Does Finance Matter in Climate Change Adaptation? Evidence from Smallholder Farmers' Access to Informal Credits in Hanang District, Tanzania.

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Abstract

This paper examines smallholder farmers' access to and use of informal credits for climate change adaptation in Hanang District, Tanzania. The paper used bivariate probit model to analyze data. The results reveal that about 75% of respondents indicated to have access to informal credit, with 68.3% actively employing credit in agriculture for climate change adaptation. The bivariate probit regression analysis shows that having good relationships with other farmers and neighbors or relatives, along with a lower perception of risk, are the most important factors that affect access and use of informal credit for climate change adaptation. Building relationships and connections among farmers through organized networking events, the implementation of risk mitigation strategies, and the promotion of financial literacy initiatives to bolster the capacities of smallholder farmers in the credit market are important factors that should be considered by policymakers and other stakeholders to enhance their adaptive capacity in the changing climate.

Keywords: Smallholder farmer, informal credit, climate change adaptation, mountainous area, Hanang district.

JEL : Q54, Q12,013, G51, G23, D14

1. Introduction

People increasingly recognize climate change as a significant global development challenge that jeopardizes the sustainability of various sectors, especially agriculture (Comoé & Siegrist, 2015; Iglesias & Garrote, 2015). An ongoing increase in greenhouse gas emissions has led to heightened climate change effects on the agricultural sector, with these effects varying as either beneficial or detrimental based on geographical location and other factors (Tripathi and Mishra, 2017). Consequently, global change may result in significant agricultural losses and jeopardize global food security; however, the implementation of climate change adaptation strategies to mitigate these

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risks is receiving heightened attention (Schneider & Asch, 2020; Hornton & Comberti, 2017; & Hijioka et al., 2014).

Dang et al. (2019) & Jiang et al. (2017) formulate strategies for climate change adaptation to mitigate the detrimental impacts of climate-related hazards on agricultural practices. Severe weather and climate phenomena, including drought, adversely impact agricultural productivity by reducing yields and revenue and hence hindering food production (Gomez-Zavaglia et al., 2020 & Trinh et al., 2018). The ramifications of climate change on agriculture are significant, as the sector is crucial to the economy by generating employment opportunities, foreign exchange revenues, and contributing to poverty alleviation. Because of this, many semi-arid countries around the world have quickly thought about putting in place different adaptation strategies to boost agricultural productivity, make sure there is enough food, and help smallholder farmers make a living (Kibue et al., 2015).

Climate change primarily affects the agricultural sector, especially smallholder farmers who mainly practice rain-fed farming (Hosu et al., 2016). Climate change induces variability in precipitation, potentially resulting in drought, which may diminish crop yields and livestock output (Dang et al., 2019). Reports from the International Disaster Database (EM-DAT 2017) indicate that the drought in Africa in 2015 caused significant economic losses and adversely impacted the livelihoods of numerous smallholder farmers, who lacked the financial capacity to effectively manage climate change risks. Future climate-related risk occurrences may further undermine the agriculture sector's viability in supplying food for the increasing population.

According to the existing literatures, African countries primarily adapt by planting more trees, growing more crops, preserving soil, altering the timing of plant planting, and using different irrigation methods (Gebru et al., 2020; & Gwambene et al., 2015). Several studies (Chapagain et al. 2019; Devkota et al. 2017; Dhakal et al. 2016; & Sujakhu et al. 2016) have shown that climate change is a major threat to agricultural production and sustainability. This is due to expected temperature and rainfall changes and more droughts. Consequently, it is imperative to examine the relevant indicators and determinants influencing farmers' selection of adaptation strategies. Despite its significance in climate risk reduction and food security (Kassie et al., 2018), the implementation of adaptation measures remains insufficiently low (Holden et al., 2023). Numerous factors hinder agricultural investments, with credit constraints, imperfections in credit markets, and stringent credit accessibility conditions significantly deterring investments, especially in climate change adaptation strategies (Ojo & Baiyegunhi, 2020).

Smallholder agricultural systems, prevalent in developing countries, often face challenges due to limited access to formal credit markets, inadequate infrastructure, and reliance on informal loan sources (Hussain & Thapa, 2018). The disjointed configuration of farms, predominantly small and marginal, intensifies the difficulties in obtaining formal credits, as farmers frequently lack collateral, credit history, and financial acumen (Sher et al., 2020). This leads numerous smallholder farmers to rely on informal loan markets, which are crucial for maintaining agricultural operations in areas where official financial institutions are either unavailable or impose excessive requirements (Nordjo & Adjasi, 2020).

Conversely, credit is essential for sustainable agriculture since it enables access to two primary components of production: fixed and working capital, as well as overall agricultural investment (Sawe, 2022). Credit is essential for farmers to enhance their operations through the use of modern technologies and improved agricultural inputs, thereby increasing productivity (Ado et al., 2019). Farmers with access to loans can expand their output frontier outward. Empirical research demonstrates that access to credit enhances the agricultural output of smallholders across many nations (Nordjo & Adjasi, 2020; Abel et al., 2015) and improves technical efficiency (Abdallah, 2016).

