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A Review on Climate Change, Credit Risk and Agriculture

***Mário Santiago Céu[1], Raquel Medeiros Gaspar[2]**
[1] ISEG - Lisbon School of Economics & Management and Advance/CSG Research Center, Rua do Quelhas 6, 1200-078, Lisbon, Portugal
[2] ISEG - Lisbon School of Economics & Management and Cemapre/REM Research Center, Rua do Quelhas 6, 1200-078, Lisbon, Portugal

Abstract. Climate change poses a significant threat to agricultural productivity, necessitating a comprehensive understanding of its implications for both agricultural firms and capital lenders. This systematic literature review aims to elucidate emerging trends in addressing climate-related risks in agriculture and credit sectors. Drawing from a rigorous analysis of 39 articles sourced from Scopus and Web of Science databases, three key thematic dimensions have emerged: (i) agricultural lending and credit risk, (ii) green principles and sustainability, and (iii) the context of developing countries. From the impact of climate change on the recoverability of loans to the imperative of transitioning towards a greener and more sustainable economy, alongside the nuanced challenges faced by agriculture in developing countries, we analyzed prominent and recent literary approaches. The findings underscore the need to integrate climate change considerations into agricultural and credit policies. Policymakers and financial institutions should prioritize climate education for farmers and promote sustainable financial approaches. Anticipated climate risks will impact lenders' capital reserves, necessitating portfolio adjustments. A deep understanding of climate change's interplay with agriculture lending and credit risk is vital, urging proactive policy and practice. Addressing climate challenges in agriculture demands a multifaceted strategy encompassing tailored credit policies, improved access to credit, financial empowerment, and the mitigation of social inequalities. This review highlights the urgent need for proactive strategies to mitigate climate risks and ensure a resilient agricultural sector, emphasizing the crucial role of research and policy interventions in navigating the complex landscape of climate change impacts on agriculture.
Key words: climate change, agricultural lending, sustainability, credit risk.

Introduction

The primary sources of uncertainty and risk in agriculture stem from production uncertainty, where unpredictable weather impacts output quality and quantity, further exacerbated by the significant time requirements dictated by biological processes (Moschini and Hennessy, 2001). Changes in temperature patterns, precipitation levels and extreme weather events can affect crop yields, water availability and livestock health. Farmers face the challenge of adapting their farming practices to these changing conditions to maintain productivity and profitability. This may involve implementing new technologies, diversifying crops, or adopting more sustainable farming practices.

However, these adaptations often require financial resources that may not be readily available to farmers. Lenders providing loans to agricultural businesses need to assess the risk associated with the impacts of climate change on the borrower's ability to repay the loan. Furthermore, agriculture contributes to greenhouse gas emissions, further exacerbating climate change. To tackle these challenges, there is increasing pressure to embrace sustainable farming practices that mitigate climate change impacts and foster a circular economy. With the uncertainty and volatility brought on by climate change, lenders must assess the potential for crop failures, supply chain disruptions and reduced market demand to make informed decisions regarding loan terms, collateral requirements, and risk mitigation strategies.

The significance of the 2030 Agenda for Sustainable Development (United Nations, 2015), adopted by all member countries, is clear. This

* Corresponding Author's email: mariosantiago@phd.iseg.ulisboa.pt

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global agenda establishes priorities and aspirations for sustainable development, aiming to mobilise worldwide efforts towards shared goals and targets. A key tool in this context is the Paris Agreement (United Nations Environment Programme, 2015), established during the 2015 United Nations Climate Change Conference (COP 21). Its objective is to restrict the global temperature increase to below 2 degrees Celsius and strive for a limit of 1.5 degrees Celsius above pre-industrial levels. By aligning with the Paris Agreement, financial institutions can aid the shift to a low-carbon agricultural economy and mitigate credit risks linked to climate-related events.

Furthermore, integrating the Sustainable Development Goals (SDGs) into financial decision-making empowers financial institutions to contribute to the goals of the Paris Agreement. By promoting sustainable agriculture, facilitating the adoption of renewable energy, and encouraging energy-efficient practices, financial institutions can mitigate climate risks, strengthen agricultural resilience, and foster a transition toward a more environmentally conscious and economically sustainable future. Of the 17 SDGs adopted, there are several that depend on best practices in agricultural activity, which promote food security, actions to mitigate the impact of climate change, protect the forest, combat soil degradation, and conserve ecosystems and biodiversity.

