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Participation and utilisation levels of smallholder farmers agricultural credit guarantee scheme in Shinyanga and Iringa Regions, Tanzania

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Abstract
Agricultural credit is a key instrument in improving smallholder farmers' agricultural production. However, in Tanzania, access to agricultural credit is a significant challenge due to the higher transaction costs of lending to smallholder farmers. The Smallholder Farmers Agricultural Credit Guarantee Scheme (SCGS) was introduced in 2018 to enhance access to credit. The study employed a double hurdle model and a Heckman two-step selection model on farm-level survey data of 500 smallholder rice farmers to estimate determinants of participation and levels of credit utilisation. The results revealed that ten variables significantly influenced participation in the SCGS, six variables determined the levels of credit utilisation and four variables had a joint influence on both participation and credit utilisation levels. Specifically, education level, household size, SCGS awareness, land ownership, rice farm size, extension services, frequency of extension contacts and membership in farm-based groups positively explain participation in the SCGS. Similarly, age, education level, household size, rice farm size, frequency of extension contacts and loan repayment period positively determined credit utilisation levels. Moreover, education level, household size, rice farm size and frequency of extension contacts jointly influenced participation and credit utilisation levels. However, off-farm income and savings from the previous cropping season negatively determined participation. These results offer valuable insights for policymakers on factors driving participation in the SCGS and credit utilisation levels, thereby supporting the design of effective strategies to enhance smallholder farmers' participation in the SCGS and credit utilisation levels.

Keywords Participation, Levels of credit utilisation, Credit guarantee scheme, Double hurdle model, Smallholder rice farmers, Tanzania

1 Introduction

The agricultural sector plays a critical role in the economic development across the globe, particularly in developing countries where a significant portion of the population depends on agriculture as a source of livelihood [1, 2]. Over 80% of the farmers in

sub-Saharan Africa own less than two hectares of farmland for agricultural activities, while food demand is expected to increase by 35–56% from 2010 to 2050 [3]. Moreover, [3] contented that the total food demand will change by 30–62% due to climate change, and the population experiencing hunger is expected to change by − 91% to + 30% over the same period.

In Tanzania, for example, the agricultural sector plays a vital role in enhancing food and nutritional security, reducing poverty and promoting rural development as well as contributing to economic growth [4]. The sector accounts for over 26% of the gross domestic product (GDP) [5]. Like other developing countries, Tanzania has an agricultural sector dominated by smallholder farmers who mainly practice at the subsistence level. The sector faces low productivity due to a low adoption of productivity-enhancing technologies. The average growth rate of the agricultural sector was estimated at 4.8% in 2022, compared to the target average growth rate of 6% that is required to achieve the country's development vision by 2025 [5].

Access to agricultural credit is crucial in advancing agricultural production and productivity. Smallholder farmers need credit to invest in improved crop varieties, fertilisers and farm machinery. Adopting modern agricultural technologies is essential for smallholder farmers to transition from subsistence farming to commercial agriculture and enhance agricultural output. The adoption of these technologies requires adequate and timely access to agricultural credit [6–16]. However, smallholder farmers in developing countries, including Tanzania, often face significant challenges in accessing essential credit needed to finance farming enterprises, which can have a profound impact on farm productivity [17–20]. Additionally, most smallholder farmers are constrained in accessing the credit they need to procure agricultural inputs [21–23]. This is primarily due to the high-risk nature of agriculture, the high transaction costs of lending to smallholder farmers, over-reliance on rain-fed farming, unavailability of financial products that suit smallholder farmers, inability of the farmers to repay loans, and limited access to markets [17, 24–28]. Furthermore, empirical evidence indicates that smallholder farmers and agricultural-related enterprises face significant constraints in accessing credit from formal financial institutions through conventional means. These constraints primarily stem from a lack of collateral, information asymmetry and a lack of credit history [29–32].

Credit guarantee schemes (CGSs) are policy instruments that play a pivotal role in improving access to credit, particularly for the agricultural sector, Small and Medium Enterprises (SMEs) and other underserved borrowers [33–36]. CGSs helps mitigate the risk perceived by lenders, incentivising them to extend financial services to credit-constrained SMEs [37, 38]. Furthermore, CGSs contribute to a more equitable lending environment by reducing information asymmetry, lowering the collateral requirements and decreasing transaction costs, which enables resource-limited enterprises to access financing more effectively [38, 39].

In response to challenges associated with access to agricultural credit, the government of Tanzania and other stakeholders have initiated and implemented several interventions to facilitate access to agricultural credit. One of the interventions implemented is the Smallholder Farmers Agricultural Credit Guarantee Scheme (SCGS). The SCGS was initiated in 2018 by the Tanzania Agricultural Development Bank (TADB) and implemented through partner financial institutions to provide agricultural credit to

smallholder farmers. The TADB provides a guarantee cover of up to 50% to encourage commercial banks to extend credit to smallholder farmers. Access to affordable agricultural credit can foster the development of rural economies, enhance the socio-economic standing of smallholder farmers and promote sustainability of agricultural production [33, 35, 40, 41].

Empirical evidence demonstrates that access to agricultural credit promotes the adoption of agricultural technologies, enhances crop productivity, farm incomes, and facilitates capital formation [42–49]. Additionally, [21] found that limited access to agricultural credit is a key constraint to adopting agricultural technologies. Thus, access to affordable agricultural credit is crucial for improving agricultural production and food security. However, [50] found no evidence of the relationship between credit access, the adoption of chemical fertilisers, and farm productivity in Tanzania. Furthermore, evidence indicates that smallholder farmers' participation in agricultural credit support programs such as SCGS is determined by socio-economic, farm-level and institutional characteristics [8, 51–59]. Similarly, evidence shows that socio-economic, farm-level and institutional variables are key factors influencing levels of credit utilisation [22, 51, 52, 59–63].

Several studies have been conducted on participation in agricultural credit programs and the intensity of participation in developing countries [51, 52, 61, 64–68]. However, to the best of the researcher's knowledge, there is no empirical study that specifically examines smallholder farmers' participation in credit support programs such as the SCGS or the levels of credit utilisation in Tanzania. The available evidence, such as that of [21] focused on the demand and supply constraints of agricultural credit. Additionally [69], examined the determinants of access to credit in rural areas while [70] assessed the determinants of access to credit and agricultural technology adoption. Therefore, there is still a gap in empirical literature regarding the determinants of participation in the SCGS and credit utilisation levels among smallholder rice farmers in Tanzania. The SCGS is the first credit support program that explicitly targets smallholder farmers to facilitate their access to agricultural credit. The limited empirical evidence motivated this study to fill the existing gap in the literature by examining the determinants of participation in the SCGS and the levels of credit utilisation. The contribution of this study to the body of knowledge is in three ways: firstly, the study identified the determinants of participation in SCGS, and secondly, it estimated the determinants of the levels of credit utilisation. Thirdly, the study employed the double hurdle model and the Heckman two-step model to simultaneously estimate the determinants of participation in SCGS and the level of utilisation of SCGS.

2 Materials and methods

2.1 Study area

The study was conducted in the Iringa District Council in Iringa Region and the Ushetu District Council in Shinyanga Region. These Districts were selected because they were the major beneficiaries of the SCGS. The districts also have the same agricultural practices and socioeconomic characteristics of the smallholder farmers. Moreover, the selection of the study areas was influenced by the fact that they are far from the regions where there are agricultural research institutes that play a vital role in supporting farmers by providing a range of services. Furthermore, these districts were selected because

of the extensive land areas supporting rice farming and many smallholder farmers with rice as their main crop. In this study area, the credit was issued to individual smallholder rice farmers, unlike in other regions in Tanzania, where the credit was issued through cooperative societies. Credit provided through cooperative societies may not give a clear picture of the determinants of participation in SCGS and the utilisation of credit, as it is the cooperative societies that borrowed the loan guarantee from the financial institutions and to issued smallholder farmers who are members of the cooperatives instead of individual smallholder farmers directly accessing the loan from the financial institutions.

2.2 Sources of data

A pretested structured questionnaire was used to collect cross-sectional survey data from smallholder rice farmers. The sample for this study comprises two groups, namely the SCGS participants and non-participants. The information collected covered respondents' socio-economic, farm-level and institutional characteristics. Previous related empirical studies informed the choice of the variables in the questionnaire. The questionnaire was pre-tested with 40 rice farmers to validate the survey instruments and to ensure the effectiveness of the data collection procedures. The pre-testing was conducted outside the study areas to maintain the validity and integrity of the primary data collection by avoiding bias and preserving the sample quality in the study areas. The necessary adjustments were made afterwards. A team of well-trained enumerators collected the data between August and October 2024.

2.3 Sampling and sampling procedure

A multistage sampling approach was adopted in the study. Firstly, the list of SCGS beneficiaries was solicited from one of the partner financial institutions, namely the Tanzania Commercial Bank (TCB), that facilitated agricultural credit to smallholder farmers through the SCGS. Secondly, purposive sampling was employed to select two regions and one district from each region based on the number of smallholder rice farmers' beneficiaries. Thus, the Iringa District council was selected from Iringa Region and the Ushetu District council from Shinyanga Region. Thirdly, from each district, one ward was purposively selected, and from each ward, two villages were purposively selected due to a higher number of SCGS beneficiaries. Therefore, Mboliboli and Mbugani were selected from Mboliboli ward in Iringa District and Ulowa and Ilomelo Villages from Ulowa Ward in Ushetu District. The simple random sampling approach was used in the final stage to select 500 smallholder rice farmers for this study, of which 200 were SCGS beneficiaries and 300 were non-beneficiaries. The sample of non-beneficiaries was included for comparison purposes.

The sample size was established adopting Yamane's (1967) sample size determination formula for a known population size specified as: $n = \frac{N}{1+N(e^2)}$ [71].

where n is the expected sample size, N is the population size in the study area and e is the margin of error, which is equal to 0.05 for a 95% confidence level. Using Yamane's (1967) formula, 399 households from 147,046 farming households in the study area were selected. To capture variability and diversity within the farming household, obtaining reliable and generalisable findings, including a significant number of farming households, is paramount. Thus, 101 households were added, making a sample size of 500 smallholder rice farmers.

