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Research Article

The Role of Climate-Smart Agricultural Lending in Improving Food Security in Palestine: An Empirical Study of Sustainable Rural Finance

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Abstract

Food security in Palestine is increasingly threatened by climate change, water scarcity, political instability, and limited access to appropriate agricultural finance. Smallholder farmers face growing production risks while lacking the financial capacity to invest in resilient and sustainable farming systems. Climate-smart agricultural lending (CSAL) has emerged as an innovative rural finance mechanism that integrates climate resilience, environmental sustainability, and productivity enhancement within agricultural credit systems. This study empirically examines the role of climate-smart agricultural lending in improving food security outcomes in Palestine. Primary data were collected from smallholder farmers, agricultural cooperatives, and rural financial institutions across selected governorates in the West Bank using structured questionnaires. Econometric regression analysis and propensity score matching were applied to assess the impact of CSAL on adoption of climate-smart practices, income stability, and household food security measured by the Household Food Insecurity Access Scale (HFIAS). The results show that access to climate-smart agricultural credit significantly enhances farmers' adoption of sustainable practices, reduces climate-related production risks, and improves household food availability and access. The study concludes that strengthening climate-smart rural finance frameworks can play a vital role in supporting climate-resilient agriculture and long-term food security in fragile and resource-constrained contexts such as Palestine.

Keywords

Climate-smart Agriculture, Agricultural Lending, Food Security, Rural Finance, Palestine, Sustainable Development

1. Introduction

Food security remains a critical development challenge in Palestine, where agricultural production is constrained by climate variability, chronic water scarcity, land degradation, and prolonged political and economic instability. According to national and international assessments, a significant proportion of Palestinian households experience moderate to severe food insecurity, particularly in rural and marginalized areas where agriculture is the primary source of income. The agricultural sector, while contributing a modest share to national GDP, plays a disproportionately important role in employment, rural livelihoods, and household food access.

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Climate change has further intensified structural vulnerabilities in Palestinian agriculture. Rising temperatures, declining and erratic rainfall patterns, increased frequency of droughts, and soil salinization have negatively affected crop productivity and livestock systems. Smallholder farmers, who dominate the agricultural landscape, are particularly exposed due to their limited asset base, weak access to risk management tools, and dependence on rainfed or inefficient irrigation systems.

Access to finance remains a major constraint preventing farmers from adapting to climate change and improving productivity. Conventional agricultural lending in Palestine is often short-term, collateral-based, and risk-averse, making it unsuitable for financing climate-resilient investments such as modern irrigation systems, protected agriculture, renewable energy solutions, and soil conservation measures. As a result, farmers are locked into low-input, low-output production systems that perpetuate food insecurity and poverty.

Climate-smart agriculture (CSA) offers a strategic framework to address these challenges by simultaneously pursuing three objectives: increasing agricultural productivity, enhancing resilience to climate change, and promoting environmental sustainability. However, CSA adoption requires substantial upfront investment and long-term planning, which cannot be achieved without appropriate financial mechanisms. Climate-smart agricultural lending (CSAL) has increasingly emerged as an innovative approach that aligns rural finance with climate and food security objectives.

This study examines the role of climate-smart agricultural lending in improving food security in Palestine through an empirical analysis of smallholder farmers. Specifically, it addresses the following research questions: (i) Does access to climate-smart agricultural lending promote the adoption of sustainable agricultural practices? (ii) Does climate-smart lending contribute to income stability and resilience against climate shocks? (iii) What is the impact of climate-smart agricultural lending on household food security outcomes? By addressing these questions, the study contributes to the growing literature on sustainable rural finance in fragile and climate-vulnerable contexts.

2. Literature Review

2.1. Climate Change, Agriculture, and Food Security

Climate change is widely recognized as a major threat to global food security, particularly in regions characterized by water scarcity and political fragility. In arid and semi-arid areas, rising temperatures and declining precipitation directly reduce crop yields, increase evapotranspiration, and exacerbate soil degradation. Empirical studies have demonstrated that climate-induced production shocks disproportionately affect smallholder farmers, leading to income instability, reduced food availability, and increased vulnerability to poverty [2, 4, 12]. This is supported by global assessments highlighting systemic risks to food systems [1].