The coming years will present significant agricultural challenges, which could be considered the most comprehensive yet. Farmers must provide enough food for a population of nearly 10 billion people by 2050 while also employing around 2 billion individuals and addressing environmental concerns such as land degradation, water scarcity, and the adverse impacts of climate change (Searchinger et al., 2019). Forecasts for future food demand vary, yet even the most hopeful projections necessitate a minimum of 50% growth in food production. The surge in demand for agricultural and food commodities, driven by expanding population and evolving consumption habits, is anticipated to reach its zenith in the next half-century (Baulcombe et al., 2009).

There is also an imperative need for agricultural activity to reinvent itself to meet the SDGs. Climate change is expected to negatively impact crop production worldwide. Researches indicate that crop yields have already been affected, and future climate conditions are projected to decrease further yields (Tilman et al., 2011; Vermeulen et al., 2012; Ray et al., 2019; Molotoks et al., 2021).

Climate change forecasts play a crucial role in determining economic losses, with benign forecasts resulting in economic benefits for society, while more severe forecasts lead to substantial losses (Adams et al., 1995). Capasso et al. (2020) examined how exposure to climate change affects a company's credit risk and found that the distance-to-default is lower for firms with higher carbon emissions and carbon intensity, indicating that the market sees such companies as having a greater likelihood of default. Furthermore, the impacts of climate change on crop yield levels and variances are not uniform across all types of crops, as they manifest in a crop-specific manner. Specifically, increases in rainfall and temperature positively influence both the yield level and variability of sorghum. Conversely, the effects of precipitation and temperature on corn yield levels and variability exhibit contrasting patterns (Chen et al., 2004). Other studies address the impact of climate change on poverty by 2030 due to the increase in prices of basic foodstuffs in low productivity scenarios, which will consequently also affect farmers' incomes (Hertel et al., 2010).

Depending on the region, the impacts of climate change are indeed alarming. Projections indicate that, under the most severe scenario, Australian farm profits could decline by as much as 50% compared to the latter half of the last century. Moreover, given the diverse responses of regions and countries to climate change, the international competitiveness of farmers might also be compromised (Hughes et al., 2022).

The gradual deterioration of business liquidity, accompanied by an increased default rate caused by climate change-induced destruction of capital and reduced profitability, poses potential risks to the financial and non-financial sectors (Dafermos et al., 2018). While studies based on thermal stress have indicated a direct relationship between extreme heat and elevated credit delinquency rates, primarily within the agricultural sector, this raises the discussion of whether long-term climate changes will also impact the credit quality provided to agricultural businesses (Aguilar-Gomez et al., 2022).

The intricate relationship between climate change, agricultural loans, and credit risk is of paramount importance in understanding the vulnerabilities and dynamics of the agricultural sector. Climate change has a profound impact on agricultural productivity, and this, in turn, affects loan repayment abilities and credit risk. This literature review seeks to provide a comprehensive understanding of the interconnectedness of climate change, agricultural loans, and credit risk and its implications for policy, finance, and sustainable agricultural development. By analysing and synthesising existing literature, we aim to identify key findings, and research gaps and highlight areas for future research. In this study, our objective is to elucidate the concept of credit risk resulting from the impact of climate

change on the agricultural sector, especially about its implications for sustainable development. By providing comprehensive understanding, we seek to facilitate informed decision-making and guide policy interventions in this critical domain.

The remainder of this article is organised as follows: Section 2 outlines the research methodology, Section 3 discusses the results of the bibliometric analysis, and Section 4 provides the study's conclusions, implications, and suggestions for future research.