2.4 Analytical framework

The two-stage models, such as the double hurdle model and the Heckman two-stage technique, are a widely employed analytical approach in empirical studies [72–81]. When the same set of covariates does not jointly determine the decision to participate and use the agricultural credit program, the two-step models are preferred over the one-step model [82, 83]. However, when the same set of covariates determines the decision and outcome, then the Tobit model is the appropriate one [82, 83]. More often, the decision to participate and credit utilisation levels are non-random and heterogeneous. Nevertheless, the study was not certain whether the covariates jointly determine the decision to participate in SCGS and the credit utilisation levels. Thus, the study conducted the separability test using the likelihood ratio test to identify the appropriate model.

Building on the work of Anang and Dagunga [59] the double hurdle model can be specified as follows:

$$C_i = Pro\,(C|\,C^*) > 0 = \beta\, X_i + \epsilon_{\,i}, \qquad \epsilon_{\,i} \approx\ N(0,1) \tag{1}$$

$$y = E\,(y|y^*) > 0 = \alpha\, X_i + \mu_{\,i} \tag{2}$$

$$Y = (\beta\, X_i + \epsilon_{\,i}) + (\alpha\, X_i + \mu_{\,i}) = \phi\, X_i + \omega_{\,i}, \qquad \omega_{\,i}\ \approx\ N(0, \sigma^{\,2}) \tag{3}$$

Equation (1) is the probit model with C = 1 if the smallholder rice farmers participated in the SCGS and C = 0 for the smallholder rice farmers without farm credit through SCGS, while C^* denotes the latent variable for participation in the SCGS. Equation (2) is the truncated regression, where y is the credit access and y^* the latent variable for the amount of credit borrowed. Equation (3) is the Tobit model, which combines Eqs. (1) and (2). $\beta\,, \alpha\ and\, \phi$ denotes the parameters of the equations to be estimated. Furthermore, the Heckman two-step model consists of two equations, where the first stage uses the probit model to estimate the selection equation, and the second stage applies ordinary least squares (OLS) regression while correcting for selection bias. Following Kelifa [84], the Heckman model can be specified as follows:

$$y^*_{\,1i} = X_{1i}\beta_{\,1i} + \epsilon_{\,i} y_{1i} = 1\ \ if\ y^*_{\,1i}\ > 0 \tag{4}$$

$$y_{1i} = 0\, if\ y^*_{\,1i} \leq\ 0 \tag{5}$$

$$y_{2i} = X_{2i}\beta_{\,2i} + \mu_{\,i}\lambda_{\,i} + \eta_{\,i} \tag{6}$$

where Eqs. (4) and (5) represents the selection equation (probit model) and Eq. (6) is the OLS model, $y^*_{\,1i}$ is the dummy variable (SCGS participation), and y_{2i} is the levels of credit utilisation. X_{1i} and X_{2i} are vectors of explanatory variables that influence the probability of participation and levels of credit utilisation. $\epsilon_{\,i}$ and $\eta_{\,i}$ are the error terms while $\mu_{\,i}$ is the parameter that capture the effect of selectivity bias on the outcome equation.

Following [84, 85], the likelihood ratio test statistic is expressed as follows:

$$\lambda\ = -2(LL_{tobit} - (LL_{probit} + LL_{truncreg}\,)) \tag{7}$$

were LL_{probit} represent the log-likelihood from the probit model, $LL_{truncreg}$, denotes log-likelihood from the truncated estimation and LL_{tobit} represents the log-likelihood from the Tobit regression. The test statistic has the chi-square distribution with degrees

of freedom equal to the number of parameter restrictions made to get the Tobit model [84]. According to [84], the Tobit model is rejected in favour of the two-step model if λ is greater than the chi-square critical value. Similarly, the selection between the Cragg double hurdle model and the Heckman model is based on the Inverse Mills Ratio (IMR) from the Heckman estimation. If IMR is statistically significant, it indicates a selection bias in farmers' decisions to participate in the SCGS. Thus, the Heckman model is preferred over the Cragg double hurdle model [84, 86]. Following the likelihood ratio test, the Cragg double hurdle model was selected over the Heckman model since λ exceeds the chi-squared critical value, and the IMR was not statistically significant.

The Cragg double hurdle model comprises two stages. The first stage identifies the determinants of participation, while the second stage estimates the factors that determine the levels of credit utilisation among those who actually participated [82–84, 87]. The first stage of the Cragg double hurdle, which assesses the participation decision, is commonly estimated using a probit or logit regression approach. In this stage, the dependent variable is a binary indicator denoting whether a farmer has participated in the SCGS or not. The independent variables can be continuous or dummy. In the second stage, the credit utilisation level is estimated using a truncated regression approach, as the dependent variable is continuous, but only observed within the restricted range. This technique is appropriate in capturing the censored nature of the data, which arises because credit utilisation levels cannot be below zero. Truncation and censoring are similar concepts, yet they are distinct and are frequently used interchangeably with the term sample selection. Censoring is a common econometric technique that limits the value of the dependent variable and occurs when a dependent variable is assigned to a specific, arbitrary value [88]. Conversely, truncation is fundamentally a characteristic of the distribution from which sample data is drawn, while censoring is a defect in the data itself [88]. Truncation also arises when the data is adjusted to eliminate the values that seem to be outliers [88, 89]. A censored sample is one in which information for the response variable is available only for some observations [88, 90].

The Double hurdle model offers a more holistic understanding of the factors influencing the decision to participate in the SCGS and the credit utilisation levels, allowing policymakers to develop more targeted interventions to improve access to credit. While the model offers a practical analytical framework, it has some limitations. The model assumes that the decision to participate and utilise credit is independent, which may not align with the realities faced by the farmers [82]. Additionally, the model relies on a restricted set of observables, which may not fully capture the nuances and complexities inherent in the decision-making process. However, despite its limitations, the double hurdle model remains appropriate for this study, as participation in the SCGS and credit utilisation levels are influenced by different sets of covariates and no evidence of self-selection bias was found.

2.5 Conceptual framework and choice of variables

The empirical evidence on participation determinants and credit utilisation levels offered valuable insights for this study. This study conceptualises that socio-economic, farm-level, and institutional characteristics influence participation in the SCGS and credit utilisation levels. Figure 1 presents the conceptual framework for this study.

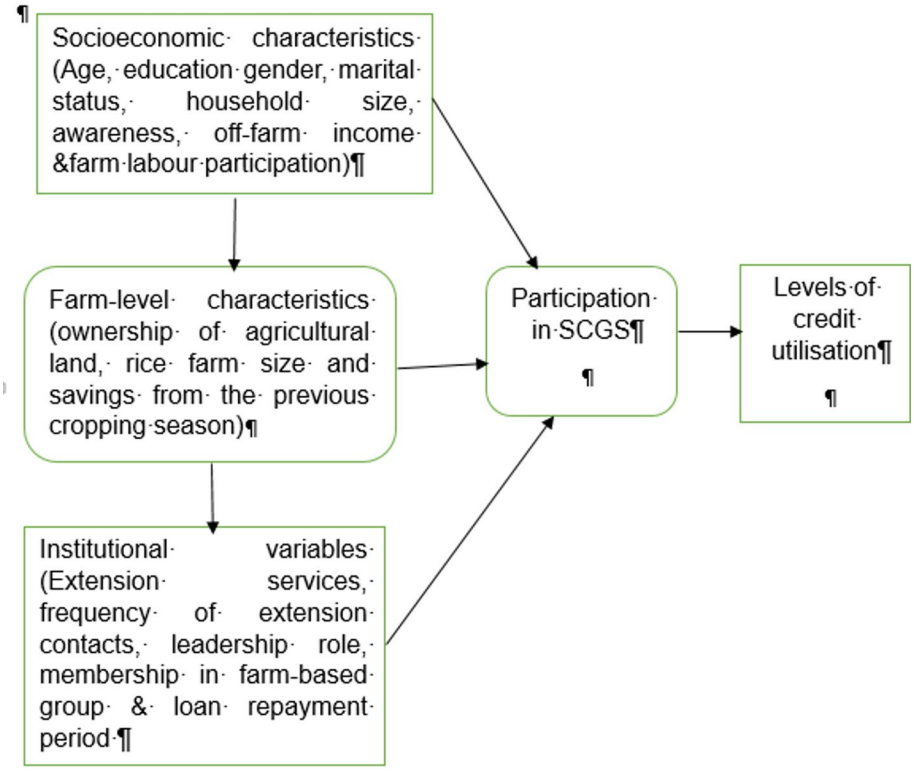

Fig. 1 Determinants of participation in smallholder farmers' agricultural credit guarantee scheme and levels of credit utilisation. Source: Author's construct 2025

2.6 Description of the variables used in the model

Table 1 presents the list of explanatory variables hypothesised to influence participation in the SCGS and credit utilisation levels. These variables include socio-economic, farm-level and institutional characteristics drawn from previous empirical studies.

2.6.1 Dependent variables: participation and levels of credit utilisation

The dependent variables used in the model were participation in the SCGS and credit utilisation levels. Participation in the SCGS is represented by a binary variable that takes a value of 1 if a smallholder rice farmer participated in the SCGS and 0 otherwise. The levels of credit utilisation is a continuous variable measured by amount of credit borrowed by smallholder rice farmers.