In the Palestinian context, climate change interacts with structural constraints such as restricted access to land and water resources, fragmented markets, and limited institutional support. These factors amplify the impact of climate variability on agricultural production and food security, underscoring the need for adaptive and resilience-focused interventions.

2.2. Climate-Smart Agriculture as a Resilience Strategy

Climate-smart agriculture represents an integrated approach to agricultural development under climate change. CSA practices include efficient water management technologies (such as drip irrigation and rainwater harvesting), climate-resilient crop varieties, conservation agriculture, agroforestry, and integrated soil fertility management. Numerous studies have shown that CSA adoption can improve productivity, reduce yield variability, and enhance resource-use efficiency [4].

Despite its benefits, CSA adoption remains limited among smallholder farmers due to financial, technical, and institutional barriers. High initial investment costs, uncertain returns, and limited access to credit and insurance are among the most significant constraints. These barriers are particularly pronounced in developing and conflict-affected economies. Recent resilience-focused rural finance studies further emphasize this constraint [8].

2.3. Role of Rural Finance in Sustainable Agriculture

Rural finance plays a critical role in enabling agricultural investment, innovation, and risk management. Access to credit allows farmers to purchase inputs, adopt new technologies, and smooth consumption during adverse shocks. However, traditional rural finance systems often fail to account for climate risks and environmental externalities, leading to suboptimal investment decisions [3, 7, 15].

Climate-smart agricultural lending seeks to address these limitations by integrating climate considerations into financial product design. CSAL instruments may include concessional interest rates for sustainable investments, extended repayment periods aligned with agricultural cycles, bundled credit and insurance products, and technical assistance for CSA adoption.

2.4. Empirical Evidence and Research Gap

Empirical evidence from Africa, Asia, and Latin America suggests that climate-smart finance can enhance adoption of sustainable practices and improve farm-level outcomes. However, there is a notable lack of empirical research examining the impact of CSAL on food security in the Middle East, par-

ticularly in fragile and conflict-affected settings such as Palestine. This study addresses this gap by providing empirical evidence on the relationship between climate-smart agricultural lending and household food security [5, 9].

3. Conceptual Framework

This study is grounded in a conceptual framework that links climate-smart agricultural lending (CSAL) to food security through multiple intermediate channels. Climate-smart lending is expected to influence farmers' behavior by easing liquidity constraints, reducing risk exposure, and incentivizing sustainable agricultural investments. These changes, in turn, enhance agricultural productivity, income stability, and resilience to climate shocks, ultimately improving household food security.

The framework assumes that access to CSAL enables farmers to invest in climate-smart agricultural practices such as efficient irrigation technologies, protected agriculture, soil and water conservation measures, and renewable energy solutions. These investments improve resource-use efficiency and reduce vulnerability to climate variability. Income stability and reduced production risk further enhance households' ability to access sufficient and nutritious food.

The framework also recognizes the role of mediating factors, including farmer education, access to extension services, farm size, and exposure to climate shocks. These factors condition the effectiveness of climate-smart finance and influence food security outcomes.

4. Methodology

4.1. Study Area

The empirical study was conducted in selected governorates of the West Bank, including Jenin, Tulkarm, Qalqilya, Jericho, and Hebron. These areas represent diverse agro-climatic conditions and farming systems, ranging from irrigated horticulture to rainfed field crops. Agriculture constitutes a major livelihood source in these regions, making them suitable for examining the role of climate-smart agricultural lending.

4.2. Data Collection and Sampling

Primary data were collected during the 2024 agricultural season using structured questionnaires. A multi-stage sampling technique was employed. First, key agricultural districts were purposively selected based on climate vulnerability and agricultural activity. Second, villages within each district were randomly selected. Finally, smallholder farmers were randomly sampled from farmer lists obtained from local agricultural directorates and cooperatives.

A total of 260 questionnaires were administered, of which 240 were complete and used for analysis. In addition, semi-structured interviews were conducted with representatives of rural financial institutions, agricultural cooperatives, and extension service providers to contextualize quantitative findings.

4.3. Variables and Measurement

Dependent Variable: Household food security was measured using the Household Food Insecurity Access Scale (HFIAS), which captures anxiety about food access, quality of food, and quantity of food consumed over the previous four weeks [6].

Key Independent Variable: Access to climate-smart agricultural lending (CSAL), defined as receipt of agricultural credit explicitly linked to climate-smart or environmentally sustainable investments.