Material and Methods

Study Selection

In this review, we aim to investigate the impact of climate change and sustainability policies on the credit risk faced by agricultural firms, as outlined in the study's overarching objectives detailed in the introduction. Our methodology will involve a comprehensive analysis of existing literature to uncover insights into this complex relationship. We conducted a systematic review (SR) using the most reputable electronic bibliographic data sources, namely Scopus and Web of Science (WoS). Considering the theme of climate change and its contemporary relevance, we refrained from imposing temporal constraints on our search to encompass the entirety of the bibliographic essence from its inception to August 2023. Only articles submitted to the peer-review process were considered, so we excluded conference papers, systematic reviews, book chapters and other reports. We performed an extensive database search using specified keywords to link agriculture, credit risk and climate change. Consistent terminology is observed across studies in describing the challenges a company faces in meeting its financial obligations, albeit from varied perspectives of the authors. Keywords such as 'bankruptcy' hold legal implications, indicating a formal state of non-compliance with obligations. Conversely, terms like 'insolvency' and 'default' are informal, signaling solvency issues that may lead to financial losses for creditors. 'Loan' or 'indebtedness' are inherently linked to both formal and informal states, hence its inclusion as keywords. Thus, the selection of these keywords, as opposed to others, reflects our commitment to maintaining objectivity in line with existing literature. To identify the most relevant studies for our purpose, we conducted an advanced search using the boolean functions 'AND' and 'OR', combining them to make the search more efficient (see Table 1).

Screening and Eligibility Process

Our search yielded 1,109 bibliographic references, all of which underwent screening. We conducted a comprehensive review involving a bibliometric analysis and a systematic content analysis of the selected articles. The schematic representation of the SR methodology is shown in Figure 1.

There were 282 duplicate articles between Scopus and WoS, so they were removed. The literature on agriculture is broad and essentially linked to agronomic conditions and practices. Therefore, the associations

Table 1

Search criteria in Scopus and Web of Science (WoS)

Source	Search criteria
Scopus	TITLE-ABS-KEY (("credit risk" OR "financial distress" OR insolvency OR bankruptcy OR default OR loan OR indebtedness) AND (agriculture OR agricultural) AND ("climate change" OR "climate risk" OR sustainability)) AND (LIMIT-TO (DOCTYPE, ar")
WoS	((TS= ("credit risk" OR "financial distress" OR insolvency OR bankruptcy OR default OR loan OR indebtedness)) AND ALL= (agriculture OR agricultural)) AND ALL= ("climate change" OR "climate risk" OR sustainability) AND Article (Document Types)

Source: Own elaboration

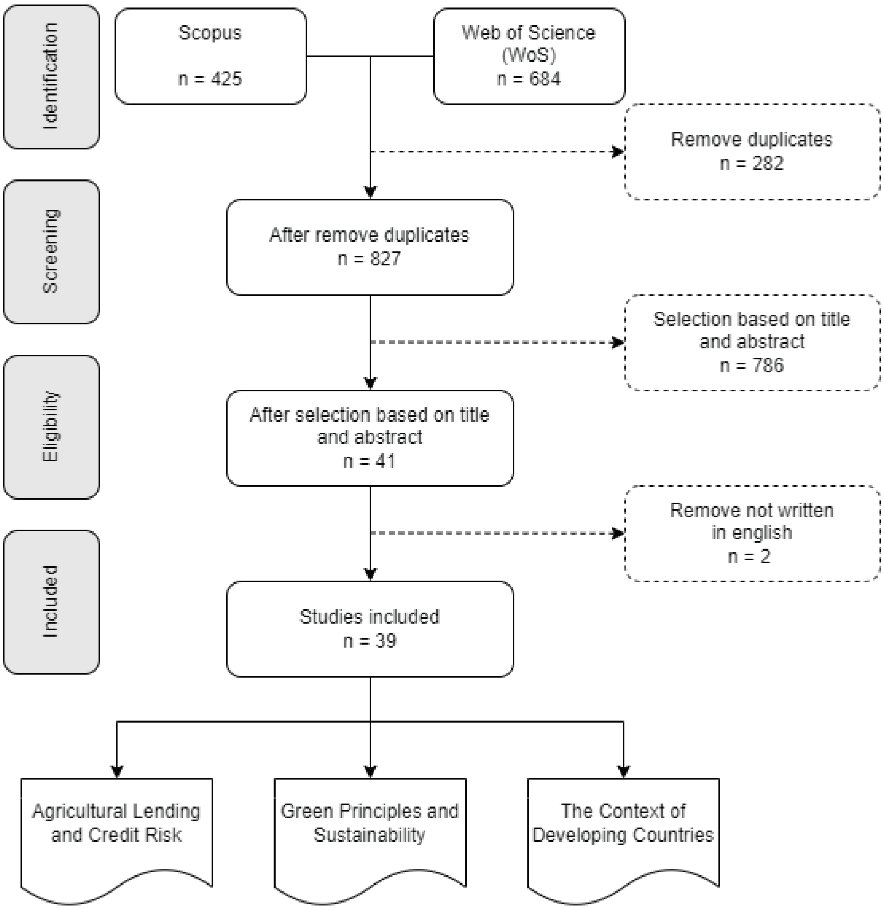

Figure 1. Diagrammatic flow of the selection process.