2.6.2 Socio-economic characteristics

The existing literature claims that farmers' age has a heterogeneous effect on the credit uptake. For example [51] found that age jointly explains the decision to participate in the credit scheme and the intensity of borrowing. While [19, 22, 91] reported a negative relationship between age and credit uptake, on the other hand [44, 52, 92] argued that older farmers are likely to participate in the credit scheme as they have developed better skills in efficiently utilising their resources. Moreover, studies have indicated a significant nexus between education, participation in credit support programs and levels of credit utilisation [93]. Therefore, it was uncovered that the educational attainment of smallholder farmers is a key determinant of participation in the credit scheme [61]. Similarly, [94] underline that the household head's education level significantly determines

Table 1 List of explanatory variables used in the model

Variable	Unit of measurement	Expected sign	Literature source
Dependent variables			
Participation in the SCGS	Binary (1 = participants, 0 = non-participant)		
Levels of credit utilisation	Continuous (amount of loan borrowed)		
Explanatory variables			
Socio-economic characteristics			
Age	Continuous (age of the household head in years)	+ or–	[22, 51, 52, 56]
Education level	Continuous (household head's years of schooling)	+	[61, 97]
Gender	Dummy (1 = male, 0 = female)	+ or–	[51, 66]
Marital status	Dummy (1 = married, 0 = otherwise)	+ or –	[51, 55, 66]
Household size	Continuous (number of household members)	+ or –	[52, 55, 66, 98]
Farm labour participation	Dummy (1 = full time, 0 = otherwise)	+	[99]
SCGS awareness	Dummy (1 = aware,0 = not aware)	+	[32, 35, 100]
Off-farm income	Dummy (1 = have off-farm earnings,0 = otherwise)	+ or –	[51, 53, 56]
Farm-level characteristics			
Land ownership	Dummy (1 = owned, 0 = otherwise)	+	[51, 53, 57]
Rice farm size	Continuous (land size under rice cultivation)	+ or –	[8, 51, 53]
Savings from the previous seasonal	Dummy (1 = saved, 0 = otherwise)	+ or –	[14, 53, 101]
Institutional characteristics			
Extension services	Dummy (1 = access, 0 = otherwise)	+ or–	[8, 57, 100, 102]
Frequency of extension contacts	Continuous (number of contacts with extension agent)	+	[51, 52]
Membership in a farm-based group (FBO)	Dummy (1 = member, 0 = otherwise)	+	[8, 66, 97]
Leadership role	Dummy (1 = leader, 0 = otherwise)	+	[103, 104]
Loan repayment period	Continuous (number of months to repay the loan	+	[92]

the utilisation levels. However [95] disclosed that general education alone may not be sufficient to participate in the credit scheme instead, financial literacy is a key factor that enhances an individual's decision to participate. Existing literature highlights that farmers with higher levels of education better understand the conditions and terms of the credit, evaluate potential benefits and risks and make informed decisions about borrowing and utilising the acquired credit for its intended purpose.

A couple of empirical studies have underlined that the gender of the household head jointly determines participation and utilisation of the credit [51, 52]. Nevertheless, [61, 66, 94], argued that male farmers are more likely to participate than their female counterparts because of gender-based social norms that discriminate against females in decision-making and financial autonomy. Similarly, a significant relationship between marital status, participation in credit schemes, and utilisation of the credit has been reported in empirical studies [52, 94, 96]. Married smallholder farmers possess greater financial stability and decision-making power within the household, which can facilitate participation in the SCGS and effective use of the credit for its intended purpose. However, unmarried households may have less control over resources and decision-making, limiting their ability to participate and channel credit to agricultural activities.

Several studies demonstrated that household size plays a pivotal role in participation in credit support programs and levels of credit utilisation. Empirical evidence underlined that household size jointly determined participation and credit utilisation [52]. Additionally, [61, 63, 94] established that household size positively influences participation in the credit scheme. Larger household size increases consumption expenditure, creating pressure on limited resources that may influence farmers to participate in the credit support services. However, [98] found a negative relationship between household size and participation in the credit scheme. Furthermore, related studies reported that full-time farm labour is a crucial factor that can influence participation in the credit support schemes [99]. Farmers with adequate labour resources may be more inclined to participate in credit support programs, as they can channel the acquired credit towards investment in labour-intensive technologies and practices that can enhance agricultural productivity. Moreover, the significance of off-farm income in the uptake and utilisation of agricultural credit is evident in existing literature. For example, [22] contented that participation in off-farm activities jointly determines the decision to participate in the credit scheme and the amount borrowed. Furthermore study by [96] attest that off-farm income has a significant impact on credit utilisation. Similarly [51] reported that participation in off-farm activities explains smallholder farmers' decision to participate in the credit scheme.

2.6.3 Farm-level characteristics

Ownership of agricultural land and farm size have been reported to influence participation in agricultural credit programs positively [51, 54, 56, 57, 105]. This positive association is attributed mainly to land's role as a vital form of collateral. Lenders often perceive land as a tangible and fixed asset that can be used to secure loans, particularly when recognised property rights back the land. Similarly, previous studies have uncovered a significant relationship between farm size and participation in agricultural credit schemes and levels of credit utilisation [51, 92, 96, 106]. The extant literature suggests that the capital investment required for agricultural production is presumed to rise as the farm size increases. Hence, farmers with large farm enterprises are anticipated to exhibit greater participation and utilisation of the credit. Moreover, [62] underlined that institutional credit agencies often favour farmers with a large farm size as they can provide more collateral. However, [107] found that farm size is negatively related to credit market participation. Furthermore, the savings accumulated from agricultural activities influence farmers' propensity to participate in credit scheme and utilisation. The existing literature argued that higher farm earnings suggest the availability of capital for farm enterprises, thus reducing the likelihood of participating in the agricultural credit scheme [93, 101, 108].

2.6.4 Institutional characteristics

A significant nexus between extension services, participation in credit schemes and credit utilisation levels has been underscored in past studies [17, 22, 51, 100]. Moreover, a significant relationship between the frequency of contact with extension agents and credit utilisation levels has been reported in previous studies [51, 52]. Extension services constitute an essential source of information on agricultural programs and offer technical guidance on best farming practices. Therefore, their availability is critical for

smallholder farmers' participation in the SCGS and credit utilisation levels. Moreover, the empirical literature highlights the influence of membership in a farm-based organisation (FBO) on participation in credit schemes and utilisation [66, 68, 97, 109, 110]. These earlier studies argued that financial institutions often prefer the group lending approach because group members can be a guarantor for individual smallholder farmers. Additionally, the group lending approach is preferred as it helps reduce the risk for the lender by having multiple borrowers collectively share the liability.

Moreover, the influence of leadership role within a community on farmers' participation in credit support programs and levels of credit utilisation is acknowledged in the empirical literature [103, 104]. Community leaders, such as village leaders, religious leaders, and political leaders, are often connected to information sources and can expose farmers to various agricultural initiatives, helping them better understand the benefits of such programs. Additionally, community leaders can play a critical role in facilitating access to credit by linking farmers with lending institutions and offering guidance on the effective use of the acquired credit.

Furthermore, previous studies have identified interest rate and loan repayment period as key factors influencing smallholder farmers' participation in credit support programs such as the SCGS, as well as the levels of credit utilisation [53, 66, 92]. Smallholder farmers, whose incomes are unstable, are often highly sensitive to borrowing costs due to their limited repayment capacity. Depending on the terms offered, this can either discourage or encourage participation in credit support programs. However, interest was excluded from the analysis, as all the SCGS beneficiaries received the credit at the same interest rate.

3 Results and discussion

3.1 Descriptive statistics

Table 2 presents the descriptive statistics for continuous variables of the surveyed household, while Table 3 shows the descriptive statistics for dummy variables. Table 4 reports the mean differences between SCGS participants and non-participants. The result indicates that the average loan amount borrowed by the participants' households was 2,207,000 Tanzanian Shillings, with an average repayment period of approximately nine months. This suggests that, on average, participants accessed a substantial loan amount to meet their financial needs, with a repayment timeframe that aligns with the rice farming cycle from planting to harvesting and selling crops. The average age of the smallholder rice farmers is 41 years, with a significant difference between participants and non-participants reported in Table 4. This suggests that most smallholder farmers fall within the economically active group, which is a good source of power and labour for agricultural production activities. This further implies that these smallholder farmers may have gained enough knowledge in farming, enabling them to make more informed and strategic decisions regarding farming enterprises. The average years of formal education was seven years of schooling, with a significant difference between participants and non-participants.

The education level of a farmer can enhance their ability to understand better the credit services, terms and conditions and the ability to invest the acquired credit in productivity-enhancing agricultural practices. The average household size is five members, with a significant difference between SCGS participants and non-participants. This

Table 2 Descriptive statistics for the continuous variables

Variable	Overall($n=500$)		Participants ($n=200$)		Non-participants($n=300$)	
	Mean	SD	Mean	SD	Mean	SD
Loan amount	–	–	2,207,000 ($817)	2,481,095	–	–
Loan period in months	–	–	8.570	2.298	–	–
Age	40.758	12.438	42.295	9.339	39.733	14.053
Education level	7.180	2.555	7.600	2.155	6.900	2.758
Household size	4.556	1.963	5.19	1.942	4.133	1.864
Frequency of contact with the extension agent	2.027	0.854	2.090	0.805	1.898	0.941
Rice farm size	4.150	3.713	6.080	4.808	2.863	1.863

The exchange rate at the time of data collection ($1 = 2, 700 Tsh)

suggests the availability of family labour for farming activities that may influence the decision to participate in agricultural support credit. Furthermore, on average, four acres were under rice cultivation, with a significant mean difference between participants and non-participants. This implies that most of the surveyed households were smallholder farmers. The average frequency of contact with the extension agent was two times per year, with no significant difference.

The result indicates that 66% of the surveyed smallholder rice farmers were male-headed households, and 79% were married. Additionally, results show that about 97.6% of the respondents were full-time smallholder rice farmers. The higher rate of full-time farm labour participation underscores the significant role of agriculture as a primary economic activity for the rural population and the main source of income for the smallholder farmers. On average, 67% of the respondents owned land for agricultural activities. Additionally, 13% of the respondents held a leadership position in the community. Approximately 29% of the surveyed households had access to extension services. The result indicates that a considerably higher proportion of the participants' households accessed extension services than non-participants. Moreover, approximately 74.6% of the respondents were aware of the SCGS. This indicates that despite their awareness of the SCGS, many smallholder farmers in the study area seem to have faced challenges in participating and benefiting from it. About 44% of the surveyed households are members of farm-based groups, with a larger proportion observed among participating households. This suggests the significance of farm-based groups in facilitating access to valuable resources, information and support networks. Additionally, approximately 43% of the respondents participated in off-farm activities. This suggests that household income diversification could help mitigate risk and vulnerability, often inherent in relying on farming as a livelihood strategy. Furthermore, 68% had savings from selling their produce in the previous cropping season. This suggests that a large portion of the surveyed households can generate surplus income from their farming activities and build a savings behaviour, potentially contributing to long-term financial resilience and the ability to invest in modern agricultural practices.