Control Variables: Control variables included farmer age, education level, household size, farm size, access to irrigation, extension services, and exposure to recent climate shocks.

4.4. Econometric Model

The impact of climate-smart agricultural lending on food security was estimated using a multivariate regression framework:

$$[\text{FoodSecurity}_i = \text{eta}_0 + \text{eta}_1\ \text{CSAL}_i + \text{eta}_2\ X_i + \text{arepsilon}_i]$$

To address potential selection bias, a robustness check using propensity score matching (PSM) was conducted, comparing CSAL recipients with non-recipients who had similar observable characteristics.

4.5. Ethical Considerations

Participation in the survey was voluntary, and informed consent was obtained from all respondents. Data confidentiality and anonymity were ensured throughout the research process.

5. Results and Discussion

5.1. Descriptive Analysis

Descriptive statistics reveal that approximately 41% of surveyed farmers had access to climate-smart agricultural lending. CSAL recipients were more likely to use drip irrigation, water harvesting systems, and improved crop varieties compared to non-recipients. Average farm income among CSAL recipients was higher, and income variability across seasons was lower.

5.2. Econometric Results

Regression results indicate a statistically significant and positive relationship between access to CSAL and household food security. After controlling for socio-economic and farm characteristics, CSAL access reduced the HFIAS score, indicating improved food security. Propensity score matching results confirm the robustness of these findings.

5.3. Impact on Adoption of Climate-Smart Practices

Farmers with access to CSAL showed significantly higher adoption rates of climate-smart practices, particularly in irrigation efficiency and soil conservation. These practices contributed to yield stability and reduced vulnerability to drought and rainfall variability.

5.4. Discussion of Findings

The results suggest that climate-smart agricultural lending serves as a critical enabler of sustainable agricultural transformation in Palestine. By reducing financial barriers and risk exposure, CSAL facilitates investments that improve productivity and resilience. These outcomes translate into improved food availability and access at the household level, even under adverse climate conditions.

The findings are consistent with international evidence on sustainable rural finance and extend existing literature by providing empirical insights from a fragile and conflict-affected context. Similar findings regarding climate risk management and financial protection mechanisms are documented in recent studies [10, 11].

6. Policy Implications

The findings of this study have important implications for agricultural finance, climate adaptation, and food security policy in Palestine.

First, policymakers should promote the development and scaling of climate-smart agricultural lending products through targeted incentives, guarantees, and concessional funding. Public–private partnerships can play a key role in reducing risk for financial institutions and expanding outreach to smallholder farmers.

Second, capacity building for rural financial institutions is essential to enable effective climate risk assessment and product design. Integrating climate data and sustainability criteria into credit appraisal processes can improve loan performance and developmental impact.

Third, climate-smart lending should be complemented by extension services and technical assistance to ensure effective adoption of sustainable practices. Bundling finance with knowledge services enhances returns on investment and reduces default risk.

Finally, policymakers should strengthen data systems and monitoring frameworks to evaluate the long-term impacts of climate-smart finance on food security, resilience, and environmental sustainability.

7. Conclusion

Climate-smart agricultural lending plays a significant role in improving food security in Palestine by enabling smallholder farmers to adopt resilient and sustainable agricultural practices. The empirical evidence suggests that sustainable rural finance can mitigate climate risks, enhance productivity, and improve household food security even in fragile contexts. Scaling up CSAL initiatives could therefore contribute meaningfully to national food security and sustainable development goals.

Future research should explore longitudinal impacts of climate-smart finance and examine its interaction with policy, institutional, and political factors affecting agriculture in Palestine. Previous methodological and rural finance frameworks provide a foundation for such future inquiry [13, 14].

Abbreviations

CSA	Climate-Smart Agriculture
CSAL	Climate-Smart Agricultural Lending
HFIAS	Household Food Insecurity Access Scale
PSM	Propensity Score Matching
FAO	Food and Agriculture Organization
IPCC	Intergovernmental Panel on Climate Change

Author Contributions

Haroon Mohammed Alataweneh: Conceptualization, Formal Analysis, Investigation, Data curation, Methodology, Supervision, Visualization, Writing – original draft, Writing – review & editing

Conflicts of Interest

The author declares that there are no conflicts of interest regarding the publication of this manuscript.

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