

Research Article

Farmers' Choices of Financial Services for Drip Irrigation System in Southern Mozambique

Dercio Alberto Macuacue* , Benxi Lin 

College of Economics and Management, Fujian Agricultural and Forestry University, Fuzhou, China

Abstract

In this paper, we study the farmers' choices of financial services for drip irrigation systems in Southern Mozambique using survey data collected from 150 household farmers, involving 3 main irrigation schemes in Maputo, Gaza, and Inhambane. The statistical results show the significance of the outlined factors in the performance of small household farmers' adoption of financing options for irrigation. We find that farmers are more likely to adopt financial services for drip irrigation under subsidized interest rates and low irrigation costs. Farmers with lower incomes are less likely to adopt financial services compared to others. Additionally, the main gaps between the supply and demand of irrigation-based financial services can be explained by the farmers' inability to meet the funding requirements. The solution lies thus in improving the quality of both demand and supply on its critical dimension, which also implies an increase in the economic activity of financing institutions and small farmers. Our study provides useful policy implications for designing efficient financing programs to enhance farmers' accessibility to funds. Thus, implementing special public policies to minimize financial gaps among small household farmers can play a potential role in driving the household farmers sub-sector, and public incentives are crucial in ensuring sustainable irrigation programs aimed at low-income farmers. The study also suggests the creation of funding institutions aimed at irrigation, which can expand the range of financing mechanisms and take diverse financial services to low-income farmers in rural areas, such as savings, subsidies, vouchers and other types of credit.

Keywords

Financial Services, Drip Irrigation, Household Farmers, Southern Mozambique, Africa, Logistic Regression

1. Introduction

Drip irrigation has gained more attention in rain deficit regions in Mozambique. It allows for high application efficiency and low water consumption. Despite their benefits, drip irrigation systems generally require a high initial investment, making their adoption more challenging for small farmers [1].

Access to financial services by small farmers in southern Mozambique and throughout the country is limited [2]. The

lack of rural financial institutions and the lack of interest of formal financial institutions in operating with low-income farmers are the main reasons [2]. Thus, the main factors holding back the expansion of funding programs include the role of the government in regulating rural funds, the country's basic interest rate, the inflation rate, and the infrastructure available in rural areas. [3]

Others, however, are more related to the institutions'

*Corresponding author: dercioam@outlook.com (Dercio Alberto Macuacue)

Received: 17 September 2025; **Accepted:** 29 September 2025; **Published:** 27 October 2025



Copyright: © The Author(s), 2025. Published by Science Publishing Group. This is an **Open Access** article, distributed under the terms of the Creative Commons Attribution 4.0 License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

management process, such as guarantees, access to information and its implications (moral hazard and adverse selection), the client selection process, loan methodology (individual, group or collective), the existence of credit, savings, subsidies, and risk diversification agents. [3]

The high investment cost, as well as limited access to extension services, stand out as the main determining factors for the insignificant amount of irrigated agriculture in Mozambique [4, 5].

This study aims to assess the main factors behind household farmers' choices of irrigation financial services in Southern Mozambique. Several financial institutions operating in Mozambique are mainly focused on economic profitability, acting practically as private banks [6]. Many public programs adopted were ineffective because of long subsidized vouchers combined with unsustainable rural financial programs [7]. This has often resulted in shifting the responsibility of financing small farmers' irrigation to the Government with the cooperation of development partners [8]. Nevertheless, the economic uncertainty and the reduction in external financial services have led to policy reforms, and some current irrigation strategies advocate measures to better respond to constant natural disasters. [9]. Overall, more efforts need to be taken in offering diverse financial services to small farmers through the conception of funding institutions aimed at irrigation [10].

2. Overview on Irrigation Financing

With the rapid and global development of agricultural technologies, often related to the Green Revolution, many developing countries implemented different subsidized rural financing programs that some have lasted up to now [11].