Financial institutions have recognized the distribution of credits to smallholder farmers for climate change adaptation as a complex endeavor in developing nations, including Tanzania (Abdallah 2016). This viewpoint arises from the experiences of financial institutions that regard agricultural production as a high-risk investment due to factors such as production seasonality, erratic cash flows, natural disasters, and diseases affecting crops and livestock (Mukonyora & Bugo, 2023; Hishigsuren, 2019). These issues lead to deficiencies in the credit market, resulting in only about 10 percent of rural populations worldwide having access to basic formal financial services for farmers (Gebru et al., 2020). This condition arises from multiple aspects, including insufficient collateral, inadequate credit security, the restricted capacity of financial service providers, and poor client education levels (Hosu et al., 2016).

Climate change has compelled farmers to rely on informal credit to maintain agricultural production, intensifying hardships for smallholder farmers. The phrase "informal credit" refers to loans that depend on personal relationships or societal punishments for enforcement. Relatives, acquaintances, or neighbors may provide such loans. Informal credit sources may also include additional entities such as credit cooperatives or village funds. On the other hand, Paymard et al. (2019) defined formal credit as loans and credits that do

not rely on social connections between the lender and borrower to guarantee repayment. Research indicates that numerous farmers rely on informal credit to fulfill their financial requirements (Devkota et al. 2017; Dhakal et al. 2016).

It is essential to examine the prevailing informal credit systems to provide policy suggestions that foster stable financial arrangements in agricultural and rural areas, thereby improving farmers' resilience to climate change. The utilization of informal financing in agriculture often entails the acquisition of vital inputs, such as seeds, fertilizers, insecticides, and agricultural machinery, which are critical components. These inputs significantly impact the productivity and sustainability of agricultural systems. Current data indicates that informal lending can aid farmers in regulating consumption, investing in productivity-enhancing technologies, and alleviating risks linked to climate change (Pretty, 2021). Smallholder farmers often utilize informal credit to acquire inputs at the beginning of the planting season and repay the loans after the harvest, thus synchronizing the credit cycle with their production cycles (Sher et al., 2020). Moreover, informal credit offers adaptable repayment conditions, which is especially advantageous for farmers experiencing erratic agricultural outputs and income fluctuations (Ullah, 2020).

Prior scholarly investigations have observed and recorded multiple facets of the current literature on informal credit within the agriculture sector. Moahid & Maharjan (2020) investigated the determinants affecting farmers' access to formal and informal finance in rural Ghana, revealing that substantial obstacles hinder farmers' access to informal financing, hence constraining their capacity to enhance agricultural productivity. A study by Dang et al. (2019) indicates that borrowers are more susceptible to pricing information asymmetry than purchasers when acquiring agricultural supplies via informal loan, negatively impacting their adoption of enhanced agricultural technology.

Ali and Erenstein (2017) assessed the demand for informal credit and its contributing factors among cotton growers in Bahawalpur, Pakistan, discovering that distance, multiple visits, elevated transaction costs, and corruption compel farmers to seek informal credit rather than formal loans. Likewise, research including Bryceson (2019) has emphasized socioeconomic variables such as gender, age, household size, educational attainment, farming experience, farm size, and income as critical drivers of access to formal credit. Notwithstanding these findings, research has infrequently examined the distinctive socioeconomic effects of informal loan access in mountainous regions, especially its application in agriculture.

Furthermore, the mountainous areas of Hanang district in Tanzania present additional challenges such as geographical remoteness, low agricultural output, and heightened susceptibility to environmental deterioration, which in turn intensify reliance on informal finance institutions. This study fills a significant vacuum in the literature by concentrating on the function of informal credit in mountainous locations, where the interaction of these issues is most evident. In contrast to earlier studies that examine general rural or lowland agricultural settings, our research offers new insights into how socioeconomic factors in distant, mountainous regions influence informal finance access and utilization in agriculture for climate change adaptation.

The existing literature has not sufficiently examined the unique geographical and socioeconomic aspects, thereby making this study a significant contribution to the discourse on informal loan markets in developing countries. The findings of this study provide valuable insights for crafting agricultural credit policies tailored for smallholder farmers in mountainous regions, where formal credit access often faces constraints. This research enhances an understanding of informal credit's function in supporting agricultural livelihoods in difficult conditions. This study investigates the dynamics of farmers' access to and utilization of informal loans for sustainable agriculture to address two primary research issues. What variables affect farmers' access to informal credit? Do farmers utilize the obtained informal financing for agriculture in order to adapt to climate change? This study's findings will aid policymakers in formulating targeted agricultural and rural development initiatives that foster community networking, improve risk management strategies, and establish financial literacy programs to enable farmers to access and utilize informal credit effectively.

2. Theoretical framework

This research is theoretically based on credit rationing theory and social capital theory. These theories offer a thorough framework for analyzing factors underlying informal loan access and its application in agricultural settings. Stiglitz and Weiss (1981 assert that the Credit Rationing Theory posits that an information imbalance between borrowers and lenders frequently results in credit rationing, leading to the denial of loans to applicants who are willing to pay excessive interest rates. Informal credit minimizes market defects that may stem from ethical risk, adverse selection, and limited commitment. The inability of farmers to offer collateral, together with higher access costs resulting from insufficient credit history, financial illiteracy, and uncertain property titles, leads to the exclusion of numerous

impoverished households from the formal credit market (Rahman & Smolak, 2019). The present paper elucidates the reasons behind farmers' reliance on informal finance sources within the agricultural sector.