3.2 Diagnostic tests

3.2.1 Normality test for continuous variables

The normality test results for continuous variables are presented in the appendix (Table 6). The test indicates that skewness and kurtosis values mostly fall within the acceptable ranges of – 2 to 2 and 1 to 7, respectively, for a sample size greater than 300 [111–113]. This suggests that, aside from farm size, the distribution exhibits approximate asymmetry and moderate tails. The Shapiro-Wilk test indicates a statistically significant value for all variables, leading to rejection of the null hypothesis of normality. This apparent disparity from normality is likely attributed to the sensitivity of the Shapiro-Wilk test to minor deviations in large samples. In contrast, loan amount and farm size are presented with a marked skewness and kurtosis, indicating a pronounced right tail and a peaked distribution. Moreover, visual inspection of the histogram and normal distribution curve showed that age and household size were slightly skewed, necessitating a logarithmic transformation for subsequent analysis.

Table 3 Descriptive statistics for the independent dummy variables

Variables	Overall ($n=500$)		Participants ($n=200$)		Non-participants($n=300$)	
	N	%	*N*	%	*N*	%
Gender (1 = male, 0 = female)	330	66.000	149	74.500	181	60.330
Marital status (1 = married, 0 = otherwise)	395	79.000	177	88.500	218	72.670
Farm-labour participation (1 = full time, 0 = parttime)	488	97.600	197	98.500	291	97.000
Leadership role (1 = yes, 0 = no)	68	13.600	37	18.500	31	10.330
Accessed extension services (1 = yes, 0 = no)	146	29.200	99	49.500	47	15.670
SCGS awareness (1 = yes, 0 = no)	373	74.600	200	100	174	58.000
Land ownership for agricultural activities (1 = yes, 0 = no)	335	67.000	184	92.000	151	50.330
Membership in farm-based group (1 = yes, 0 = no)	220	44.000	129	64.500	91	30.330
Off-farm income (1 = yes, 0 = no)	214	42.800	83	41.500	131	43.670
Savings from the previous season (1 = yes, 0 = no)	339	67.800	138	69.000	201	67.000

3.2.2 Multicollinearity and heteroscedasticity tests

Building on the argument of [114–116], the study conducted a multicollinearity diagnostic test for explanatory variables used in the model. Specifically, the variance inflation factor (VIF) was estimated to evaluate the magnitude of multicollinearity. The diagnostic test revealed that, on average, the VIF value is 1.32, and all the explanatory variables had VIF values less than 5, indicating that multicollinearity was not a significant concern that could potentially compromise the validity of the regression results. Regarding heteroscedasticity, the result of the white test is not statistically significant (P-value 0.2540), implying that the error terms exhibit constant variance across the observations. Thus, there is no problem of heteroscedasticity in the model. Detailed results for the OLS model are presented in Table 7, and the results for multicollinearity and heteroscedasticity tests are presented in Table 8 in the appendix section.

3.3 Determinants of participation in the SCGS and levels of credit utilisation

Table 5 presents the estimates of the determinants of participation in the agricultural credit guarantee scheme and credit utilisation levels. The LR test results indicate that the double hurdle is appropriate for this data ($\lambda = 329.112$), which exceeds the chi-square value (${\chi^2}_{0.01,\,16} = 32.00$). Similarly, the results from the Heckman selection model support the validity of the double hurdle model, as the Inverse Mills Ratio is not statistically significant (p-value=0.190). The estimates from Tobit and Heckman selection models are presented for comparison and to assess the robustness of the findings. However, for the sake of brevity, the discussion focuses primarily on the double hurdle model. In empirical studies, econometric interpretation of limited dependent variable models has traditionally relied on marginal effects or model coefficients. However, [117] argued that using marginal effects can lead to confusion and inaccurate conclusions. Additionally, the author contends that reporting marginal effects requires fixing specific values, which limits their general usefulness to the readers. This study adopted standard model coefficients to interpret the results in light of this argument.

The findings indicate that ten variables significantly influence participation in the SCGS, while six variables determine credit utilisation levels. Specifically, socio-economic characteristics such as education level, household size and awareness positively affect participation in the SCGS, whereas off-farm income negatively determines participation. Age, education level and household size positively explain levels of credit utilisation. Moreover, farm-related characteristics such as land ownership for agricultural activities and rice farm size positively influence participation, while savings from the previous cropping season have a negative effect on participation. Additionally, rice farm size positively determined levels of credit utilisation. Furthermore, institutional characteristics such as access to extension service, frequency of contact with extension agents and membership in farm-based groups positively influenced participation in the SCGS. Regarding levels of credit utilisation, frequency of contact with extension agents and loan repayment period were found to be positively related to levels of credit utilisation. Notably, education level, household size, rice farm size and frequency of extension contacts jointly influence participation in the SCGS and credit utilisation levels.

Table 4 Mean difference between SCGS participants and non-participants for the continuous explanatory variables

Variable	Overall ($n=500$)	Participant($n=200$)	Non-participant($n=300$)	Difference
Age	40.758 (0.556)	42.295 (0.660)	39.733 (0.811)	2.562**
Education level	7.180 (0.114)	7.600 (0.152)	6.900 (0. 159)	0.700***
Household size	4.556 (0.088)	5.190 (0.137)	4.133 (0.108)	1.057***
Frequency of contact	2.027 (0.069)	2.090 (0.081)	1.898 (0.134)	0.192
Rice farm size	4.150 (0.166)	6.080 (0.339)	2.863 (0.108)	3.217***

Figures in parentheses are standard error for continuous variables

3.4 Discussion

The study indicates that the age of the household head positively influences the amount of credit borrowed for participants' households. This implies that older smallholder farmers with accumulated farming experience and asset base tend to borrow larger amounts of credit. The experience and resources accumulated by older farmers over the years can equip them with the ability to more effectively evaluate the risk and potential benefit associated with the credit guarantee scheme, allowing them to leverage large amounts of credit strategically to augment their farming activities. The finding gives credence to the findings by [51, 52], which reported a positive relationship between the age of the household head and credit uptake. The findings suggest that the SCGS should design targeted outreach strategies to facilitate participation among young farmers and develop tailored financing products to meet the needs of older and younger smallholder farmers.

The education level of the household head significantly influences smallholder farmers' decisions to participate in the SCGS and levels of credit utilisation. This suggests that smallholder farmers with more education can better understand the credit guarantee scheme's terms, conditions and requirements. Moreover, education empowers farmers with knowledge and the necessary skills to utilise credit more efficiently, resulting in loan repayment ability. Earlier studies also reported similar findings [61, 93, 108, 118]. Similarly, household size positively explains the decision to participate and credit utilisation levels. The plausible reason could be that a larger household requires more resources to meet the household consumption requirements. Since agriculture is the main economic activity for smallholder farmers, it requires investment in technologies that can increase productivity, necessitating them to participate in credit schemes programs. Moreover, a large household is prone to shocks such as droughts and floods that can lead to crop failure. Thus, adopting modern agricultural technologies that require financial resources is critical to mitigate vulnerability to economic shocks. This finding is consistent with [52, 118], who found that household size explains participation in the credit scheme and the borrowed amount.

Smallholder farmers' awareness about the SCGS significantly determines participation, but does not significantly explain the amount they borrowed. The result implies that smallholder farmers who are more informed about the program are more inclined to participate, yet their level of awareness does not necessarily translate into the credit amount. Additionally, the result suggests that by raising awareness about the SCGS,

Table 5 Determinants of participation in SCGS and levels of credit utilisation

Variable	Model 1: Tobit	Model 2: Double hurdle		Model 3: Heckman two steps	
		Probit	Truncated	Probit	Heckman
Gender	0.084 (0.077)	0.105 (0.195)	0.084 (0.088)	0.105 (0.185)	0.097 (0.093)
Marital status	− 0.082 (0.095)	0.148 (0.231)	− 0.082 (0.124)	0.148 (0.234)	− 0.048 (0.131)
Log age	0.546*** (0.161)	− 0.313 (0.313)	0.546*** (0.167)	− 0.313 (0.302)	0.476*** (0.181)
Farm labour participation	0.038 (0.257)	0.521 (0.509)	0.038 (0.288)	0.521 (0.512)	0.138 (0.306)
Education level	0.039** (0.017)	0.077** (0.031)	0.039** (0.018)	0.077** (0.035)	0.052** (0.021)
Log household size	0.169** (0.086)	0.410** (0.193)	0.169* (0.090)	0.410** (0.194)	0.220** (0.103)
Leadership role	0.046 (0.086)	0.142 (0. 223)	0.045 (0.088)	0.142 (0.219)	0.061 (0.096)
Extension services	− 0.077 (0.097)	0.845*** (0.277)	− 0.077 (0.095)	0.845 (0.287)	0.042 (0.139)
Frequency of contact with the extension agent	0.152*** (0.036)	0.148* (0.084)	0.152*** (0.037)	0.148* (0.089)	0.178*** (0.044)
SCGS awareness	0.714 (0.131)	2.189*** (0.531)	0.713 (0. 505)	2.189*** (0.388)	1.587** (0.784)
Land ownership	0.096 (0.100)	1.102*** (0.227)	0.096 (0.142)	1.102*** (0.218)	0.321 (0.226)
Log farm size	0.522*** (0.080)	0.600*** (0.143)	0.522*** (0.061)	0.600*** (0.147)	0.613*** (0.097)
Membership in farmer's group	0.042 (0.076)	0.914*** (0.166)	0.042 (0. 075)	0.915*** (0.167)	0.198 (0.146)
Off-farm income	0.088 (0.083)	− 0.422** (0.189)	0.088 (0.086)	− 0.422** (0.176)	0.014 (0.108)
Savings from the previous season	− 0.011 (0.078)	− 0.723*** (0.189)	− 0.011 (0.079)	− 0.723*** (0.191)	− 0.111 (0.116)
Loan repayment period	0.144*** (0. 012)		0.144*** (0. 017)		0.144 (0.017)
Constant	8.536*** (0.704)	− 4.425*** (1.259)	8.536*** (0.883)	− 4.425*** (1.356)	7.016*** (1.452)
N	200	500	200	500	500
Log pseudolikelihood	− 135.88	− 164.556	− 135.88	− 164.556	
F (16,184)	213.72***				
Wald $\chi^2(16)$		103.96***	440.200***	103.96***	301.790***
Pseudo R^2	0.461	0.511		0.511	
IMR					0.392 (0.298)
P-value (IMR)					0.190
χ^2 (16) at 1%	32.00				
λ	329.112				