Even though general outcomes suggest an overall upward trend, investment in irrigation has increased the most in Europe, followed by Oceania and Asia in the last two decades, with an insignificant increase in Africa and the Americas. [12]

Furthermore, the economic uncertainty in most developing countries in the region and the reduction in external financing led to a reduction or complete reformulation of the irrigation financing policies. In addition to the lack of resources, an increase in the concentration of land and income has been observed, low loan recovery rates, inefficient rural financial services, and relatively high operating costs.[8]

Public expenditure in irrigation accounted for 6 percent of Mozambique's global public spending in agriculture between 2013 and 2017, representing an upward increase of 53% to 81% from 2000 to 2017. On the other hand, total spending on extension services has been insignificant, leading to many unsustainable irrigation programs [13].

Meanwhile, over 90% of the Mozambican agriculture is from the small household segment, with rain-fed farming as the main characteristic, so, financing irrigation has not yet attracted much-needed attention in the academic domain [13].

Previous studies in irrigation and financial programs did

not make a comprehensive analysis of appropriate funding options for low-income farmers, nor for funding irrigation in particular. This study is therefore aimed at conducting a comprehensive analysis of appropriate financing mechanisms for household farmers in southern Mozambique, considering both public and private sector opportunities.

Additionally, previous studies were based on the principle that rural farmers lack credit services in general, but did not examine appropriate and special funding programs for low-income farmers. This study, however, addresses new guidelines, direction, and main decisive steps that household farmers should consider toward financing their agricultural inputs, including irrigation.

Thus, financial institutions in Mozambique have often intended to address the lack of financial services instead of the high loan requirements common in the market [14]. However, both the lack of financial services and the excessive lending requirements are the major problems for small farmers in the adoption of irrigation financial services [14]. Subsidies for small farmers revealed a positive effect in reducing the risk and cost of using agricultural inputs in Mozambique. Thus, a periodic subsidies approach was more appropriate as it produced more long-lasting benefits [15]. Meanwhile, loans for irrigation have increased by 22% and general credit has expanded from 12.5% to 33% between 2012 and 2014 [13]. Despite the notable financial coverage increase, the number of non-covered farmers is still high, causing a substantially high demand for financial services [15]. Therefore, there is a gap between the supply and demand of irrigation financial services [15].

Overall, a wide range of financial irrigation programs have proven their effectiveness in different regions with similar climate, soil, and water availability conditions. Our study emphasizes the adoption of a concept in which a set of financial services should cover the demand segments through a diversified supply model adapted to the characteristics of small farmers.

3. Data Sources and the Variable Specifications

A survey was carried out during the period of October 2021 to January 2022 to collect primary data from 150 small farmers in Southern Mozambique, involving 3 main irrigation schemes. Through a stratified random sampling method [16], we selected 50 small farmers from each of the three schemes, including Maputo, Gaza, and Inhambane provinces. The [Table 1](#) presents the variable definitions and descriptive statistics of the study. The variable coding followed the nature of the binary choice method to predict choice's behaviors and probabilities of small farmers between two equally exclusive alternatives [17].

Table 1. Table caption.

Variable	Definition	Mean	Std. Dev
Adopt Financial Service	=1 if adopt, = 0 otherwise	0.13	0.34
Interest rate	loan interest rate. =1 if $\geq 10\%$ (high), = 0 if otherwise (low)	0.89	0.31
Loan period	Duration of loans' repayment. =1 if ≥ 3 years (long), =0 otherwise (short).	0.12	0.33
Income	= 1 if $\geq 7,000$ MZN (high), =0 otherwise (low)	0.26	0.33
Cost of irrigation Sys	Cost of irrigation per hectare. =1 if $\geq 20,000$ MZN (high), =0 otherwise (low)	0.91	0.29
Loan guarantee	Loan assurance from lending institutions. =1 if $\geq 20,000$ MZN (high), =0 otherwise (low)	0.91	0.29
Subsidies (MZN)	Public subsidies for irrigation.	338.67	757.75