Source: Own elaboration

Figure 2. Most frequently used keywords.

Source: Own elaboration

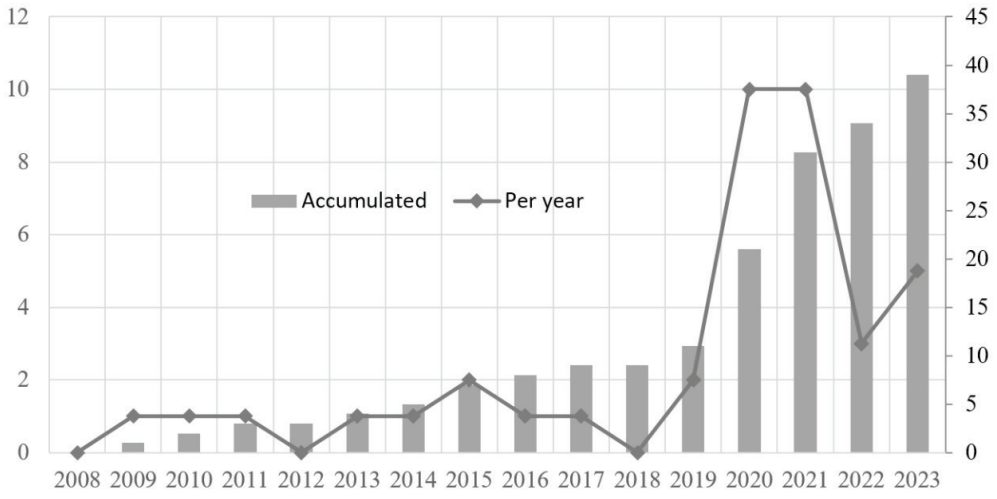

Figure 3. Number of publications per year.

Source: Own elaboration

between finance, climate change and agriculture are difficult to isolate from bibliometric noise.

Next, we made an exhaustive selection by title and abstract reading, and then those we considered candidates, underwent a full-text assessment. To reach the ultimate selection, a meticulous analysis was conducted on the articles, in which the assessment encompassed aspects such as content relevance, employed methodologies, novel discoveries, contributions to the existing literature, and implications for researchers and policymakers. The final selection fell on 39 articles written in English that were considered relevant to our study. To better understand the keywords used in the 39 articles, we show a word cloud diagram (Figure 2).

The analysis of Figure 3 shows that only since 2020 has the production of research relating to the theme of this systematic literature review demonstrated a notable increase in interest. Before 2009, no scientific production on the topic had been identified. In 2023, until August, 5 articles had already been recorded, indicating a continuation of interest and academic production in the area. "It is important to note that the significant growth in research production from 2020 on the topic of this systematic literature review may be directly related to the influence of the 2030 Agenda for Sustainable Development (United Nations, 2015) and the Paris Agreement (United Nations Environment Programme, 2015) marking an important milestone in global discussions on sustainability and climate change.

Results and Discussion

The empirical insights compiled from the literature in this study provide valuable analytical insights into the intricate relationship between climate change, agricultural lending, and credit risk, underlining the critical importance of understanding climate risk in agricultural finance and the need for approaches and solutions to effectively mitigate these risks.

Integrating climate considerations into agricultural credit practices not only reduces risk but also increases resilience to changing environmental conditions. Furthermore, empirical evidence highlights the importance of addressing credit constraints and promoting innovative financial products to improve farmers' adaptive capacity. Balancing the advantages of formal credit with the flexibility of informal sources is still essential to overcome barriers to access to credit and promote sustainable agriculture.

