

Advancing climate-smart financial solutions for smallholder farmers: Lessons from the CGIAR Research Initiative on Climate Resilience



INITIATIVE ON
Climate Resilience

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Abstract

Smallholder farmers in low- and middle-income countries face climate-related risks that increase their income volatility and compromise their well-being. The CGIAR Research Initiative on Climate Resilience (ClimBeR) has developed and implemented a suite of innovative instruments aimed at transforming the climate adaptation capacity of smallholder farmers. This brief examines the potential of these bundled financial solutions in enhancing smallholder farmers' resilience to climate risks and documents ClimBeR's experience in implementing and scaling these instruments.

1. Background

Smallholder farmers in many low- and middle-income countries (LMICs) face a myriad of production and marketing risks that lead to income volatility and compromised well-being. These challenges are intensified by climate variability and change, which increases the frequency and severity of risks such as changes in temperature and precipitation patterns, and more frequent and extreme weather events. Climate disruptions impact agricultural productivity, resulting in long-term negative consequences on household food security, food prices, and child nutrition (Paparrizos et al. 2021; Ringler et al. 2010). The vulnerability of smallholder farmers is further exacerbated by their heavy reliance on rain-fed agriculture, underdeveloped commodity, and financial markets, and limited capacity to adopt improved and resilience-enhancing farm technologies (Knox et al. 2012; Tol, 2018). Current projections indicate that by 2050, nearly 80 percent of smallholder farmers worldwide will be affected by at least one climate hazard (Niles and Brown, 2017). The impacts of climate change are not uniform across households in LMICs, research shows that women and their dependents are highly vulnerable due to their lower asset ownership and control, disproportionately enormous burden of domestic responsibilities, and heavy reliance on natural resources (Kakota et al. 2011).

Improving smallholder farmers' capacity to adapt to, and cope with climate-related risks can substantially enhance their welfare and support them in building long-term resilience to climate shocks (Sargani et al. 2023; Ngoma et al. 2024). The use of new and improved production technologies, such as better seeds or machinery or better farm infrastructure, provides an avenue to increase farmers' resilience and improve farm incomes. Yet many farmers lack sufficient access to credit to purchase these technologies, either because they do not have the required collateral for credit, or the interest rate of the credit is too high due to information asymmetries in the prevailing underdeveloped financial markets. Transferring some of the production risks to insurance markets can also enhance smallholder farmers' risk management ability and their resilience to climatic shocks, however, insurance markets are either missing or incomplete in many LMICs.

To address some of these needs, the CGIAR Research Initiative on Climate Resilience (ClimBeR)¹ has developed and implemented a suite of innovative instruments that are aimed at transforming the climate adaptation capacity of smallholder farmers in LMICs. A larger component of the ClimBeR initiative involves employing locally suited, and tailored agricultural risk management strategies that could effectively reduce smallholder farmers' vulnerability to climate risks. These include, but are not limited to, bundled financial solutions that are aimed at enabling farmers to invest in improved and resilient production technologies, while also allowing them to transfer some of their risks to insurance markets. Additionally, ClimBeR provides early warning systems and climate

¹ More information on the CGIAR Research Initiative on Climate Resilience (ClimBeR) can be found here: <https://www.cgiar.org/initiative/climate-resilience/?section=about>

information services that allow farmers to better anticipate extreme climate events and make informed decisions. This policy brief aims to provide insights into the potential of these bundled financial solutions in transforming rural economies and identifying key factors that can contribute to their long-term viability and expansion in LMICs. Focusing on three technologies—risk contingent credit, climate-credit scoring tools, and agricultural insurance – we document the experience of ClimBeR in implementing and attempting to scale the bundled financial solutions.