Table Footer: currency in MZN, 1MZN=63USD

4. Analytical Method

We employ the binary logistic regression model to analyze farmers' intention in adopting financial services for irrigation and measure the main explanatory variables of farmers' choices [18, 19]. The farmer's adoption of financial services is the dependent variable of the model, and the explanatory variables include the loan interest rate, loan period, farmers' income, the cost of irrigation, loan guarantees, and subsidies,

as shown in Table 1. $U_n(Y_n, X_n)$ is the utility drive of small farmer n , where Y_n represents whether the farmer adopts financial services and X_n is a vector of small farmer characteristics. Small farmers are likely to adopt financial services or not if such an alternative offers a higher level of utility over its alternative [20]. The relationship between the farmers' probability to adopt financial services and key explanatory factors is represented by the following logit Equation

$$\text{Logit}(y=1|x) = F(x'\beta) = F(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6)$$

Where:

y = Adoption of financial option, X_1 = Interest rate, X_2 = Guarantees, X_3 = Income, X_4 = Loan period, X_5 = Irrigation cost, X_6 = Subsidies

5. Model Results and Discussion

5.1 Model Results

As shown in Table 2, nearly all the model's results were statistically significant at the 0.05 level. The Pearson chi-square result of 0.618 suggest that the model has a goodness of fit to the data.

Table 2. Logistic regression results on farmers' adoption of irrigation financial services.

Variable	Coeff.	Odds Ratio	dy/dx
Interest rate (base =low)	-.4.82064***	.0080616***	-.3278547 *

Variable	Coeff.	Odds Ratio	dy/dx
high	.1.866235	-0.0150449	-0.2751569
Loan period (base =short)	. 4.914351*	. 0073405*	. 0514509**
long	.3.905385	-0.0286674	-0.0184373
Farmers income (base =low)	. 4.753937***	116.0403***	. 3083858**
middle	.1.902085	.220.7184	-0.2673898
Irrigation cost (base =low)	-5.707666***	0033204***	-.4822364**
high	.1.933839	-0.0064211	-0.2752316
Loan guarantee (base =low)	-4.225902***	. 0146121***	-.2214952*
high	.1.772614	-0.0259017	-0.1905743
Subsidies (continuous)	.0017885**	1.00179***	. 0000333***
	-0.0008065	-0.0008079	-0.0000136
	. 9.048097***	8502.345***	-
-Cons	.3.304852	-28099	-

Table Footer: Number of Observations: 150. SEs are shown in parentheses, ***, **, and * represent significant levels of 0.01, 0.05, and 0.1, respectively. Log-Likelihood: -10.337723, Pearson chi-square: 0.618

5.2. Discussion

1) Main findings

The interest rate variable has shown a high negative coefficient and marginal effect for the farmers' intention to adopt a financing option for irrigation. The result suggests a negative impact of the variable on the household farmer's probability of adopting irrigation financial services. The income and loan period variables revealed a positive impact for both the coefficient and marginal effect. A possible explanation for this fact is that the funding options with low loan periods are more likely to come with high interest rates, making it unaffordable for low-income farmers. Household farmers within the low-income group are less likely to adopt irrigation loans due to their inability to offer competitive guarantees of repaying the loans. Meanwhile, the cost of irrigation has revealed a high negative impact for both the coefficient and marginal effect, suggesting an inverse relationship with the farmer's adoption of the irrigation funding option. The subsidies-related variable showed a high positive coefficient, and about 86% of household farmers have revealed intentions to adopt financial services under subsidized programs.

In general, the logistic output demonstrated that all the variables are significant predictors of household farmers' intention to adopt financial options for irrigation in Southern Mozambique. From the financial coverage perspective, household farmers are still poorly served, as many programs designed for low-income farmers have been unsustainable, given the lack of proper management and follow-up mechanisms.