The financial stability of a farmer depends on several factors, including the age and agricultural experience of the household head, level of education, and income. People often view experienced farmers as less harmful. Simultaneously, higher levels of education and income may reduce lenders' reservations regarding repayment, thereby enhancing access to informal loans. Stiglitz and Weiss, 1981. Additionally, landholding size functions as a type of quasi-collateral in informal lending, thereby diminishing the perceived risk for lenders and enhancing access to credit. Access to input markets and engagement with agricultural extension services are crucial for the productive utilization of loans, as they furnish the requisite resources and expertise for efficient agricultural investments. These economic aspects correspond with the Credit Rationing Theory by emphasizing how human and financial characteristics affect credit accessibility and usage.

The Social Capital Theory, defined by Putnam (2023) & Bourdieu (2020) underscores the significance of social networks and relationships in economic exchanges. Social capital is essential in informal credit networks within rural agricultural frameworks. Informal credit' can be categorized into two main types: cost-free credit and transactional credit. In numerous cases, acquaintances, wealthy villagers, and relatives extend interest-free loans, usually a small amount with a defined or undefined repayment timeline. Hansen and Kim (2017). These characteristics render informal credit easily obtainable. Input suppliers, traders, wholesalers, moneylenders, and land mortgages acquire transactional credit, typically with elevated interest rates and insufficient transparency (Rahman & Smolak, 2019).

Participation in village gatherings strengthens social connections and trust, thereby augmenting the probability of obtaining informal loans. Favorable relationships with fellow farmers, neighbors, and family enhance social capital, facilitating farmers' access to informal loans grounded in trust and mutual assistance. Stiglitz and Weiss (1981). Moreover, social capital influences the perceived risk associated with borrowing. Farmers integrated within robust social networks may have enhanced confidence in their loan repayment capabilities, diminishing perceived risk and promoting credit utilization for productive agricultural investments (Dhakal et al. 2016). This research combines credit rationing theory and social capital theory to look closely at how economic and social factors affect getting and using informal

credit. This research provides crucial insights for formulating policies aimed at enhancing the sustainability of farming.

3. Methodology

3.1 Study area description and justifications

This study was conducted in Hanag District, which is located in the Manyara region of northern Tanzania. The district's landscape is characterized by its diverse terrain, which includes mountains, plains, and valleys. The dominant feature in the district is Mount Hanang, standing at an elevation of 3420 meters, making it one of the highest peaks in Tanzania. Hanang District has a semi-arid climate with distinct wet and dry seasons. The district typically receives 500 to 800 mm of rainfall annually, concentrated between November and May. The daily temperature usually ranges from 10^0C to 30^0C (District profile, 2023). The majority of the people are smallholder farmers. Farmers mostly cultivate staple crops such as maize, beans, wheat, millets, potatoes, and vegetables under rain-fed conditions. The study was conducted in the upper part of Mount Hanang, specifically in the Bassodesh, Gidahababeig, and Endasaki villages. These villages were chosen for the study because of their unique geographical and socioeconomic characteristics, which have received little attention in studies on informal credit. Moreover, the study villages are characterized by their mountainous terrain, limited infrastructure, and restricted access to formal credits, all of which exacerbate farmers' vulnerability to climate change. These factors make smallholder farmers highly reliant on informal credit networks as a major strategy to respond to climate change.

3.2 Research approach and design

This study utilized a combination of quantitative and qualitative research methods. Quantitative and qualitative approaches were used concurrently to enhance their respective strengths. Hofmann (2019) argues that a mixed research design enables researchers to acquire information with breadth and detail regarding the topic under study. In that case, with a mixed research design, the researcher was able to gather information with breadth and adequate details regarding smallholder farmers' access to and use of informal credits for climate change adaptation. Likewise, with a mixed research design, the researcher was able to overcome the weaknesses of one method over the other. Furthermore, the researcher employed a mixed research approach to guarantee data triangulation. Additionally, the research employed a descriptive case study design. The descriptive case research design provides an opportunity to address the specific questions of how and

what. Therefore, Hanang District used a descriptive case research design to explore in-depth and detailed information on factors affecting smallholder farmers' access to informal credits as a strategy for climate change adaptation.

3.3 Target population for study

According to Terrell (2016), the targeted population are a subset of the population with similar characteristics. Since the study used a mixed research approach, the target population for acquiring quantitative data consisted smallholder farmers who were found in their households. On the other hand, the target population for acquiring qualitative data included key informants such as the District Agricultural Extension Officer, Ward Agricultural Extension office, Ward Executive Officer, Village Executive Officers, and village elders.

3.4 Sample size and sampling procedures

To enable the determination of the sample size for the study, village executive officers provided official data on the total number of smallholder farmers from each study village. The data indicated that Bassodesh village has about 1100 registered smallholder farmers; Gidahababeig has about 900 registered smallholder farmers; and Endasaki has about 1000 registered smallholder farmers. The data revealed that approximately 3000 smallholder farmers reside in the three villages, serving as the sampling frame for determining the sample size. Therefore, the study used 3000 registered smallholder farmers as a sampling frame for sample size determination. Thus, the sample size for this study was determined using 10% of the 3000 registered smallholder farmers in three study villages, which equates to 300 smallholder farms. Kothari (2004) supports this, recommending a sample size of 10% and above as an adequate representation of the study population. In this context, the sample size for Bassodesh village was 110 smallholder farmers, Gidahababeig was 90 smallholder farmers, and Endasaki was 100 smallholder farmers.