2. Financial innovations and inclusion

Previous studies have documented how innovations in smallholder financial instruments such as insurance and bundled innovations have bridged rural financial market gaps by supporting smallholder farm investment, farm productivity, stabilizing farm incomes and consumption, and long-term resilience to climate shocks. For instance, agricultural insurance has been shown to encourage farmers to make riskier but potentially more profitable farm investment decisions, leading to higher productivity and incomes (Karlan et al 2014; Cai 2016; Jensen et al. 2017). Evidence also shows that bundling credit and farm inputs with insurance (such as risk contingent credit) can help smallholder farmers access and use technologies that can increase their farm yields, incomes, and household food security, ultimately building their resilience against climate-related risks (Ndegwa et al. 2024; Carter et al. 2016). Integrating climate risk assessments into lending decisions and the development of flexible repayment terms that align with the crop cycle have also improved farmers' access to finance and their ability to invest in climate-resilient practices (ISF, 2024).

Despite the promising findings, a significant gap persists in the reach and accessibility of these financial tools among many smallholder farmers. These challenges stem from both the demand and supply side of the financial markets. On the demand side, several studies have highlighted barriers that hinder farmers' participation in agricultural financial markets. Key factors include basis risk (low correlation between index readings and individual losses), liquidity constraints, limited education and financial literacy, lack of trust, inadequate product understanding, and risk aversion (Giné et al. 2009; Matul et al. 2013; Takahashi et al. 2016; Hill et al. 2016). On the supply side, research emphasizes issues such as suppliers' risk attitude, high market fragmentation, high transaction costs, stringent government regulatory frameworks, information asymmetries (e.g., moral hazard and adverse selection), expensive reinsurance, poor financial distribution networks, and poor-quality data, which limit services to the smallholder farmers (see Hazell and Timu, 2024 for the latest review). Recent reviews have also highlighted how inequities in product design and delivery, biases in financial markets, and entrenched social and cultural norms have disproportionately hindered the ability of marginalized smallholder farmers, particularly women and youth, from accessing and benefitting from these financial tools (Fisher et al. 2019; Timu et al. 2024). Consequently, many financial interventions remain limited to small-scale pilots in specific regions, failing to achieve the widespread adoption and scaling needed to support the broader smallholder farming community. The lack of reach and scalability restricts the potential of these innovations to significantly enhance smallholder farmers' resilience to climate change at a national or global level.

In this brief, we aim to:

- evaluate the effectiveness of these tools in promoting financial inclusion among different groups of farmers,
- explore the opportunities and challenges for achieving large-scale implementation and adoption, and
- propose strategic approaches that incentivize sustainable participation from the private sector and other supporting institutions in smallholder financial markets.

3. Overview of ClimBeR's financial instruments

This section presents a brief overview of the three innovations implemented by ClimBeR, detailing each innovation's background, target farmers, execution strategies, and partnerships.

3.1 Risk contingent credit

Risk contingent credit (RCC) is an innovative bundled credit product that embeds within its structure insurance protection which, when triggered, offsets the credit repayment obligation of farmers, which in turn removes, or at least reduces, the credit exposure of lenders. By linking loan repayment to the underlying risk, RCC bypasses the need for stringent bank collateral requirements, making credit available to many small-scale farmers who

otherwise could not afford the collateral. This approach reduces the probability of default on loans and improves the farmers' risk-bearing capacity. Research shows that by minimizing the stringent lender's collateral requirements, and the probability of default on loans, RCC can improve the farmers' risk-bearing ability thereby promoting credit uptake among the different categories of smallholder farmers. Further, unlike the conventional, stand-alone agricultural insurance products that require upfront premium payment, RCC premiums are deferred until the end of the cropping cycle. This structure helps address liquidity constraints which often constrain the demand for agricultural insurance in many developing countries (Shee et al. 2019; Casaburi and Willis, 2018).