2) comparison with literature,

The results obtained in this study confirm trends already documented in the African and Asian literature on agricultural credit. First, the evidence that high interest rates and guarantee requirements drastically reduce the adoption of financing is consistent with studies in Nigeria, which point to credit costs, lack of guarantee, and risk perception as key barriers to access [21]. Similarly, research in Mozambique and other African countries shows that the use of formal credit by smallholder farmers remains extremely limited, even in contexts with active financing programs, mainly due to conditions poorly adapted to rural realities [18].

Our results also confirm the findings from Veldwisch on Smallholder irrigators, water rights, and investments in agriculture [22], which stated that household farmers in Mozambique were less likely to choose private financial options due to farmers' inability to meet the funding requirements. From the subsidies' perspective, the outcomes of this paper are aligned with results on Subsidies and Savings [23, 24] as the temporary subsidies' vouchers revealed an immediate increase in farmers' adoption of agricultural inputs. Therefore, more emphasis should be placed on promoting diversified programs for low-income farmers, by providing temporary subsidies for irrigation and by ensuring that small farmers can use their assets as guarantees.

The negative and inverse relationship of the cost of irrigation system, interest, and guarantee confirms a robust pattern that cost barriers are cross-cutting determinants of low financial adoption among smallholder farmers. Though, temporary subsidies and flexible financing instruments emerge as effective interventions to increase adoption, accompanied by

adequate management and monitoring. Nevertheless, the government remains the principal drive for small farmers-based irrigation programs through extension services and proper subsidized programs [25, 26].

Overall, the literature on irrigation in Mozambique confirms that, although there is strong demand, systems remain largely informal and underfunded. Financial and institutional barriers continue to limit investment in sustainable irrigation [24]. Similarly, experiences in South Asia show that irrigation expansion depends on integrated packages of affordable credit, subsidies, agricultural insurance, and institutional support rather than on credit alone. [27]

3) Implications.

Public incentives still play a potential role in driving the household farmers subsector and are crucial in ensuring sustainable financial programs for low-income farmers [28]. The conclusions of this research highlight the reformulation and employment of special public policies to minimize financial gaps among household farmers. Thus, factors such as high interest rates and excessive guarantees were identified as the main generators of irrigation financial gaps among household farmers. It is therefore recommended that public policy should be supported by a very solid follow-up mechanism. The study also recommends the promotion and registration of informal financial institutions working with household farmers as low-income farmers demand low, inexpensive interest rates and lending guarantees.

6. Conclusions

Although significant progress has been made in improving financial coverage for irrigation, our study found that small farmers are still poorly served, as many funding programs designed for this segment were unsustainable given the poor management and follow-up mechanisms. In general, our study suggests that as the loan interest rate and guarantee increase, the likelihood of household farmers in Southern Mozambique adopting irrigation funds decreases. Our results also imply that the main gaps between the supply and demand of financial services for small farmers are related to the farmers' inability to meet the funding requirements. Our study provides useful policy implications to design efficient financing programs to enhance farmers' accessibility to funds and help them overcome rainfall deficits in Southern Mozambique.

Abbreviations

MZN New Mozambican Metical

Acknowledgments

Dr. Benxi Lin offered vital guidance on the topic's direction, validation and visualization.

Author Contributions

Dercio Alberto Macuacue: Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Writing – original draft

Benxi Lin: Data curation, Formal Analysis, Supervision, Validation, Writing – review & editing

Funding

This work is not supported by any external funding.