A simple random sampling technique was used to select respondents for quantitative data collection. To facilitate the operation of this technique, the names of the smallholder farmers provided in each village were written on pieces of paper, and then the papers were shuffled in a box. The selection process was done by randomly picking one piece of paper with one household name from the box. This process was repeated until the required sample size was reached in each village. Moreover, purposive sampling techniques were used to select key informants for qualitative data collection. Generally, the

sample size determined was used to collect data regarding farming practices and factors affecting smallholder farmers' access to informal credits for climate change adaptation.

3.5 Data collection methods

This study employed various methods of data collection, such as household surveys, key informant interviews, focus group discussions, field observations, and document reviews. A household survey was used to collect quantitative data through questionnaires. Before administering the main survey, the questionnaire underwent a rigorous pretesting phase to ensure its validity in relation to the study theme. The questionnaires included both open-ended and closed-ended questions. The household survey method was also used to collect information from smallholder farmers in the study villages (Bassodesh village, Gidahababeig, and Endasaki). The information collected included factors influencing smallholder farmers' access to informal credit for climate change adaptation. The household questionnaire was a suitable method as it allows the collection of data from a large population.

Additionally, qualitative data were collected through structured interviews with key informants. An interview guide tool was prepared to guide the discussion. This method facilitates the gathering of comprehensive and detailed data from individuals with extensive experience and knowledge of the study topic. Therefore, this method was utilized to acquire in-depth information on factors influencing smallholder farmers' access to and use of informal credits for climate change adaptation. Key informants included the District Agricultural and Extension Officer, Village Executive Officers, three experienced smallholder farmers from each village, and a Ward Agricultural and Extension Officer. The selection of these key informants was based on their knowledge of factors affecting farmers' access to and use of informal credits with the aim of adapting to climate change.

Moreover, Focus Group Discussions (FGDs) were undertaken to elicit qualitative data. The FGD method leverages the interaction among small groups of participants who respond to and elaborate on the contributions of others in the group. Focus Group Discussions (FGDs) provide a source of more nuanced qualitative insights on social processes that quantitative statistics cannot provide. A checklist instrument was employed to facilitate the conversations. A focus group comprised eight participants, consisting of four men and four women, paying attention to age and experience. Participants were selected with the aid of village leaders. Focus Group Discussions (FGDs) lasted from one to two hours, contingent upon the intricacies of the dialogue, and were done in Kiswahili. The acquired information was transcribed into

English and subsequently coded. The observation approach was employed for data collecting. This method involves firsthand visitation and observation of the region being evaluated. Consequently, onsite field observation was essential throughout data collection since it enhance comprehension of the study area and themes. The researcher engaged with community members in the study villages during their everyday activities to observe and document events and practices pertinent to the study. A document review was employed to gather secondary data. This entailed the examination of both published and unpublished sources pertinent to the study issues.

3.6 Data analysis and presentation

A bivariate probit model was used to analyze the relationship between access to informal credit and subsequent credit utilization for agricultural activities. This model choice is appropriate for examining the joint determination of two binary outcomes (Anang et al., 2020). The responses of smallholder farmers from the household survey were processed using STATA version 14. The bivariate probit model enabled the researcher to figure out what factors affect both the households' access to informal credit and their subsequent use of that credit for agricultural activities. The dependent variables in the model are binary, with 1 indicating access to informal credit and the use of credit in agriculture and 0 representing the absence of these actions.

The model can be represented by the unobserved latent variables as follows

$$Y_1 = X_1 + \varepsilon 1 \qquad (1)$$

$$Y_2 = X_2 + \varepsilon 2 \qquad (2)$$

The bivariate probit model specifies the outcomes as follows:

$$Y_1 = \begin{cases} 1 \; if \; Y_1 > 0 \\ 0 \; if \; Y_1 \leq 0 \end{cases} \qquad (3)$$

$$Y_2 = \begin{cases} 1 \; if \; Y_2 > 0 \\ 0 \; if \; Y_2 \leq 0 \end{cases} \qquad (4)$$

Marginal effect for the joint probability is calculated as follows:

$$P(Y_1 = 1 \text{ and } Y_2 = 1)\Phi \quad (5)$$

Here, Y_1 represents the access to informal credit, and Y_2 is the use of informal credit in agriculture. Φ represents the cumulative distribution function of the standard normal distribution; X_1 to X_k are independent variables, and ε1and ε1 are error terms. This model enables detailed analysis of factors influencing access to informal credit and the subsequent use of credit in agricultural activities among the surveyed households. Variance inflation factor (VIF) test was conducted to test for multicollinearity among the covariates prior to estimating the bivariate probit model.