The ClimBeR Initiative implemented RCC in Kenya, Ethiopia, and Zambia in partnership with financial service providers, including Awash Bank (Ethiopia), Equity Bank and Family Bank (Kenya), and insurance companies including Oromia Insurance Company, and APA Insurance. Re-insurance services were provided by Swiss-Re and Africa-Re. The underlying insurance was linked to the rainfall outcomes enabling insurance providers to cover a portion or the full loan repayment depending on the amount of rainfall received during the cropping cycle. The insurance index was based on Climate Hazards Group InfraRed Precipitation with Station (CHIRPS) rainfall data. For each insured cropping season, a dynamic index trigger was developed using a 21-day moving average to define four payout events corresponding to key phenological stages: germination, emergence, flowering, and maturity. If the accumulated rainfall in the current season falls below 60 percent of the long-run average, a payout event will be triggered, with a payout issued directly to the lending institution offset farmers' loan obligations. The initiative also explored additional aspects of climate risk profiling, including drought stress, heat stress, and flood and waterlogging hazards, to enhance the insurance index. By integrating these indicators with satellite observations, the initiative provided more comprehensive insights into climate risks, thereby improving the robustness of the insurance product.

3.2 Climate-credit scoring

The lack of a good credit history commonly referred to as "thin files" (Björkegren and Grissen, 2020), has been a major barrier preventing smallholder farmers from accessing production credit through conventional lending institutions. This challenge is further exacerbated by biased credit scoring matrices that overlook unique circumstances and the potential of smallholder agriculture. To address these challenges, the ClimBeR Initiative program has been working with private financial service providers to innovatively integrate climate data—such as seasonal climate forecasts and satellite-derived weather information—into conventional credit scoring algorithms. In theory, this approach aims to help quantify the potential impact of climate variability on crop yields and farm income, reducing the perceived risks of lending to smallholders (Römer and Mußhoff, 2018). As a result, farmers who adopt climate-smart practices or operate in areas with favorable climate forecasts may receive better credit terms, even if they lack traditional collateral or credit history. ClimBeR's credit scoring tool was developed in partnership with local microfinance institutions such as Ecumenical Church Loan Fund (ECLOF), Centenary Bank, Agora Microfinance, and Agricultural Finance Corporation, and leveraged fintech solutions like Financial Access LendXS platform for efficient data processing and outreach. Tailored to farmers in the dairy and maize value chains, the tool was piloted in Kenya, Uganda, and Zambia. The integration of advanced climate analytics enabled the model to incorporate real-time climate forecasts from sources like the European Centre for Medium-Range Weather Forecasts (ECMWF), thereby accounting for climate exposure, sensitivity, and adaptive capacity—factors crucial for accurate risk assessment in agricultural contexts. This innovation significantly bridges data gaps, providing financial institutions with a more nuanced understanding of borrowers' risk profiles, leading to a reduction in non-performing loans (Benami and Carter, 2021). Additionally, ClimBeR conducted a series of capacity-building events to ensure that loan officers were well-equipped to utilize the scoring tool and engage effectively with farmers.

3.3 Agricultural Insurance

To help reduce smallholder farmers' exposure to climate risks the ClimBeR Initiative developed and implemented an Area-Based Yield Index Insurance (ARBY) product for rice farmers in the Philippines. The product was developed in collaboration with the Philippine Crop Insurance Corporation (PCIC), the Philippine Rice Research Institute (PhilRice), and the International Rice Research Institute (IRRI). The ARBY product leveraged the Philippine Rice Information System (PRISM)—a satellite-based rice mapping and monitoring system co-developed by IRRI and PhilRice. Since its operational launch in 2018, PRISM has provided high-resolution and timely data on rice areas and yields across the country. Historical seasonal yield data from PRISM were used to set insured yield thresholds and determine payout triggers for the ARBY product. Unlike conventional insurance, ARBY calculates payouts

based on the average yield of a defined geographic area or insurance zone rather than individual farm performance. If actual yields in the zone fell below a predefined threshold, all insured farmers in the zone received compensation. This approach reduces issues like information asymmetry and offers comprehensive protection against risks such as drought, floods, typhoons, saline intrusion, heat waves, and pest outbreaks.

4. Uptake and Financial inclusion

To evaluate the impact of these innovations, ClimBeR designed a rigorous monitoring and evaluation system that involved both quantitative and qualitative household surveys and focus group discussions with all stakeholders.