Data Availability Statement

The data supporting the outcome of this research work has been reported in this manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

References

- [1] Ducrot, R., Leite, M., Gentil, C., Bouarfa, S., Rollin, D., & Famba, S. (2020). Strengthening the capacity of irrigation schemes to cope with flood through improved maintenance: A collaborative approach to analyze the case of Chokwe, Mozambique. *Irrigation and Drainage*, 69, 126-138. <https://doi.org/10.1002/ird.2229>
- [2] Anderson Jamie, & Ahmed, W. (2020). Smallholder Financial Diaries: Building the Evidence Base with Farming Families in Mozambique, Tanzania, and Pakistan. https://bfaglobal.com/wp-content/uploads/2020/06/CGAP_Smallholder-Diaries.pdf
- [3] Hunguana, et al. (2012). The Status of Agricultural and Rural Financial Services in Mozambique. Ifad. (2017). Rural Enterprise Financing Project (Refp). https://finmark.org.za/system/documents/files/000/000/413/original/Rep_statusofAgRuFin_MOZ1.pdf?1614925224
- [4] Pittock, J., Bjornlund, H., & van Rooyen, A. (2020). Transforming failing smallholder irrigation schemes in Africa: a theory of change. *International Journal of Water Resources Development*, 36, S1-S19. <https://doi.org/10.1080/07900627.2020.1819776>
- [5] Yaron, J., Benjamin, M., & Piprek, G. (1997). Rural finance: issues, design and best practices. Environmentally and Socially Sustainable Development (ESSD) Studies and Monographs Series 14. World Bank: Washington DC, USA. <http://documents.worldbank.org/curated/en/680961468136490369>
- [6] Antunes, A., Cavalcanti, T., & Villamil, A. (2015). The effects of credit subsidies on development. *Economic Theory*, 58(1), 1-30. <https://doi.org/10.1007/s00199-014-0808-0>