3.7 Specification of selected variables

This study examines the factors influencing smallholder farmers' access to and utilization of informal financing for climate change adaptation. The analysis was guided by a comprehensive examination of ten factors. Each factor was chosen for its significance in agricultural contexts and its potential impact on farmers' financial actions, as demonstrated by the existing literature. It was anticipated that the age of the household head, which represents the accumulated wisdom and decision-making process, would positively impact access to credit and use in agriculture, which aligns with findings from previous studies (Putman, 2023). Moreover, it was posited that high educational attainment would improve community members' access to and utilization of credit in agriculture, as education fosters awareness of the benefits of informal credit within the community (Bryceson, 2019). Household size is expected to greatly affect both access to informal credit and utilization. This hypothesis posits that larger families typically correlate with enhanced social ties (Ullah, 2020). The size of landholdings was also considered, based on the idea that farmers with larger holdings may exhibit more participation in informal credit use due to their increased engagement in agricultural operations (Hosu et al., 2016).

The monthly revenue was analyzed to ascertain its influence on farmers' propensity to engage in informal credit arrangements. Active involvement in community meetings, as shown by prior research (Abel et al., 2015), is examined as a determinant of community engagement in informal credit availability. Positive relationships among farmers, as well as with neighbors and family, are acknowledged as essential social variables influencing involvement in informal credit arrangements. The possible impact of access to input markets on farmers' engagement in informal credit was analyzed, considering the importance of inputs in agriculture (Hishigsuren, 2019). From a behavioral perspective, perceived risk is assessed to comprehend how

farmers' views of repayment uncertainty may affect their decisions to engage in informal credit arrangements (Putman, 2023). Finally, the function of extension services in promoting farmer engagement in informal credit systems was examined (Rahman & Smolak 2019).

3.8 Descriptive statistics of variables

Table 1 presents the descriptive statistics of the variables used in the study, providing insights into the characteristics of the sample population and key factors under consideration for the analysis. The average age of the household head is 40.60 years, reflecting the mature composition of the sample, with a standard deviation of 12.12. Education levels measured in years of formal education show an average of 3.54 years with a standard deviation of 4.19, suggesting a diverse educational background within the sample. The number of people in the household, which represents the total number of family members, averages at 12.44, with a standard deviation of 3.90, illustrating the differences in family structures among the respondents.

The number of years a smallholder farmer spent farming was a crucial factor in agricultural contexts, with an average of 26.82 years and a standard deviation of 10.36, indicating substantial expertise within the sample. Furthermore, the findings showed that the average landholding size, as measured by the cultivated land size, was 3 acres, with a standard deviation of 2.98. Moreover, the findings indicate that the average monthly income of the households in the study area was 180,000 Tanzanian Shillings, while the data of the year 2023 from the National Bureau of Statics indicate a national average monthly salary range between 300,000 to 450,000 Tanzanian Shillings (TZS) (NBS, 2024). This indicates that smallholder farmers in the study area are earning less than the national average. Additionally, the variable "meeting participation" captures participation in monthly village meetings, with an average of 0.51, indicating that approximately half of the farmers actively participate in these meetings.

Likewise, the variable "farmers relationships with relatives and other farmers," with averages of 0.82 and 0.71, respectively, reflects positive relationships with other farmers, neighbors, and relatives. The variable "input market access," which measures access to input markets, exhibits an average of 0.62, indicating a moderate level of access among participants. Moreover, perceived risk, representing uncertainty about repayment, demonstrates an average of 0.61, indicating a balanced perception among participants. Finally, the measurement of extension contact was based on the availability of extension services from extension officers. The results show an

average score of 0.36 for agricultural extension services, suggesting that a significant portion of the sample has limited contact with them.

Table 1: Variable definitions and descriptive statistics

Variable	Description of Variables and Measurement	Mean	Std. Dev.
Age	Age of the household head (in years)	40.60	12.12
Education	Education of a household head (in years)	3.54	4.19
Household size	Total number of family members in a household	12.44	3.90
Farming experience	Total farming experience of the household head (years)	26.82	10.36
Landholding size	Total agricultural land owned by the household head (in acres)	3.00	2.98
Monthly income	Monthly income of the household head	180,000	5,341.52
Meeting participation	1 if actively participates in monthly village meetings decision makers, 0 otherwise	0.51	0.50
Relations with relative	1 if has a positive relationship, 0 otherwise	0.82	0.38
Relations with other farmers	1 if the farmer has a positive relationship with all neighbors, 0 otherwise	0.71	0.45
Input market access	1 if the individual has access to input markets, 0 otherwise	0.62	0.48
Perceived risk	1 if perceives a risk of uncertainty about repayment, 0 otherwise	0.61	0.43
Access to extension	1 if access agricultural extension services 0 otherwise	0.36	0.48

Source: Field data, (2024).