Between the classic concerns related to agricultural credit, the more recent concerns about green credit policies and the very specific context of developing countries, three main dimensions emerge (Figure 4).

i. *Agricultural Lending and Credit Risk*

a) *Climate Sensitivity in Loan Recovery*

There is a crucial interconnection between agricultural loans and agricultural productivity, highlighting their strong dependence on climatic conditions. Climate change asymmetrically affects the recovery of agricultural loans, i.e., negative sensitivities result in lower recoveries, while positive sensitivities lead to improved recoveries (Wahab et al., 2023). Climate-driven shifts in productivity strongly impact how borrowers in rural credit markets manage their loan repayments. This dynamic heightens the chances of defaults and exacerbates market failures. Remarkably, even the existence of credit information exchange systems, such as credit bureaus designed to boost financial inclusivity, fails to mitigate these outcomes. These insights are important considering

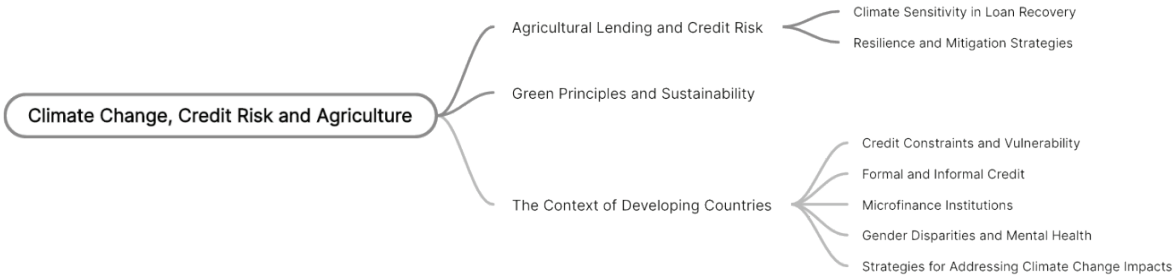

Figure 4. Summary diagram of the literature review.

Source: Own elaboration

climate change's adverse effects on agricultural productivity, particularly in vulnerable communities with limited capacity to cope. (Adjognon et al., 2019).

Emphasising the importance of lenders understanding natural capital risks, if the risk premium for agricultural loans is not well understood, it could become misaligned and potentially cause net losses in the lender's portfolio. On the other hand, setting a premium that is too high could burden borrowers with excessive costs and limit the availability of financing for sustainable scaling efforts (Ascui et al., 2021).

An analysis of past climate events was conducted to develop a stress-testing methodology aimed at predicting future droughts. The research highlighted significant macroeconomic impacts in specific regions of the United States, particularly regard to Real Gross Domestic Product (RGDP), resulting in job losses and property devaluation. Lenders have experienced varying effects based on their geographic diversification, concluding that it is important to have access to historical data on localised weather events so that lenders can assess the resilience of their portfolios against such impacts (Breeden, 2023).

Examining the impact of climate change on credit risk within the agricultural sector, Brar et al. (2021) presented a structured framework. The study explored various climate change scenarios, assessing their influence on agricultural loan portfolios. Temperature increases from 0°C to 4°C were used as scenarios for evaluation. Employing a case study approach, the research analysed agricultural loan portfolios dedicated to maize producers across diverse regions of Ontario, Canada, considering distinct climate change conditions. The findings emphasised the importance of integrating climate change considerations for a more resilient loan portfolio compared to disregarding climate effects. The methodology involved simulating corn productivity under varying climate change scenarios, allowing an evaluation of its impact on agricultural income and loan losses. The study's conclusions showcased significant risk reductions achievable through the application of climate change models, contingent on the chosen modelling strategy. The study's implications extend to the adaptability of the framework across different cultures and regions. Furthermore, it suggests the potential for future research to encompass a broader range of climate change impacts beyond just temperature escalation, including phenomena such as severe weather patterns."

Castro and Garcia (2014) studied the effects of commodity price volatility and climate variations on a default risk model. The findings reveal statistical significance for both price volatility and climate factors, yet their economic relevance is eclipsed by macroeconomic conditions and intermediate input prices. Moreover, the suggested model enables stress testing through risk scenarios, highlighting the dominance of climate-related risks over those arising from commodity price volatility. Bergman et al. (2020) employed random weather shocks as an exogenous source of variation in farm cash flow, revealing that these shocks had significant effects on multiple sectors of the economy of Iowa, United States. During the crisis, cash injections positively influenced land values but also increased loan default rates and the number of bank failures, indicating that climate shocks can play a significant role in economic dynamics.