*Note. *, **, *** Indicates significance at 10%, 5%, and 1% levels, respectively. Standard errors are reported in parentheses*

smallholder rice farmers are more likely to participate. The insignificant result on the amount of credit indicates that even if smallholder farmers are well informed about the guarantee scheme, their ability to borrow larger amount may still be constrained by their overall financial standings and lenders' risk assessment. Likewise, [35, 40] argued that farmers' awareness and knowledge of the credit guarantee scheme positively explain their decision to participate in the agricultural credit guarantee scheme.

The findings revealed that household off-farm income is negatively related to participation in the SCGS. Conversely, the relationship between off-farm income and the amount of credit borrowed is positive but insignificant. This suggests that smallholder farmers with off-farm income may be less likely to participate in the SCGS because of an alternative source of funding to finance their farming enterprises. Moreover, smallholder farmers with off-farm income possibly possess sufficient collateral as sought by lending institutions, enabling them to directly access credit from financial institutions without resorting to a guarantee scheme. Notably, once the smallholder farmers participate in the credit guarantee scheme, their levels of off-farm income do not significantly explain the loan amount they can obtain. Similar findings have been reported by [119]. However, this result is contrary to that of [51, 120, 121] who reported that off-farm income positively influences smallholder farmers' decision to participate in agricultural credit. Moreover, [22] found that off-farm income jointly explains participation in agricultural credit and the amount of loan borrowed.

Regarding farm-related factors, land ownership significantly influences participation in the SCGS. This finding suggests that smallholder rice farmers who own land are more likely to participate in the credit support scheme, as land ownership provides a stable asset that can be used as collateral, enhancing their creditworthiness. Additionally, land ownership gives farmers a sense of security, motivating participation in the credit support program and utilising credit to make long-term investments in their farming enterprises. Similar findings have been reported by [67, 93]. Moreover, rice farm size explains jointly participation and levels of credit utilisation. The finding suggests that smallholder farmers with large rice farm size may be able to generate more revenue and demonstrate a stronger repayment capacity, which can increase their eligibility and appeal to lenders. Furthermore, smallholder farmers with large rice farms may have a greater need for credit to purchase farm inputs and other agricultural machinery. Additionally, the large rice farm size may be associated with more established and diversified agricultural enterprises, providing farmers with a strong financial base and a record of successful farming operations. This can further enhance their creditworthiness and willingness to participate in the credit guarantee scheme. They may feel more confident in utilising the borrowed funds more effectively and repay the loans on time. The result is supported by [51, 67, 96, 108, 122].

Savings from the previous cropping season negatively determined smallholder farmers' decision to participate in the SCGS, but not the amount of credit they can borrow. This result suggests that farmers with higher savings from their production may possess a greater financial buffer and sense of security, viewing the SCGS as less pressing a financial need. However, once they decided to participate, their savings levels did not significantly explain the loan amount they could borrow. This result underscores the importance of considering the manifold nature of smallholder farmers' financial decision-making and resource allocation when designing and implementing agricultural credit enhancement initiatives. This result contradicts the findings by [123] who found that voluntary saving positively explains smallholder farmers' credit scheme participation.

Extension service positively determined the decision to participate in the SCGS. This result suggests that smallholder farmers who had contact with an extension agent are likely to access information about the availability of the credit guarantee scheme,

eligibility requirements and the application process. Additionally, the extension service provides valuable guidance on participation in credit support programs and using acquired credit for agricultural activities. Furthermore, in rural areas, extension services could be the primary source of financial literacy for smallholder farmers and the agribusiness skills needed to manage financial resources responsibly. The results are consistent with those of [17, 51, 100, 124] who reported a positive relationship between extension contact and participation in credit programs. However, the finding is contrary to [123] who found that extension services negatively determined participation in the agricultural credit support program. The frequency of extension contacts significantly explains the decision to participate and credit utilisation levels. The finding suggests that extension support is pivotal in enabling smallholder farmers to manage credit resources effectively. Moreover, this implies that the number of extension contacts facilitates and empowers smallholder farmers' decision to participate in the SCGS and the amount of credit to borrow. This finding gives credence to the results of [19, 51, 60] who argued that the frequency of extension contacts is positively related to participation in credit programs and the loan amount.

Membership in farm-based groups significantly influences participation in the SCGS. This result underscores the importance of collective action and social capital in enhancing the financial capabilities of the smallholder farmers. Membership in farm-based groups can confer several benefits that facilitate greater credit access to smallholder farmers. These groups often serve as important channels for information dissemination, collective negotiation and resource aggregation. Additionally, through these groups, smallholder farmers can acquire valuable knowledge about the SCGS and learn from the experience of their peers. Moreover, farmer-based groups can serve as a form of social collateral, demonstrating to lenders and guarantee providers that farmers belong to a cohesive and reliable group. Furthermore, these groups can pool their resources and enhance the bargaining power of their members, enabling them to negotiate better terms and conditions with financial institutions. The collective bargaining can lead to a more flexible loan repayment schedule, making it more feasible for smallholder farmers. This result is in tandem with earlier studies [8, 66, 93, 94, 97, 125].

Furthermore, the study found that the loan duration positively relates to the credit utilisation levels. This result indicates that an increase in the loan repayment period influences smallholder farmers to borrow larger loan amount. The result demonstrates that a more flexible repayment schedule that aligns with the rice farming cycles is crucial for smallholder farmers' decisions on the amount of credit to borrow. Therefore, the result underlines the significance of designing the guarantee scheme with an appropriate repayment period that aligns with smallholder farmers' financial situation and credit needs. Furthermore, a more extended repayment period can equip smallholder farmers with flexibility during unanticipated shocks, enabling them to sustain consistent loan repayment. This finding is in line with the findings by [92] who reported that the loan repayment period is a key determinant of the amount of loan borrowed by smallholder farmers.

4 Conclusion and policy implications

4.1 Conclusion

The purpose of the Smallholder Agricultural Credit Guarantee Scheme (SCGS) was to facilitate access to credit for smallholder farmers, which has the potential to enhance food production and agricultural productivity in Tanzania. This study found no evidence of sample selection bias in participation in the SCGS, as indicated by the insignificant Inverse Mills Ratio in the Heckman two-step model (p-value = 0.190). Therefore, a double hurdle model was employed to analyse the determinants of participation in the SCGS and credit utilisation levels.

The study concludes that SCGS is an important policy instrument in improving access to agricultural credit and credit utilisation levels. Moreover, the study concludes that socio-economic characteristics, farm-level attributes and institutional factors are the major drivers of participation in the SCGS. Specifically, positive determinants of participation in the SCGS were education level, household size, SCGS awareness, land ownership, rice farm size, extension services, frequency of extension contacts and membership in farm-based groups. However, off-farm income and savings from the previous cropping season negatively influence participation, suggesting that households with alternative income sources may have less demand for credit support services. Furthermore, the study concludes that the socio-economic, farm-level and institutional variables influence credit utilisation levels. Particularly, age, education level, household size, rice farm size, frequency of extension contacts and loan repayment period positively affect credit utilisation levels.

Additionally, the study concludes that education level, household size, rice farm size and frequency of extension contacts jointly influenced participation in the SCGS and credit utilisation levels. These findings highlight that farmers with higher levels of education better understand the conditions and terms of the credit, evaluate potential benefits and risks and make informed decisions on participation and levels of credit utilisation. Household size and farm size are resource-related factors, where larger households may indicate labour availability and potential repayment capacity, while farm size can serve as collateral, thereby enhancing participation and levels of credit utilisation. Moreover, findings suggest that the frequency of extension contacts enhances smallholder farmers' knowledge of credit and confidence in managing the credit resources.

Finally, this study concludes that none of the variables jointly influenced both participation and levels of credit utilisation negatively. However, there are some variations in the determinants of participation and credit utilisation levels. In particular, extension services, SCGS awareness, membership in farmer-based groups, and land ownership significantly influence participation, but not credit utilisation levels. In contrast, age positively influences credit utilisation levels but not participation in the SCGS. These results suggest that interventions aimed at improving participation in the SCGS should prioritise education and awareness about the scheme, support land access, strengthen extension services, and promote membership in farm-based groups. Efforts to enhance credit utilisation levels should focus on education, frequency of extension contact and loan repayment period.

4.2 Policy implications

In light of these findings, we recommend the targeted policy interventions. The fact that the socio-economic, farm-level and institutional factors influenced both participation and levels of credit utilisation, policy measures to enhance participation in the SCGS should prioritise education, awareness about the scheme, supporting land access, strengthening extension services and promoting membership in farm-based groups. Efforts to increase credit utilisation levels should focus on smallholder farmers' education, age, frequency of extension contacts and loan repayment period.