Figure 1 illustrates the effective demand of the RCC product among different categories of smallholder farmers based on the pilot studies in Kenya and Ethiopia. In Ethiopia, 58 percent of the target population applied for the RCC product, but only 44 percent of applicants were approved. In Kenya, 62 percent of the target population applied, however, only 47 percent of households were granted credit. A qualitative survey shows that pre-implementation training on financial literacy and risk management significantly improved farmers’ knowledge of the value of the product, positively influencing their uptake. Farmers who adopted the product cited several key factors influencing their decision, including ease of product understanding, trust in providers, and confidence in RCC’s ability to safeguard them against downside climate risks. However, we found that application and approval rates were higher amongst older men and lowest among younger women. These gender and age disparities in application persisted despite ClimBeR’s efforts to implement training and extension approaches that were specifically designed to address gender and social equity gaps in financial access and utilization. The significant differences in application and approval rates suggest the existence of systemic barriers in agricultural lending and supply-side constraints, that cause credit providers to either deny or reduce credit offerings to some groups of farmers, a phenomenon known as quantity rationing.

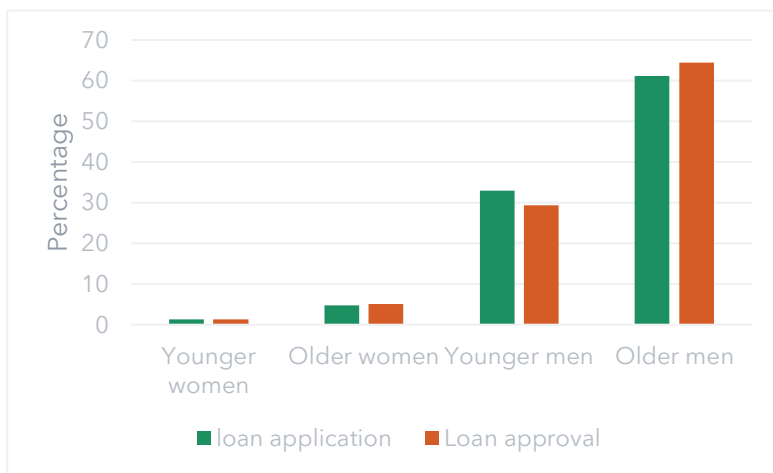


Figure 1: RCC uptake by gender and age

Ongoing impact evaluation indicates that RCC adoption has significantly increased household investment in chemical fertilizer which, in turn, led to increased farm productivity. The broader impacts of RCC adoption extend beyond individual households. By increasing access to credit and promoting investments in agricultural inputs, RCC contributes to improved food security and economic stability in farming communities. Furthermore, the reduction in loan defaults, as a result of RCC’s built-in insurance mechanism, strengthens the relationship between farmers and financial institutions, fostering trust and encouraging greater financial inclusion. These ripple effects position RCC as a transformative innovation for smallholder agriculture, with the potential to enhance resilience and drive sustainable development at the community and national levels. However, ensuring social equity in the implementation of these financial innovations remains a critical challenge. Ongoing impact evaluations for instance show that RCC benefits were disproportionately higher among older male farmers, highlighting demographic disparities in the benefits of the innovation.

The Climate-Credit Scoring innovation reached approximately 1100 farmers across Kenya, Uganda, and Zambia, during its pilot phase—disbursing loans worth 18 million Kenyan shillings and 22 million KSH currently under review (totaling up to 0.3 million USD). The project also focused on capacity building, by training 120 loan officers

on the climate-credit scoring approach. The distribution of credit scores revealed that 54 percent of farmers were classified as grade B, indicating a strong credit profile with a high likelihood of loan approval, while 16 percent of farmers achieved grade A, representing the most creditworthy segment. Farmers in grades C and D accounted for 26 percent and 3 percent respectively, highlighting areas requiring additional support to improve creditworthiness. Gender-disaggregated data showed notable differences in outcomes. Female farmers outperformed males in higher credit grades, with 57 percent of women classified in grade B and 18 percent in grade A, compared to 46 percent and 10 percent of males, respectively. Male farmers exhibited a more even distribution across grades, with a significant portion in grade C, indicating potential for targeted interventions to enhance their credit profiles.