The age and education of farmers are also covariates associated with agricultural credit risk. Spicka (2020) reveals that due to climate change and the associated risks in agriculture, younger, unmarried, and less educated farmers have a significantly higher propensity for risk-taking, potentially making them risky clients for banks.

b) *Resilience and Mitigation Strategies*

In a study by Ranjan (2013) regarding credit constraints for farmers and their connection to drought resilience, the significance of credit access in promoting water-saving technologies during droughts and groundwater depletion is underscored. The study explores the influence of credit costs and their interaction with various farmer constraints. Shorter repayment periods are suggested to encourage prudent

water resource management, while excessively high-interest rates may lead to harmful approaches. The study emphasises the need for timely credit access to address the increasing frequency of droughts, advocating for its integration with other strategies to support productive investments and ensure food security. However, it acknowledges challenges such as farmers' risk aversion and the necessity for innovative credit mechanisms. Moreover, the study highlights the potential of timely credit availability in promoting the adoption of water-saving technologies during droughts while recognising the negative impact of high credit costs and the risk of recurring droughts on groundwater sustainability. Additionally, the study underscores the role of the loan duration in shaping farmers' groundwater utilization strategies, emphasizing the potential for financial institutions to encourage sustainable outcomes.

Ali et al. (2020) assessed the willingness of Togolese farmers to pay for insurance based on weather indices as a market option to share climate risks. Although the results indicate that respondents are willing to pay, this option must be interconnected with other factors, which include loans to organised groups of farmers. This study presents a very interesting perspective, opening the horizons for composite financial products associated with climate data, which could mitigate the associated credit risk.

Jones et al. (2015) suggests that agricultural lenders should transition from using uniform credit risk assessment models to ones that comprehend the specificities of organic farms. Additionally, farmers should gain a better understanding of credit risk assessment principles to effectively advocate with lenders and compete for terms that are not disadvantageous compared to conventional loans.

In a study about crowdfunding to support climate change mitigation practices, Kragt et al. (2021) interviewed 443 Norwegian farmers with low knowledge about crowdfunding. Those who are interested prefer subsidy or reward models that cover all mitigation costs. Factors such as agricultural financial stability and responsibility for climate change increase interest in crowdfunding. There is, however, farmer hesitancy to be publicly identified as a recipient of funding, suggesting that joint campaigns managed by intermediary organisations are an effective approach. It concludes that, despite the limitations, well-planned crowdfunding can involve groups of farmers in mitigating climate change.

ii. *Green Principles and Sustainability*

The impact of green credit policies reveals significant profits and supply chain efficiency improvements. Implementing green credit policies can improve profits for participants in the agricultural supply chain while allowing banks to reduce interest rates, which increases the overall utility of the supply chain, contributing to efficiency and sustainable development (Deng et al., 2021). Financial institutions aligned with environmental concerns provide loans to agriculture based on the principles of the green economy and circular economy, fostering sustainable societal development. However, insufficient information poses a critical challenge for lenders. Addressing this, implementing a hierarchical blockchain model proves beneficial in ensuring data reliability, security, and traceability in rural green credit research (Tan and Zhang, 2021).

Market niches have been emerging in response to the demand for environmentally friendly agriculture that promotes a more sustainable economy. Organic farms are acknowledged for enhancing the resilience of agricultural systems to climate change by creating more stable ecosystems and even mitigating their effects through fertilisers, resulting in reduced greenhouse gas emissions. However, on the flip side, organic farms might be more susceptible to extreme and unpredictable weather events and patterns, potentially affecting the productivity of these green units. Xia et al. (2022) highlights the efficacy of agricultural supply chain finance in resolving farmers' loan difficulties. The study takes a comprehensive approach to evaluating risk decisions in green agriculture and categorises farm households into four credit-needing groups, evaluating their risk profiles. The findings confirm the indicator system's appropriateness for fostering green agricultural development and providing valuable guidance for financial decision-makers. Moreover, the study's insights can be extrapolated to different agricultural supply chain contexts, offering broader applicability.