4. Results

4.1 Credit access and its utilization in agriculture

The results from key informant interviews reveal the majority of the smallholder farmers in the study villages had access to informal credit for climate change adaptation. This signifies that a considerable segment of the smallholder farmers uses informal credit methods to access finance for their agricultural activities. Moreover, the findings indicated that the amount received was adequate for their agricultural requirements. This response implies that smallholder farmers expressed satisfaction with the credit amount they received for agriculture. This was supported by one key informant who stated that;

The majority of us are relying on the informal credits provided as a major source of income for our agricultural activities. In fact, the money they provide is sufficient for carrying out agricultural activities like purchasing fertilizers, seeds, and other minor tasks. We sincerely appreciate their credit, even though it comes with a high interest rate. However, if there is sufficient rainfall, we can at least turn a profit. **(In-depth interview with elder, Endasaki village, 2024).**

Another key informant added that:

The informal credit schemes available to smallholder farmers have been a crucial support system. While they may not cover every need, they have largely enabled farmers to invest in climate-resilient practices, such as drought-resistant crops and water conservation techniques. This accessibility has contributed significantly to their adaptation efforts. (In-depth interview with Village Executive Office, Gidahababeig Village, 2024)

4.2 Main Sources of informal credits to smallholder farmers

This study investigated the main sources of informal credit utilized by respondents for agricultural activities and in responding to climate change (Table 2). Approximately 50% of the respondents indicated that they obtain informal credit for agricultural activities from their friends. This type of credit typically relies on personal relationships and trust, offering flexible repayment options or no interest. This practice underscores the importance of social networks in providing financial resources within the farming community. Furthermore, about 24% of the respondents reported accessing credits from family members and relatives. These findings reflect the important role that family ties play in providing financial support for the development of local farming systems within the context of climate change. This was underscored by one key informant who stated that;

As smallholder farmers, don't go to banks or other big lenders for help. Instead, they turn to their friends, family, and neighbors for small loans. These people understand well the struggles of their friends and relatives, especially with the changing climate. When crops fail because of droughts or floods, their relatives and friends normally step in. Formal loans require a significant amount of documentation and guarantees, which smallholder farmers are unable to provide. That's why they depend on those closest for support in adapting to these changes. **(In-depth interview with Ward Executive Officer, Endasaki Ward 2024).**

Another responded added that;

In this village, farmers rely on those they trust during difficult times. For climate adaptation, whether it's buying seeds or repairing irrigation, we

borrow from family members, friends, or even the local community groups. No matter how close banks are, their conditions are too harsh. Our relatives and friends are the ones who truly understand our challenges. We rely on this informal help to survive and adapt to our changing environment. **(In-depth interview with village elder, Endasaki Village, 2024).**

Moreover, about 15.3% of the respondents acknowledged drawing credit from the rich farmers available in the study villages. Here, smallholder farmers can find it easier to obtain credits compared to formal financial institutions, as the process is less bureaucratic and based on local relationships and trust. However, this practice poses a risk of exploitation due to power imbalances, as wealthy farmers may impose unfavorable conditions, such as requiring smallholder farmers to sell their produce at below-market prices in exchange for credit. Other sources for credits were farmer cooperatives, as indicated by 9.4%, and traders and input suppliers, as reported by a minority of the respondents (3%). Generally, these findings highlight the intricate network of relationships and channels through which individuals access informal credit to meet their agricultural financial needs.

Table 2: Main sources of informal credits to smallholder farmers

Sources of Farm-Related Credit	Frequency (n)	Percentage
Friends	145	48.3
Family and relatives	72	24.0
Rich farmers	46	15.3
Farmers cooperatives	28	9.4
Traders and input suppliers	9	3.0

Source: Field data, 2024.

4.3. Conditions required by money lenders to provide loans to farmers

This study also analyzed the conditions imposed by lenders when granting loans to individuals engaged in farming activities. Significantly, 47% of the respondents indicated that lenders enforced stipulations concerning the agreed timing for loan release or repayment. This data indicates that a significant number of borrowers were bound by certain timing arrangements when obtaining credit. Furthermore, a substantial majority of those who responded (53%) indicated obtaining loans without stipulated criteria. This widespread practice suggests that over fifty percent of borrowers in the agriculture sector obtained credit without explicit constraints or conditions. The results highlight the different loan provision methods among the study participants, with some borrowers facing time-related conditions while others benefited from a more flexible and unconditional borrowing process. This was supported by one key informant who commented that;

Smallholder farmers mostly depend on informal loans from family or friends. These loans are flexible, with no strong conditions like those from formal institutions. The main requirement is simply agreeing on a clear time frame to repay the loan. This makes it easier for farmers to access funds for climate adaptation needs, such as buying drought-resistant seeds or repairing water systems. Mutual trust and understanding underpin these informal arrangements. **(In-depth interview with District Agricultural Extension Officer, 2024).**

Another respondent supported that:

Unlike banks, informal lenders in Gidahababeig don't demand collateral or high interest. Farmers borrow from relatives or neighbors to adapt to challenges like erratic rains. The only major condition is setting a reasonable time frame for repayment. This system allows farmers to act quickly when they face climate-related shocks. It's a practical solution in areas where formal credit is unavailable or inaccessible. Without it, most farmers would struggle to implement adaptation measures. **(In-depth interview with Village Executive Officer, Gidahababeig Village, 2024).**

4.4 Factors affecting smallholder farmers' access to and use of informal credit for agriculture and climate change adaptation

The first task was to show if the two binary outcomes are independent therefore the study used the likelihood ratio test (rho = 94.84) (Table 3), used to validate the model fit and the explanatory power of the bivariate probit regression model. The likelihood ratio test with a χ^2 (1) value of 94.844 was significant at 1%, implying the presence of cross-correlation between the residuals of the credit access and utilization equations. Therefore, it makes sense to estimate the two models jointly Meanwhile, the likelihood ratio χ^2 (22) values of 99.65 are significant at the 1% level, which shows that the covariates explain the variations in the response variable; hence, the model fits the data.