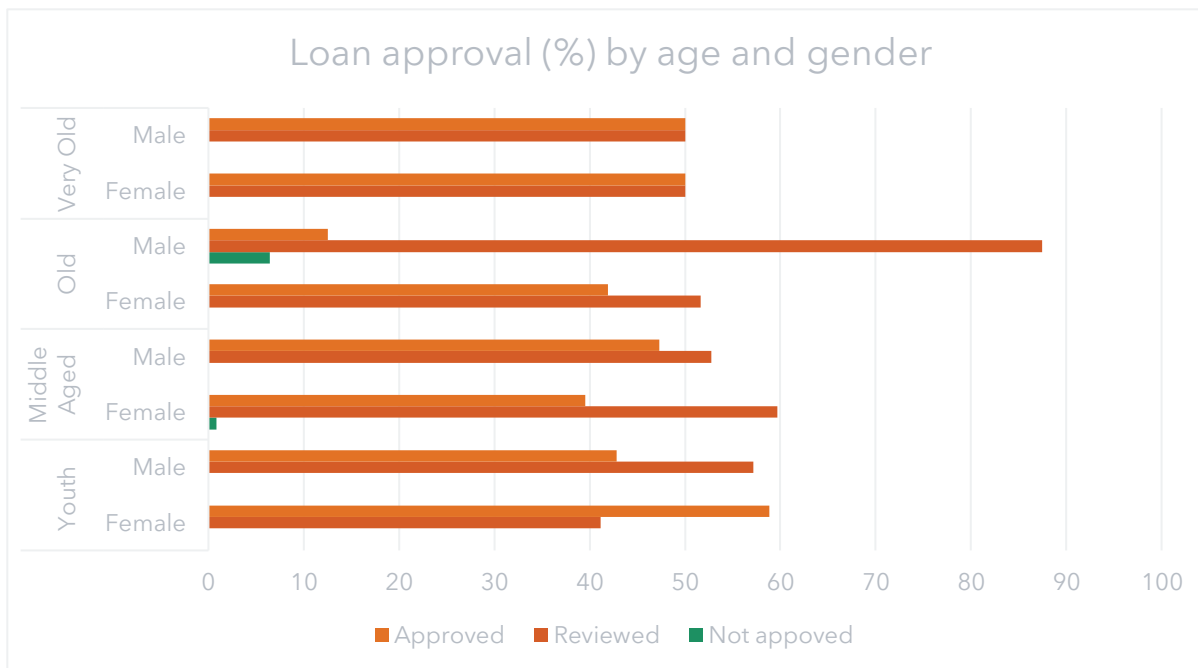


Figure 2: Loans approved through climate-credit scoring tool, by age and gender

The integration of climate risk indicators such as exposure, sensitivity, and adaptive capacity enabled financial institutions to make more informed lending decisions. Farmers with improved risk profiles experienced greater approval rates, particularly among those traditionally underserved by conventional lending systems. Survey feedback indicated that farmers valued the transparency and tailored assessments provided by the tool, which increased their confidence in engaging with formal credit systems. However, systemic barriers, particularly for younger women and older men, persisted despite efforts to address these disparities through targeted training and advisory services. The pilot demonstrated the feasibility and value of integrating climate risk into credit scoring frameworks, laying a foundation for scaling the approach to other agricultural value chains and geographies. Finally, a survey conducted among stakeholders and rice farmers in the Philippines also revealed a high willingness to pay for the ARBY product. Farmers recognize ARBY’s potential to act as a buffer against climate risks and addresses gaps in existing insurance systems, offering a scalable and data-driven model for improving the resilience of smallholder rice farmers.