iii. *The Context of Developing Countries*

a) *Credit Constraints and Vulnerability*

Climate change presents significant challenges to farmers in developing nations, affecting their ability to adapt and thrive. Among the myriad of challenges, credit constraints emerge as a critical factor hindering farmers' efforts to mitigate the impacts of climate change and implement necessary adaptation strategies. The inadequate access to financial resources severely compromises small-scale agriculture, emphasising the need for appropriate credit policies to address these challenges, particularly in vulnerable areas (Ojo and Baiyegunhi, 2020). The vulnerability of the poorest farmers is evident in their limited access to credit and insurance schemes due to low credit ratings, designating them as high-risk debtors by traditional banking institutions (Mwinjaka et al., 2010). This

low credit accessibility hampers their capacity to implement adaptation strategies, including using climate-smart agricultural technologies vital for sustainable agriculture and ensuring food security amidst climate change (Anugwa et al., 2021). Sofoluwe et al. (2011) concluded that the lack of capital is the second most reported issue by Nigerian farmers in their efforts to adapt to climate change. Therefore, access to loans plays a significant role in adaptation strategies, thus emphasising the importance of facilitating credit access.

In contexts where adverse weather events significantly impact smallholder farmers' vulnerability, hindering adequate credit access, as exemplified in less developed countries, Möllmann et al. (2020) explored the influence of remotely-sensed vegetation health indices on credit risk for agricultural loans in Madagascar. The study highlighted that these indices notably elucidate credit risk, particularly in higher-risk scenarios, underscoring their potential value for microfinance institutions in managing loan portfolio risk. The authors advocated for adopting index insurance based on these indices, envisioning potential benefits such as reduced interest rates, enhanced credit accessibility, and a positive contribution to sustainable development in the region.

Market conditions significantly affect farmers' economic sustainability, particularly in climate-vulnerable countries such as Bangladesh, where agricultural costs often surpass income, necessitating loans to sustain operations. However, profits from agriculture frequently fall short of repaying the loans, perpetuating a cycle of debt for farmers and stakeholders involved (Lázár et al., 2015).

Studies conducted in diverse regions shed light on the intricate relationship between climate change, credit access, and vulnerability. For instance, in Kenya, climate risk-induced rationing hampers credit-seeking behaviour among small-scale farmers (Ndegwa et al., 2020). Similarly, climate change adversely affects family debt in the arid and semi-arid regions of India, exacerbating existing socioeconomic disparities (Kandikuppa and Gray, 2022).

b) *Formal and Informal Credit*

Formal credit institutions, when effectively targeted and distributed, have the potential to empower farmers and enhance resilience in the face of climate change. The study by Chandio et al. (2020) underscores the necessity of aligning formal credit services with the specific needs of farmers and advocates for global cooperation in providing loan guarantees to small farmers, safeguarding funds and promoting climate change adaptation strategies.

While both formal and informal credit show positive associations with climate change adaptation strategies, farmers encounter significant barriers to accessing formal credit. Stringent requirements, lack of operational flexibility, and high-interest rates deter farmers, often leading them to turn to informal credit sources such as loans from social networks and Farmer-Based Organisations. The misalignment of formal credit with the informal nature of agricultural activities accentuates these challenges (Ankrah et al., 2023).

In the smallholder farming community, there is growing interest in accessing climate finance to support resilient agricultural development implementing climate change mitigation practices. However, challenges prevail in accessing climate finance through formal financial institutions at market rates. In a study related to the dairy sector, obstacles are highlighted not only as risks in Kenya's dairy sector but also as weak links between farmers and formal financial institutions (Odhong et al., 2019).

c) *Microfinance Institutions*

Microfinance institutions play a crucial role in providing essential liquidity to affected communities and mitigating natural disasters linked to climate change (Sseruyange and Klomp, 2021). However, caution is warranted, as microfinance products for climate adaptation can inadvertently create debt cycles due to adverse weather conditions, offering short-term solutions without addressing underlying vulnerabilities (Guermond et al., 2023). In a study examining the impact of climate change on microinsurance programs for impoverished farmers in Malawi, various climate-induced precipitation scenarios were analysed. Despite data uncertainties, this research's findings unveil vulnerabilities and risks associated with these programs in a distant future, specifically from 2070-2080. The revelations from this study have sparked discussions concerning the potential influence of uncertainties on capital requirements and insurance premiums. While this investigation does not establish a direct link to the credit risk of agricultural firms, it underscores the critical importance of addressing climate change (Hochrainer et al., 2008).