The bivariate probit regression analysis revealed three significant factors influencing both the access to and utilization of informal credit in agriculture. Access to informal credit and its use in agriculture were both affected by having good relationships with other farmers (Table 3). The coefficients for both were 1.261 and 0.632, which means they were statistically significant at the 1% level. Positive relationships with neighbors and family members also had a relationship. For example, having a coefficient of 0.692 for access to informal credit and 0.688 for its use in agriculture was statistically significant at the 1% level. Also, lower perceived risk had a big effect on both getting and using informal credit, as shown by coefficients of -0.382 and -0.323, which are both statistically significant at the 5% level. These findings underscore the

importance of social relationships and risk perception in the dynamics of informal credit within the agricultural context.

Table 3. Factors influencing the access to and utilization of informal credit in agriculture (Bivariate probit regression).

Variable	Access to Informal Credit		Utilization of Informal Credit	
	Coeff (S.E.)	M.E. (S.E.)	Coeff (S.E.)	M.E. (S.E.)
Farming experience	−0.013 (0.013)	−0.003 (0.003)	−0.012 (0.012)	−0.004 (0.004)
Land holding size	0.032 (0.038)	0.008 (0.010)	−0.038 (0.033)	−0.012 (0.010)
Monthly income	−0.029 (0.101)	−0.007 (0.026)	0.053 (0.091)	0.017 (0.029)
Age	0.005 (0.012)	0.001 (0.003)	0.016 (0.011)	0.005 (0.004)
Education	−0.033 (0.023)	−0.008 (0.004)	−0.014 (0.021)	−0.004 (0.007)
Household size	0.016 (0.027)	0.004 (0.007)	0.038 (0.025)	0.012 (0.008)
Meeting participation	−0.319 (0.204)	−0.083 (0.052)	−0.307 (0.186) *	−0.097 (0.058)
Relations with relative	0.692 (0.205) ***	0.179 (0.051)	0.688 (0.196) ***	0.222 (0.058)
Relations with farmers	1.261 (0.233) ***	0.329 (0.051)	0.632 (0.227) ***	0.203 (0.069)
Input market access	0.017 (0.213)	0.004 (0.055)	0.282 (0.204)	0.089 (0.064)
Perceived risk	−0.382 (0.209) **	−0.094 (0.056)	−0.323 (0.191) **	−0.083 (0.049)
Access to Extension	−0.139 (0.188)	−0.036 (0.049)	0.033 (0.176)	0.010 (0.056)
Constant	−0.423 (1.164)		−1.733 (1.058)	
Diagnostic tests				
Number of observations	300			
LR χ^2 (22)	99.65 ***			
LR test of rho χ^2 (1)	94.84 ***			
Log likelihood	−259.222			

Notes: S.E.—Standard Error, M.E.—Marginal Effect; *** Significant at 1%, ** Significant at 5%.

Source: Field data, (2024).

5. Discussion

Table 1 presents descriptive data that offer a thorough summary of the respondents and essential characteristics relevant to the study, highlighting significant socioeconomic factors. The advanced age demonstrates the importance of age in decision-making in agricultural practices (Asfaw & Battista, 2016). The low attainment of higher education highlights the persistent difficulties in accessing education in rural regions (Diiro, 2018). The substantial household sizes identified in our analysis indicate potential

labor availability; however, they also impose strain on resources, a prevalent pattern in rural agrarian economies (Berdegue et al., 2023).

The farming experience documented in the study reflects a profound reservoir of practical knowledge, crucial for sustainable agricultural operations (Sawe, 2022). The study's average modest landholding size and income differences illustrate the prevalent fragmented land ownership and income variability in emerging regions (Malekela & Nyomora, 2022). Moderate engagement in village meetings and favorable social interactions underscore the significance of social capital in rural community dynamics (Pretty, 2021). Access to markets (average of 0.62) and risk perception (average of 0.61) underscore their essential contribution to agricultural investments (Anderson, 2019).

The study ultimately indicated a lack of extended interaction, highlighting the need for improved agricultural advising services. This aligns with the literature promoting enhanced extension support to augment agricultural innovation and productivity (Anderson, 2019). These inferences highlight the complex nature of rural lives and the intricate interactions of socioeconomic factors influencing agricultural results.

This study underscores the fundamental significance of informal credit access and use in the agricultural sector, as the majority of respondents engage with informal credit for agricultural activities. The results show that farmers who use informal credits were able to adapt to climate change through using appropriate climate change adaptation strategies because of their financial stability. These findings align with the existing literature that emphasizes the importance of informal credits in rural regions, where formal financial services often face constraints (Diiro, 2018). The adequate amount of credit continues to be a major issue, as numerous respondents perceive the credit they obtained as inadequate. To obtain adequate credit, many farmers emphasized the necessity of accessible institutional financing. This aligns with the statement, “The informal credit I receive is perpetually inadequate.” I utilize informal credit due to my inability to afford formal credit. Due to my financial disadvantage, I may not be able to repay the loan to either institutional or informal lenders on time. I am extremely concerned about obtaining loans. The government needs to assist the impoverished and vulnerable. The government should grant us convenient access to formal financing to facilitate the acquisition of all necessary farming supplies. Confronted with insufficient credit, the majority of respondents chose to partially satisfy their needs, underscoring their pragmatic disposition.

