Santa Lucía, where production systems are already under stress, future credit policies should include incentives for sustainable input alternatives and address the environmental implications of credit-linked interventions.

The strategic role of formal credit access in reducing rural poverty underscores the need for action by government agencies, development cooperation entities, and stakeholders in the rice value chain. Efforts should focus on designing financial inclusion programs,

such as microcredit schemes targeting farmers with limited land and lower education levels, in order to enhance the efficiency and equity of resource allocation. Beyond financing production cycles, formal credit can serve as an ex-post risk management tool to mitigate the adverse effects of climate events, pest outbreaks, and crop diseases that pose significant threats to the area's farmers. Inclusion programs should build upon the social capital of smallholder associations across the canton, thereby improving the financing of both individual and collective productive initiatives.

A limitation of this study is that it did not quantitatively assess the impact of credit access on poverty reduction. Such analysis could provide valuable insights for evaluating socially focused credit programs and their influence on farmers' quality of life, particularly in low-sustainability production systems. Future research should explore the impact of credit on technology adoption in the region, as this represents a critical component of agricultural productivity.

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