The potential of microcredit, conceived in the previous century, is now being explored as a strategy to tackle climate change. While vulnerable populations resort to microcredit in response to climate shocks, its ability to mitigate sustained effects remains restricted due to limited outreach, supply obstacles, and a lack of alternative credit options. Alongside this limitation, microcredit contributes to the issue of over-indebtedness, potentially placing individuals on a trajectory of heightened risk in the face of future climate shocks. This can lead to loan defaults and the liquidation of assets, which are often sold to repay debts (Jordan, 2020).

d) *Gender Disparities and Mental Health*

Gender disparities further compound challenges in low-income countries, affecting small farmers' access to credit. Male-headed households tend to have greater access to formal loans, directing resources differently than female-headed households. This has varied short- and long-term impacts on the ability of small farmers to adapt to climate change (Carranza and Niles, 2019).

The impacts of climate change extend beyond the economic realm, affecting farmers' mental health. Studies demonstrate a link between adverse weather conditions, agricultural losses, debt, and an increased risk of suicidal thoughts among farmers (Swami et al., 2020). Rising temperatures, directly affecting agricultural productivity, are associated with a notable increase in farmer suicide rates (Barve et al., 2021).

e) *Strategies for Addressing Climate Change Impacts*

Selling assets and taking loans are often strategies employed to address the catastrophic impacts of climate change (Enete et al., 2016; Islam et al., 2020; Patel et al., 2020). However, the ability of developing countries to do so is compromised due to various challenges faced by these communities). These challenges include the lack of knowledge to access loans and financial support, the poor economic condition of farmers, the absence of suitable environmentally-friendly technologies for rural farmers, and a general lack of information about climate change, ranking as the top concerns expressed by farmers (Pauline et al., 2016; Kath and Kanagasabapathi, 2020). Other studies indicate that access to official loans does not significantly impact farmers' adaptation decisions regarding climate change, attributing this to inefficiencies in loan capital management. Consequently, policymakers should establish preferential loan programs with stringent oversight to ensure efficient fund utilization and prevent misuse by beneficiaries (Vo et al., 2021). A study on climate change adaptation in Iran revealed that "delaying loan repayment" ranked lowest among 31 adaptation strategies. Villagers preferred alternative approaches, such as creating new employment opportunities and sources of income, as more immediate solutions to address the challenges of climate change. This finding highlights a preference for non-financial strategies over deferring loan repayments in climate change adaptation efforts (Sarvestani and Shahraki, 2023).

Conclusions

This literature review offers valuable insights into climate risk management across three main dimensions: (i) Agricultural Lending and Credit Risk, (ii) Green Principles and Sustainability and (iii) Context of Developing Countries.

In Agricultural lending and Credit Risk, climate change strongly influences loan recovery, requiring prudent risk assessments and stress testing methodologies based on historical climate events. Lenders should align risk premiums with climate risks to ensure portfolio resilience while avoiding undue burdens on borrowers.

About Green Principles and Sustainability, aligning financial institutions with the principles of the green and circular economy is fundamental to promoting sustainable agricultural development. Implementing green credit policies in the agricultural supply chain not only increases overall efficiency but also increases profits for supply chain participants.

Understanding the impact of climate change on developing countries has been widely studied due to the intensity with which these countries feel the consequences. Climate change presents profound challenges for farmers in these regions. Insufficient access to credit amplifies vulnerability, making it difficult to implement essential adaptation strategies. Closing these gaps requires adapted credit policies, enhanced access to formal and informal credit, and addressing gender disparities in access to credit.

These findings highlight the need to integrate climate change considerations into agricultural and credit policies. Policymakers and financial institutions must prioritise climate education for farmers and advocate for sustainable financial practices. Climate risk is expected to be a crucial factor in creditors' capital reserves, requiring adjustments to investment portfolios. A comprehensive understanding of the interaction between climate change, agricultural lending, and credit risk is essential, and a proactive approach to policies and practices is advocated.

In conclusion, addressing the challenges of climate change in the agricultural sector requires a multifaceted approach, which includes specific credit policies, increased access to credit, financial empowerment and addressing social disparities. This review highlights the need for proactive strategies to mitigate climate risks and ensure a resilient agricultural sector. More research and policy interventions are imperative to navigate the complex landscape of climate change impacts on agriculture.

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