The policy measures can be achieved in several ways:

- Targeted outreach initiatives are needed to enhance smallholder farmers' understanding of the SCGS's benefits.
- The design of extension services should prioritise financial literacy and effective credit utilisation. Mobile-based extension services should be adopted to complement in-person visits, thereby enhancing outreach to a broader number of smallholder farmers.
- There is a need to design loan products tailored to the specific needs of different demographic groups.
- Smallholder farmers need to be encouraged to join farm-based groups, which provide platforms for collective bargaining and shared resources.
- Financial institutions should design loan products tailored to specific crop cycles, enabling smallholder farmers to utilise credit support services fully.
- To address the opportunity cost of off-farm income and savings, the government and stakeholders could offer bundled services such as guaranteed market access, making SCGS more attractive to smallholder farmers with alternative financial resources.

4.3 Limitations of the study

This study was conducted in the Usheti and Iringa districts councils in Shinyanga and Iringa regions in Tanzania and focused on smallholder rice farmers; thus, the findings may not fully represent smallholder rice farmers in other districts with varying ecological, social and economic conditions. Moreover, the study only focused on socio-economic, farm-level and some institutional characteristics, but did not account for psychological and behavioural factors, climatic-related factors and market access. Furthermore, the study relied on survey cross-sectional data and self-reported information, which may be subject to recall bias. To mitigate this limitation, the study employed well-trained enumerators who were conversant with the local language to probe respondents on the areas they had difficulty recalling.

4.4 Areas for future studies

A similar study can be conducted in other regions of Tanzania and on different crops not covered in this study. Other studies could examine the role of innovative financing mechanisms, such as digital banking and mobile money, in improving participation in the SCGS and credit utilisation levels, especially among marginalised smallholder farmers. Future studies could explore the impact of the credit guarantee scheme on farm productivity and household welfare.

Appendix

See Tables 6, 7, 8.

Table 6 Normality test

Variable	Mean	SD	Skewness	Kurtosis	Shapiro-wilk test
Loan amount	2207000	2481095	3.1436	15.7128	0.6637***
Loan period in Months	8.5700	2.2980	0.4415	1.7389	0.9669***
Age	40.7200	12.3118	0.7501	2.8959	0.9467***
Education in years	7.1800	2.5551	-0.0286	6.8480	0.9674***
Household size	4.556	1.9633	0.5046	3.3653	0.9839***
Farm size	4.1500	3.7132	2.7947	13.2997	0.7298***

***, **, * Indicates significance at 1%, 5%, and 10% levels, respectively.

Table 7 Results for the OLS regression

Variables	coefficients	Standard errors
Gender	0.0841	0.0915
Marital status	− 0.0823	0.1293
Log age	0.5463***	0.1748
Farm labour participation	0.0379	0.3013
Education level	0.0395**	0.0183
Log household size	0.1698*	0.0946
Leadership role	0.0455	0.0923
Extension services	0.0766	0.0993
Frequency of contact with extension agent	0.1524***	0.0387
SCGS awareness	0.7139	0.5278
Ownership of agricultural land	0.0958	0.1483
Log farm size	0.5223***	0.0639
Membership in farmer's group	0.0422	0.0787
Off-farm income	0.0883	0.0900
Savings from the previous season	− 0.0108	0.0833
Loan repayment period	0.1435***	0.0177
Constant	8.5360***	0.9233
F (16, 183)	25.17	Prob > F = 0.0000
R-squared	0.6876	
Adj R-squared	0.6603	

Table 8 Test for multicollinearity and heteroscedasticity

Variable	Variance inflation factor (VIF)	Tolerance value(1/VIF)
Gender	1.28	0.7831
Marital status	1.37	0.7314
Log age	1.19	0.8393
Farm labour participation	1.08	0.9278
Education level	1.25	0.8005
Log household size	1.37	0.7313
Leadership role	1.03	0.9700
Extension services	1.65	0.6068
Frequency of contact with extension agent	1.70	0.5876
SCGS awareness	1.11	0.9002
Ownership of agricultural land	1.30	0.7691
Log farm size	1.51	0.6608
Membership in farmer's group	1.14	0.8984
Off-farm income	1.58	0.6328
Savings from the previous season	1.19	0.8384
Loan repayment period	1.32	0.7559
Mean	1.32	

Table 8 Test for multicollinearity and heteroscedasticity

Variable	Variance inflation factor (VIF)	Tolerance value(1/VIF)
White test-chi2(115)	124.63	Prob > chi2 = 0.2540

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Author contributions
M.S: Conceptualization, Data collection, Writing-original draft, review & editing, Methodology, Formal analysis. M.M: Conceptualization, Methodology, Review & editing, Supervision.

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Data availability
The data supporting the findings of this study are available upon request from the corresponding author. In order to protect the privacy of the participants, the data are not publicly available.

Declarations

Ethics approval and consent to participate
Ethical clearance for this study was formally approved by the University of Pretoria Research Ethics Committee (Approval number NAS097/2024), ensuring the protection of participants' rights and confidentiality. The study was conducted in accordance with relevant ethical guidelines and regulations. Throughout the data analysis and reporting process, the anonymity of participants' identities was rigorously maintained. Furthermore, verbal informed consent was obtained from all participants prior to their involvement in the study, as this was deemed most appropriate given the rural settings and literacy levels of the smallholder farmers involved. All participants were adults aged 18 years and above, and were fully informed about the purpose of the study before providing their consent, which the researcher documented.

Competing interests
The authors declare no competing interests.

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Not applicable.

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References

1. Milheiras SG, Sallu SM, Loveridge R, Nnyiti P, Mwanga L, Baraka E, Lala M, Moore E, Shirima DD, Kioko EN. Agroecological practices increase farmers' well-being in an agricultural growth corridor in Tanzania. Agron Sustain Dev. 2022;42(4):56.
2. Giller KE. The food security conundrum of sub-Saharan Africa. Glob Food Sec. 2020;26: 100431.
3. Van Dijk M, Morley T, Rau ML, Saghai Y. A meta-analysis of projected global food demand and population at risk of hunger for the period 2010–2050. Nature Food. 2021;2(7):494–501.
4. Gayo L, Ngongolo K. Fostering resilience: women and youth leading agroforestry for enhanced food security and poverty alleviation in Dodoma district, Tanzania. Afr Geogr Rev. 2024;8:1–15.
5. World Bank G. Tanzania agriculture public expenditure review. Singapore: World Bank; 2022.
6. Koricho MG, Ahmed MH. The impact of credit on the technical efficiency of food crop producing smallholder farmers in Ethiopia. Agric Financ Rev. 2022;82(5):847–56.
7. Yadav IS, Rao MS. Agricultural credit and productivity of crops in India: field evidence from small and marginal farmers across social groups. J Agribus Dev Emerg Econ. 2022;8:6.
8. Amponsah D, Awunyo-Vitor D, Wongnaa CA, Prah S, Sunday OA, Acheampong PP. The impact of women groundnut farmers' participation in Village Savings and Loans Association (VSLA) in Northern Ghana. J Agric Food Res. 2023;11:520.
9. Assouto AB, Houngbeme DJ-L. Access to credit and agricultural productivity: Evidence from maize producers in Benin. Cogent Econ Finan. 2023;11(1):2196856.
10. Ding Z, Fan X, Agbenyo W. Do low-income households inevitably benefit more from microfinance participation? Evidence from rural China. J Asia Pacific Econ. 2023;8:1–23.
11. Kapari M, Hlophe-Ginindza S, Nhamo L, Mpandeli S. Contribution of smallholder farmers to food security and opportunities for resilient farming systems. Front Sustain Food Syst. 2023;7:1149854.
12. Wang Y, Xu Y, Chen W. Study on the Relationship between agricultural credit, fiscal support, and farmers' income—empirical analysis based on the PVAR model. Sustainability. 2023;15(4):3173.
13. World Bank, G., International Finance Corporation. Working with Smallholders: A Handbook for Firms Building Sustainable Supply Chains (Third Edition). Washington, DC: World Bank; 2023. https://doi.org/10.1596/.2023,WorldBank.