Furthermore, the study reveals a clear dependence on social networks, with the majority of respondents identifying friends as their primary source of credit, underscoring the critical importance of social capital (Asfaw & Battista, 2016). The varying circumstances for loan provision, with certain

respondents encountering explicit time agreements, illustrate the heterogeneous nature of informal lending practices. Additionally, the study identified contentious relationships and family conflicts as obstacles to securing loans, which adversely affect agricultural activity and prompt some to cease production. This study emphasizes complex problems and adaptive solutions in agriculture, underscoring the necessity for enhanced access to formal credit and support to boost productivity and resilience in farming systems.

The results of the bivariate probit regression analysis highlight how important social capital is in enhancing agricultural practitioners' ability to get and use informal credit. The result corroborates the proposed hypothesis, highlighting the significance of social networks in informal credit acquisition. This is consistent with the existing literature indicating that social networks substantially enhance economic activities in agriculture by offering both material and informational resources (Moahid & Maharjan, 2020). Furthermore, the data indicated that farmers frequently depend on existing contacts to obtain informal credits, which may be inaccessible through formal financial institutions.

Additionally, findings reveal that positive relationships with neighbors and family are key drivers of informal credit access and utilization. This underscores the larger community's function in offering financial assistance, further demonstrating the integration of economic activity within social frameworks (Ado et al., 2019). Research has demonstrated the significance of neighborly and family support networks in rural settings, demonstrating that these connections frequently act as safety nets during times of financial hardship (Ali & Erenstein, 2017). The farmers' capacity to utilize these networks helps alleviate risks and maintain agricultural operations despite the lack of institutional financing channels. The findings indicate that initiatives designed to fortify community connections and improve mutual support systems may enhance financial resilience and agricultural productivity.

The results indicate that perceived risk has a substantial negative impact on both access to and utilization of informal credit. This indicates that elevated perceived risks inhibit both the provision and acceptance of credit inside informal networks. The apprehension of farmers over loan acquisition, stemming from concerns about repayment difficulties, constitutes a significant obstacle. This observation corresponds with research indicating that risk perceptions significantly affect borrowing practices in rural economies (Diiro, 2018). Getting rid of perceived risks, possibly by improving risk management strategies and providing better extension services, could make it easier to get and use credit, which would lead to more resilient farming practices. These findings emphasize the interconnectedness of social

dynamics and risk perception in influencing the informal lending landscape in agriculture.

A bivariate probit analysis in Table 3 shows that social capital factors, like relationships with neighbors and other farmers, have a big impact on both getting and using informal credit in agriculture. However, demographic and socioeconomic factors, like age, education level, and farming experience, did not have as much of an impact. These results suggest that, contrary to our hypothesis, these socioeconomic variables do not play a critical role in determining informal credit access in this context. These factors might not be important because people in rural areas rely heavily on informal social networks. In these places, getting credit depends less on a person's personal qualities and more on trust and mutual support within communities (Moahid and Maharjan, 2020).

Age and education, though traditionally thought to affect financial decisions, may not play a critical role in informal credit arrangements, as these networks tend to prioritize long-standing relationships and shared community risks rather than formal indicators of creditworthiness (Pretty, 2021). Moreover, farming experience may have limited influence due to the lack of formal record-keeping or collateral-based lending mechanisms, which contrasts with formal credit systems that place greater weight on such variables (Malekela & Nyomora, 2022). These findings highlight the critical importance of social relationships over personal or economic factors in rural financial behaviors, underscoring the need for policies that strengthen community networks to enhance financial resilience.

6. Conclusions and policy implications

The paper uniquely highlights the underexplored dynamics of informal credit in a semi-arid mountainous area in Hanang District, adding new insights to the broader discourse on credit access in geographically isolated and vulnerable environments. This study analyzes small holder farmers' access to informal credit and usage for sustainable agriculture. With a substantial number reporting access to informal credit, the majority of them actively leverage credit to support their agricultural activities. What the bivariate probit regression analysis showed is very helpful for understanding what makes people in the agricultural sector get and use informal credit. Positive relationships with fellow farmers and neighbors/relatives emerged as significant factors that positively influence both the access to and use of informal credit. Furthermore, a lower perceived risk significantly impacted the likelihood of accessing and utilizing informal credit.

These findings add to the existing literature by providing specific policy recommendations for regions with limited formal credit access, thereby offering a global framework for supporting smallholder farmers in similar

contexts. This study suggests that extension services and agricultural programs should facilitate networking events to foster positive relationships between farmers and communities, thereby enhancing social ties and creating a supportive environment for informal credit access. Mitigating perceived risks associated with informal credit requires targeted interventions such as educational programs and awareness campaigns. Policymakers are advised to acknowledge the significance of social relationships in the agricultural credit landscape and contemplate formulating policies that promote community-based lending practices, thereby improving the overall financial well-being of farmers.

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