- [7] Alliance for Green Revolution in Africa (AGRA). (2019), Mozambique Outcome Monitoring Report 2019, AGRA-PIATA Programme. https://agra.org/wp-content/uploads/2020/12/AGRA-OM-Mozambique-Report_FINAL.pdf
- [8] Ruete, M. (2015). Financing for Agriculture: How to boost opportunities in developing countries Policy Brief 3 Investment in Agriculture. <https://www.wocan.org/wp-content/uploads/2015/09/financing-agriculture-boost-opportunities-developing-countries.pdf>
- [9] Bank of Mozambique.(2016a), Annual Report 2015. <https://s3.amazonaws.com/rgi-documents/b4ad686ca89153fdb595d7431457c6c3a4fc57a7.pdf>
- [10] Pernechele, V., Fontes, F., Baborska, R., Nkuingoua, J., Pan, X., & Tuyishime, C. (2021). Public expenditure on food and agriculture in sub-Saharan Africa. <https://doi.org/10.4060/cb4492en>
- [11] Suwadu Sakho-Jimbira, & Ibrahima Hathie. (2020). The Future of Agriculture in Sub-Saharan Africa. Southern Voice. Boston University, Boston. http://www.researchgate.net/profile/Julius_Gatune/publication/265118100_The_Future_of_Agriculture_in_Africa/links/5417db170cf2218008beeff5.pdf
- [12] FAOSTAT. (2021). Agricultural Investments and Capital Stock 2000-2020: Global and Regional Trends. <https://openknowledge.fao.org/server/api/core/bitstreams/01f9b9e0-6747-4275-a4a1-ee88ae040043/content>
- [13] Braverman, A., & Guasch, J. L. (1995). Rural credit in developing countries (Vol. 219), World Bank Publications. <https://ideas.repec.org/p/wbk/wbrwps/219.html>
- [14] Carter, M., Laajaj, R., & Yang, D. (2021). Subsidies and the African green revolution: Direct effects and social network spillovers of randomized input subsidies in Mozambique. *American Economic Journal: Applied Economics*, 13(2), 206-29. <https://doi.org/10.3386/w26208>
- [15] Bank of Mozambique. (2016b), National Financial Inclusion Strategy (FINS) 2016–2022. <https://thedocs.worldbank.org/en/doc/469371468274738363-010022016/original/MozambiqueNationalFinancialInclusionStrategy20162022.pdf>
- [16] Lohr, S. L. (2021). *Sampling Design and Analysis* (3rd ed.), CRC, New York. <https://doi.org/10.1201/9780429298899>
- [17] Levin, J., & Milgrom, P. (2004). Introduction to choice theory. Available from internet: <https://web.stanford.edu/~jdlevin/Econ%20202/Choice%20Theory.pdf>
- [18] Pituch, K. A., & Stevens, J. P. (2015). Applied multivariate statistics for the social sciences: Analyses with SAS and IBM's SPSS. Routledge. <https://doi.org/10.4324/9781315814919>
- [19] Veldwisch, G. J. A., Beekman, P. W., & Bolding, J. A. (2013). Smallholder irrigators, water rights and investments in agriculture: Three cases from rural Mozambique. *Water Alternatives*, 6(1), 125-141. <https://www.water-alternatives.org/index.php/alldoc/articles/vol6/v6issue1/202-a6-1-7/file>
- [20] Oni, O., et al. (2022) Socioeconomic Characteristics of Farmers, Profitability and Militating Factors Affecting Small Ruminant Production in Ondo State, South-West, Nigeria. *International Journal of Environment, Agriculture and Biotechnology*. <https://doi.org/10.22161/ijeab.72.7>
- [21] Adjognon, S. G., Liverpool-Tasie, L. S. O. and Reardon, T. A. (2017) Agricultural Input credit in Sub-Saharan Africa: Telling Myth from Facts. *Food Policy*. <https://doi.org/10.1016/j.foodpol.2016.09.014>
- [22] Carter, M. R., Laajaj, R., & Yang, D. (2014). Subsidies and the persistence of technology adoption: Field experimental evidence from Mozambique (No. w20465). National Bureau of Economic Research. <https://www.nber.org/papers/w20465>
- [23] Michael R. Carter, Rachid Laajaj, et al.(2019), Savings, Subsidies and Sustainable Food Security: A Field Experiment in Mozambique. IFDC. <https://basis.ucdavis.edu/project/savings-subsidies-and-sustainable-food-security-field-experiment-mozambique>
- [24] Collaborative Africa Budget Reform Initiative (CABRI). (2019). The role of governments in developing agriculture value chains. *Policy Dialogue*. <https://www.cabri-sbo.org/uploads/files/Documents/CS-Mauritius-Sugar-cane-ENG.pdf>
- [25] Studying African Farmer-led Irrigation. (2015), *Estudar a Irrigação Dirigida pelos Produtores Agrícolas em África*. <http://www.safi-research.org/wp-content/uploads/2015/11/SAFI-Inception-report-2015-ENG-web-v1.1.pdf>
- [26] Beekman, W., et al. (2014). Identifying the potential for irrigation development in Mozambique: Capitalizing on the drivers behind farmer-led irrigation expansion (Discussão sobre informalidade da irrigação e implicações para financiamento). <https://doi.org/10.1016/j.pce.2014.10.002>
- [27] Szymon, M et al. (2021). Unlocking smallholder finance for sustainable agriculture in southeast Asia: WWF Deutschland. <https://search.worldcat.org/pt/title/1343879936?oclcNum=1343879936>
- [28] Cabri. (2019). The Role of Governments in Developing Agriculture Value Chains. <https://www.cabri-sbo.org/uploads/files/Documents/Background-Study-PD-Agri-ENG.pdf>

Biography

Dercio Alberto Macuacue is a procurement specialist with ten (10) years of solid experience in Public and Private Procurement, with proven experience in Projects financed by external partners (World Bank Group and African Development Bank –AfDB). He holds a Master's degree in Procurement and Contract Management from Guglielmo Marconi University, Italy (2024), as well as a Master's degree in Agricultural Economics and Management from Fujian Agricultural and Forestry University, Fuzhou, China (2022). Over the past 3 years, he has been serving as a procurement specialist in a World Bank financed projects at the Provincial Directorate of Public Works of Nampula.