14. The impact of agricultural cooperatives membership on the wellbeing of smallholder farmers: empirical evidence from eastern Ethiopia | Agricultural and Food Economics | Full Text.
15. Chandio AA, Ozdemir D, Vigne SA, Du AM. Towards sustainable agricultural development and food security in East Asia: The role of broad money and banking credits. Int Rev Econ Financ. 2024;96: 103677.
16. Wanzala RW, Marwa N, Lwanga EN. Impact of agricultural credit on coffee productivity in Kenya. World Dev Sustain. 2024;5.
17. Balana BB, Oyeyemi MA. Agricultural credit constraints in smallholder farming in developing countries: Evidence from Nigeria. World Dev Sustain. 2022;1.
18. Ralph Essem N, Charles KDA. The impact of credit on productivity of smallholder farmers in Ghana. 2020.
19. Chandio AA, Jiang Y, Rehman A, Akram W. Does formal credit enhance sugarcane productivity? A farm-level Study of Sindh, Pakistan. SAGE Open. 2021;11(1):2158244020988533.
20. Khan FU, Nouman M, Negrut L, Abban J, Cismas LM, Siddiqi MF. Constraints to agricultural finance in underdeveloped and developing countries: a systematic literature review. Int J Agric Sustain. 2024;22(1):2329388.
21. Balana BB, Mekonnen D, Haile B, Hagos F, Yimam S, Ringler C. Demand and supply constraints of credit in smallholder farming: Evidence from Ethiopia and Tanzania. World Dev. 2022;159: 106033.
22. Cherotich J, Sibiko KW, Ayuya OI. Analysis of extent of credit access among women farm-entrepreneurs based on membership in table banking (TB). Agric Financ Rev. 2022;82(1):89–112.
23. Asiseh F, Ng'ombe JN, Quaicoe O, Vorsah R, Prah S. Are credit doors equally open? Gender perspectives on agricultural credit access in Sub-Saharan Africa. Rev Dev Econ. 2024;8:6.
24. Choudhury A, Jones J, Opare-Addo M. Perceived risk and willingness to provide loan to smallholder farmers in Ghana. J Afr Bus. 2022;23(1):23–40.
25. Balana B, Mekonnen DK, Haile B, Hagos F, Yiman S, Ringler C. Are smallholder farmers credit constrained? Evidence on demand and supply constraints of credit in Ethiopia and Tanzania. Intl Food Policy Res Inst. 1974;2020:8.
26. Mukasa AN, Simpasa AM, Salami AO. Credit constraints and farm productivity: Micro-level evidence from smallholder farmers in Ethiopia. Afr Dev Bank. 2017;247:1–40.
27. Lemecha ME. Credit constraint and agricultural technology adoptions: evidence from Ethiopia. Agric Finan Rev. 2023.
28. Mulume Bonnke S, Dontsop Nguezet PM, Nyamugira Biringanine A, Jean-Jacques MS, Manyong V, Bamba Z. Farmers' credit access in the Democratic Republic of Congo: empirical evidence from youth tomato farmers in Ruzizi plain in South Kivu. Cogent Econ Finan. 2022;10(1):2071386.
29. Cusmano L. SME and Entrepreneurship Financing: The Role of Credit Guarantee Schemes and Mutual Guarantee Societies in supporting finance for small and medium-sized enterprises. 2018.
30. Reuben J, Nyam CM, Rukwe DT. Agricultural credit guarantee scheme fund and its effect on agricultural output in Nigeria. Rev Agric Appl Econ (RAAE). 2020;23(2):102–11.
31. Mammadov EM, Belov A, Svistun L. Role of partial credit guarantee scheme in enabling growth of SME. in International Conference BUILDING INNOVATIONS. 2022. Springer.
32. Crawford J, Cui Z-YA, Kewley D. Government finance, loans, and guarantees for small and medium enterprises (SMEs) (2000–2021): A systematic review. J Small Bus Manage. 2024;62(5):2607–37.
33. Gurmessa NE, Ndinda C, Agwanda C, Akiri M. Partial credit guarantee and financial additionality for smallholders coffee cooperatives: experience from Ethiopia. Dev Pract. 2022;32(8):1049–62.
34. Yu J, Peng F, Shi X, Yang L. Impact of credit guarantee on firm performance: Evidence from China's SMEs. Econ Anal Policy. 2022;75:624–36.
35. Li G, Jia X, Khan AA, Khan SU, Ali MAS, Ali M, Luo J. Role of agricultural credit guarantee policies in encouraging green agricultural development: farmers' perspectives and responses, and the regulatory function of household capital. Environ Sci Pollut Res. 2023;30(24):66314–27.
36. Cowling M, Kacer M, Wilson N. The demand for loan guarantees in the UK 1981–2018: time series analysis. Appl Econ Lett. 2024;8:1–5.
37. Song P, Zhang H, Zhao Q. Innovative credit guarantee schemes with equity-for-guarantee swaps. Int Rev Financ Anal. 2021;77: 101809.
38. Zhang C. Enhancing agricultural credit guarantees in China's Agricultural value chain through relationship contracts: a study on risk prevention mechanisms. J Knowl Econ. 2024;8:1–20.
39. Yoshino N, Taghizadeh-Hesary F. Optimal credit guarantee ratio for small and medium-sized enterprises' financing: Evidence from Asia. Econ Anal Policy. 2019;62:342–56.
40. Li G, Jia X, Khan AA, Khan SU, Ali MAS, Luo J. Does green finance promote agricultural green total factor productivity? Considering green credit, green investment, green securities, and carbon finance in China. Environ Sci Pollut Res. 2023;30(13):36663–79.
41. Liu Y, Ji D, Zhang L, An J, Sun W. Rural financial development impacts on agricultural technology innovation: evidence from China. Int J Environ Res Public Health. 2021;18(3):1110.
42. Girma Y. Credit access and agricultural technology adoption nexus in Ethiopia: A systematic review and meta-analysis. J Agric Food Res. 2022;10:100362.
43. Regassa MD, Degnet MB, Melesse MB. Access to credit and heterogeneous effects on agricultural technology adoption: Evidence from large rural surveys in Ethiopia. Can J Agric Econ. 2023;71(2):231–53.
44. Rayhan SJ, Rahman MS, Lyu K. The role of rural credit in agricultural technology adoption: The case of Boro rice farming in Bangladesh. Agriculture. 2023;13(12):2179.
45. Ruzzante S, Labarta R, Bilton A. Adoption of agricultural technology in the developing world: A meta-analysis of the empirical literature. World Dev. 2021;146: 105599.
46. Teye ES, Quarshie PT. Impact of agricultural finance on technology adoption, agricultural productivity and rural household economic wellbeing in Ghana: a case study of rice farmers in Shai-Osudoku District. S Afr Geogr J. 2022;104(2):231–50.
47. Shano BK, Waje SS. Understanding the heterogeneous effect of microcredit access on agricultural technology adoption by rural farmers in Ethiopia: A meta-analysis. Heliyon. 2024;10(16): e35859.
48. Nigus G, Ketema M, Haji J, Sileshi M. Determinants of adoption of urban agricultural practices in eastern Haraghe zone of Oromia region and Dire Dawa City administration, eastern Ethiopia. Heliyon. 2024;10(4): e26758.

49. Alemayehu S, Ayalew Z, Sileshi M, Zeleke F. Determinants of the adoption of climate smart agriculture practices by smallholder wheat farmers in northwestern Ethiopia. Heliyon. 2024;10(13): e34233.
50. Nakano Y, Magezi EF. The impact of microcredit on agricultural technology adoption and productivity: Evidence from randomized control trial in Tanzania. World Dev. 2020;133: 104997.
51. Kyire SKC, Bannor RK, Kuwornu JK, Oppong-Kyeremeh H. Credit access and intensity of borrowing by irrigated rice farmers in Ghana: the role of extension services. J Agribus Dev Emerg Econ. 2023;8:9.
52. Wongnaa CA, Abudu A, Abdul-Rahaman A, Ennin JA, Awunyo-Vitor D. Awareness and participation in input credit scheme: evidence from smallholder rice farmers in Ghana's North East region. J Enterpris Commun. 2023;17(6):1388–409.
53. Yeasmin S, Haque S, Adnan KM, Parvin MT, Rahman MS, Rahman KM, Salman M, Hossain ME. Factors influencing demand for, and supply of, agricultural credit: A study from Bangladesh. J Agric Food Res. 2024;16.
54. Zhang Y, Huang Y, Zhang F, Tang Z. Effects of formal credit on pastoral household expense: evidence from the Qinghai-Xizang Plateau of China. J Integr Agric. 2024;23(5):1774–85.
55. Ding Z, Fan X, Agbenyo W. Do low-income households inevitably benefit more from microfinance participation? Evidence from rural China. J Asia Pac Econ. 2024;29(4):2087–109.
56. Hinkosa B. Determinants of adoption of female headed household in microfinance program: a case study on Oromia Credit and Saving Share Company (OCSSCO) in Guto Gida district, Ethiopia. J Innov Entrepr. 2023;12(1):82.
57. Matsvai S. Determinants of Microfinance Demand (Evidence from Chiredzi Smallholder Resettled Sugarcane Farmers in Zimbabwe). Sustainability. 2024;16(22):9752.
58. Adams F, Ullah A, Mensah A, Prah S, Rahman SA. Enhancing sustainable agriculture: exploring the impact of credit access on cocoa farming through adoption of artificial hand pollination technology. Environ Dev Sustain. 2025;8:1–32.
59. Anang BT, Dagunga G. Farm household access to agricultural credit in Sagnarigu municipal of Northern Ghana: application of Cragg's double hurdle model. J Asian Afr Stud. 2024;59(8):2449–60.
60. Moahid M, Maharjan KL. Factors affecting farmers' access to formal and informal credit: evidence from rural Afghanistan. Sustainability. 2020;8:9.
61. Mafirakurewa T, Mushunje A, Zantsi S. Factors influencing smallholder farmers' decisions to participate in loan-based farming in Mutare District, Zimbabwe—a double-hurdle model approach. Agriculture. 2023;13(12):2225.
62. Kumar A, Das R, Bathla S, Jha GK. Agric Finan Rev. 2021;81(2):250–64.
63. Kehinde AD, Ogundeji AA. The simultaneous impact of access to credit and cooperative services on cocoa productivity in South-western Nigeria. Agric Food Secur. 2022;11:1.
64. Nanyonjo G, Nchanji E. Seed credit model in Uganda": Participation and empowerment dynamics among smallholder women and men farmers. Glob Food Sec. 2023;39: 100720.
65. Ingutia R, Sumelius J. Does cooperative membership facilitate access to credit for women farmers in rural Kenya? J Agric Food Res. 2024;18.
66. Jumpah ET, Osei-Asare Y, Tetteh EK. Do farmer and credit specific characteristics matter in microfinance programmes' participation? Evidence from smallholder farmers in Ada west and east districts. Agric Financ Rev. 2019;79(3):353–70.
67. Yeboah EA, Balcombe K, Asante BO, Prah S, Aidoo R. Does participation in innovation platform improve welfare? Insights from smallholder maize farmers in Ghana. Afr J Sci Technol Innov Dev. 2024;16(2):182–94.
68. Missiame A, Irungu P, Nyikal RA, Appiah-Kubi GD. Adoption of rural bank credit programs among smallholder farmers in Ghana: an average treatment effect estimation of rates of exposure and adoption and their determinants. Agric Financ Rev. 2022;82(1):169–82.
69. Wetengere K, Kihongo V. Constraints in accessing credit facilities for rural areas: the case of fish farmers in rural Morogoro. Tanz J Appl Aquacult. 2012;24(2):107–17.
70. Twine EE, Rao EJ, Baltenweck I, Omore AO. Are technology adoption and collective action important in accessing credit? Evidence from milk producers in Tanzania. Eur J Dev Res. 2019;31:388–412.
71. Israel GD. Determining sample size. 1992.
72. Yesuph DS, Wordofa MG, Tefera TL. Determinants of exotic poultry breeds adoption by smallholder farmers in Gibe district, Hadiya zone, Ethiopia. Heliyon. 2024;10(17): e37006.
73. Ngeno V. Adoption of dairy feed technology and its impact on smallholder farmers' income and poverty in Kenya's southwestern region. Sci Afr. 2024;23:e3015.
74. Wongnaa CA, Prah S, Austin SA, Agyei Amponsah E, Achina C, Aban Ekow D, Mazzola IH, Tweneboa Kwaku S. Consumption patterns of organic vegetable consumers in Ghana. Clean Respons Consump. 2024;12.
75. Bosompem M, Arhin P, Nunoo J, Amoah KK. Smallholder farmers' participation in Cassava value addition practices: What drivers matter in Ghana? J Agric Food Res. 2024;16.
76. Kitole FA, Mkuna E, Sesabo JK. Digitalization and agricultural transformation in developing countries: Empirical evidence from Tanzania agriculture sector. Smart Agric Technol. 2024;7.
77. Kehinde A, Ojo T, Ogunleye A, Ogundeji A. Impact of access to cash remittances on cocoa yield in Southwestern Nigeria. Sustainable Futures. 2024;7: 100168.
78. Encalada D, Castro LM, Cabrera O, Ramón P, Reyes-Bueno F, Paul C. Factors influencing the expressed willingness to transition from collection to cultivation of non-timber forest products: The case of Caesalpinia spinosa in southern Ecuador. Forest Policy Econ. 2025;170: 103366.
79. Chakraborty P, Mahanta A. The role of financial and physical assets as substitute or complementary to land as collateral in credit market: Evidence from Indian households. Econ Syst. 2024;48(2): 101182.
80. Adamu A-J, Nangena MM, Anang BT. Welfare effects of agricultural extension in the sudan savanna of Ghana. World Dev Sustain. 2023;3.
81. Omotayo AO, Aremu AO. How does the decision to cultivate underutilized crops influence food and nutrition security in rural areas? J Agric Food Res. 2024;18.
82. Burke WJ. Evidence against imposing restrictions on hurdle models as a test for simultaneous versus sequential decision making. Am J Agr Econ. 2019;101(5):1473–81.
83. García B. Implementation of a double-hurdle model. Stand Genom Sci. 2013;13(4):776–94.
84. Kelifa A. Review of Tobit, Heckman and double hurdle econometric models: supported with evidences from the studies conducted in Ethiopia. SN Bus Econ. 2023;3(6):104.

85. Mabuza ML, Ortmann G, Wale E. Effects of transaction costs on mushroom producers' choice of marketing channels: implications for access to agricultural markets in Swaziland. South Afr J Econ Manag Sci. 2014;17(2):207–19.
86. Rufino CC. Microeconometric analysis of the eating-out behavior of modern Filipino households: the Tobit, the Craggit and the Heckit models. DLSU Bus Econ Rev. 2016;26(1):50–69.
87. Cragg JG. Some statistical models for limited dependent variables with application to the demand for durable goods. Econometrica. 1971;8:829–44.
88. Cameron A. Microeconometrics: methods and applications. Cambridge: Cambridge University; 2005.
89. Wooldridge JM. Econometric analysis of cross section and panel data. Cambridge: MIT Press; 2010.
90. Verbeek M. A guide to modern econometrics. New York: John Wiley & Sons; 2017.
91. Dawuni P, Mabe FN, Tahidu OD. Effects of village savings and loan association on agricultural value productivity in Northern Region of Ghana. Agric Financ Rev. 2021;81(5):657–74.
92. Falola A, Mukaila R, Abdulhamid KO. Informal finance: its drivers and contributions to farm investment among rural farmers in Northcentral Nigeria. Agric Financ Rev. 2022;82(5):942–59.
93. Ankrah Twumasi M, Jiang Y, Osei Danquah F, Chandio AA, Agbenyo W. The role of savings mobilization on access to credit: a case study of smallholder farmers in Ghana. Agric Finan Rev. 2020;80(2):275–90.
94. Nhliziyo N, Mushunje A. Determinants of Small-Scale Farmers' Participation in Social Capital Networks to Enhance Adoption of Climate Change Adaptation Strategies in OR Tambo District, South Africa. Agriculture. 2024;14(3):441.
95. Ayesu EK. Empirical determinants of traders access to credit in Ghana: does educational literacy level matter? Economics Literature. 2020;2(1):57–70.
96. Ameh M, Lee SH. Determinants of loan acquisition and utilization among smallholder Rice Producers in Lagos State, Nigeria. Sustainability. 2022;14(7):3900.
97. Silong AKF, Gadanakis Y. Credit sources, access and factors influencing credit demand among rural livestock farmers in Nigeria. Agric Financ Rev. 2020;80(1):68–90.
98. Kiros S, Meshesha GB. Factors affecting farmers' access to formal financial credit in Basona Worana district, North Showa zone, Amhara regional state, Ethiopia. Cogent Economics & Finance. 2022;10(1):2035043.
99. Motsoari C, Cloete PC, van Schalkwyk HD. An analysis of factors affecting access to credit in Lesotho's smallholder agricultural sector. Dev South Afr. 2015;32(5):592–602.
100. Osei TA, Donkoh SA, Ansah IGK, Awuni JA, Cobbinah MT. Agricultural value chain participation and farmers' access to credit in northern Ghana. Agric Financ Rev. 2023;83(4/5):800–20.
101. Chisasa J. Determinants of access to bank credit by smallholder farmers: evidence from South Africa. Academy of Accounting and Financial Studies Journal. 2019;23(4):1–10.
102. Nasereldin YA, Chandio AA, Osewe M, Abdullah M, Ji Y. The credit accessibility and adoption of new agricultural inputs nexus: Assessing the role of financial institutions in Sudan. Sustainability. 2023;15(2):1297.
103. Kofarmata YI, Danlami AH. Determinants of credit rationing among rural farmers in developing areas: Empirical evidence based on micro level data. Agric Financ Rev. 2019;79(2):158–73.
104. Mehedi S, Rahman H, Jalaludin D. The relationship between corporate governance, corporate characteristics and agricultural credit supply: evidence from Bangladesh. Int J Soc Econ. 2020;47(7):867–85.
105. Bairagi S, Mottaleb KA. Participation in farmers' organization and production efficiency: empirical evidence from smallholder farmers in Bangladesh. Journal of Agribusiness in Developing and Emerging Economies. 2021;11(2):73–87.
106. Odhiambo FO, Upadhyaya R. Flexible loans and access to agricultural credit for smallholder farmers in Kenya. Agric Financ Rev. 2021;81(3):328–59.
107. Diamoutene AK, Jatoe JBD. Access to credit and maize productivity in Mali. Agric Financ Rev. 2021;81(3):458–77.
108. Dang HD, Dam AHT, Pham TT, Nguyen TMT. Determinants of credit demand of farmers in Lam Dong, Vietnam: A comparison of machine learning and multinomial logit. Agric Financ Rev. 2019;80(2):255–74.
109. Siaw A, Jiang Y, Ankrah Twumasi M, Agbenyo W, Ntim-Amo G, Osei Danquah F, Ankrah EK. The ripple effect of credit accessibility on the technical efficiency of maize farmers in Ghana. Agric Finan Rev. 2021;81(2):189–203.
110. Nguyen T-T, Nguyen TT, Grote U. Credit, shocks and production efficiency of rice farmers in Vietnam. Econ Anal Policy. 2023;77:780–91.
111. Curran PJ, West SG, Finch JF. The robustness of test statistics to nonnormality and specification error in confirmatory factor analysis. Psychol Methods. 1996;1(1):16.
112. Ryu E. Effects of skewness and kurtosis on normal-theory based maximum likelihood test statistic in multilevel structural equation modeling. Behav Res Methods. 2011;43:1066–74.
113. West SG, Finch JF, Curran PJ. Structural equation models with nonnormal variables: Problems and remedies. 1995.
114. Alin A. Multicollinearity. Wiley interdisciplinary reviews: computational statistics. 2010;2(3):370–4.
115. Midi H, Sarkar SK, Rana S. Collinearity diagnostics of binary logistic regression model. Journal of interdisciplinary mathematics. 2010;13(3):253–67.
116. Thompson CG, Kim RS, Aloe AM, Becker BJ. Extracting the variance inflation factor and other multicollinearity diagnostics from typical regression results. Basic Appl Soc Psychol. 2017;39(2):81–90.
117. Taplin RH. Research involving limited dependent variables: Issues in the literature and recommendations for improvement. Qual Quant. 2016;50:2121–40.
118. Salima W, Manja LP, Chiwaula LS, Chirwa GC. The impact of credit access on household food security in Malawi. J Agric Food Res. 2023;11.
119. Berhe HT. Households' nonfarm livelihood participation and agricultural inputs investment: Evidence from northern Ethiopia. Afr J Sci Technol Innov Dev. 2022;14(1):147–62.
120. Shah JR, Rahman MS, Lyu K. The Role of Rural Credit in Agricultural Technology Adoption: The Case of Boro Rice Farming in Bangladesh. Agriculture. 2023;13(12):2179.
121. Dey S, Singh PK, Mhaskar MD. Determinants of institutional agricultural credit access and its linkage with farmer satisfaction in India: a moderated-mediation analysis. Agric Financ Rev. 2022;83(2):211–41.
122. Prah S, Asante BO, Aidoo R, Mensah JO, Nimoh F. Impact of agricultural policy intervention on yield and profitability of maize farmers: The case of Planting for Food and Jobs (PFJ) programme in Ghana. Cogent Food Agric. 2023;9:1.
123. Okoyo EN, Wordofa MG, Hassen JY, Bezabih M. Welfare impacts of rural credit and saving program in *Kurfa Chele* district, eastern Ethiopia: a propensity score matching estimation. Agric Financ Rev. 2021;81(4):596–613.

124. Lelisho AE, Lelisho ME. Impact of credit use on crop productivity and gross income of smallholder farmers: a propensity score matching approach. Discov Agric. 2024;2(1):38.
125. Asante-Addo C, Mockshell J, Zeller M, Siddig K, Egyir IS. Agricultural credit provision: what really determines farmers' participation and credit rationing? Agric Financ Rev. 2017;77(2):239–56.

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