5. Lessons for scaling

Achieving a fully sustainable and commercial use case for agricultural financial products for smallholder farmers in LMICs is a complex task that entails technological, social, economic, and regulatory challenges. While theoretical and preliminary evidence demonstrate ClimBeR’s positive impacts, the implementation of these financial tools faced a myriad of challenges that constrained their full efficacy and potential to unlock and transform rural financial landscapes and enhance climate resilience in agriculture. A key lesson was the importance of integrating complementary mechanisms, such as bundled insurance products and risk-sharing arrangements, to address residual risks and enhance lender confidence. The pilots (both RCC and credit scoring) emphasized the need for tailored products that combine credit with risk mitigation tools, fostering greater uptake among smallholder farmers. Operational alignment with institutional workflows was identified as crucial for seamless integration into

financial institutions' systems. Early engagement and capacity building for staff, alongside iterative feedback loops, proved effective in addressing adoption barriers.

Moreover, the sustainability of the positive impacts over the long term depends on ClimBeR's ability to maintain farmers' interest and engagement over time, especially as climate patterns and agricultural needs evolve. Equally crucial is the willingness and capacity of private financial institutions to integrate these innovative instruments into their regular commercial product offerings without the need of government and donor subsidies and support. The regulatory environment is also crucial in fostering an enabling ecosystem for agricultural financial markets to thrive. Drawing from a synthesis of existing literature (such as Carter et al. 2017; Kramer et al. 2021; Hazell and Timu, 2024) and our own field experiences, we present the key challenges encountered and proposed solutions for implementing and scaling future innovative financial instruments for smallholder farmers LMICs.

5.1 Demand-side interventions

Increasing effective demand: High product demand is important in creating a business case that aligns with the profit motives of commercial entities. Some identified ways of attracting and retaining farmers include; (i) designing simplified financial instruments that address important risks and needs from the farmers' perspective, (ii) enhancing farmer education and financial literacy, (iii) building trust in both the products and providers, and addressing risk attitudes which can be achieved by the provision of education on risk management and designing products that align farmers' risk tolerance levels.

Co-designing interventions: Addressing demand involves creating products that not only meet immediate financial needs but also align with farmers' long-term goals and aspirations. Co-designing involves actively engaging farmers, local communities, financial institutions, and other stakeholders in the design and development of financial instruments. By incorporating farmers' perspectives, needs, and local knowledge in particular, co-design ensures that products are relevant and aligned with farmers' risk attitudes and financial capabilities. Co-designing can result in products that are more likely to be adopted, effectively used, and sustained over time, ultimately contributing to increased financial inclusion and resilience among smallholder farming communities.

Reducing cost for farmers: While there is little scope for reducing the pure cost of credit and insurance, development practitioners, the private sector and the governments can adopt some mechanisms that can reduce the overall cost burden to make financial instruments more affordable and encourage wider adoption among smallholder farmers. For instance, interest rates on credit can be lowered through improved risk assessment, government support, and increased competition among lenders. Insurance premiums can also be lowered through innovative product design and reduction of commercial loadings by the financial institutions. Government subsidies play a significant role in cost reduction, either through direct support to farmers or by incentivizing financial institutions to offer more favorable terms. Additionally, leveraging technology (e.g. mobile banking and other digital technologies) to streamline processes and reduce operational costs can lead to savings that can be passed on to farmers.

Addressing gender and social equity gaps: Despite the increased accessibility of credit tools, barriers persist for marginalized groups, particularly women, youth, and farmers with limited education. These groups often face systemic exclusion due to biases in financial systems, cultural norms, and a lack of tailored outreach efforts. Addressing disparities in access requires tailored approaches that consider the unique challenges faced by women and marginalized groups. This could involve customized training, extension services, and outreach strategies to better meet the needs of marginalized groups.

5.2 Supply-side interventions

Reducing transaction costs for the private sector: Reducing transaction costs for the private sector is crucial in making financial products for smallholder farmers commercially viable and sustainable. These include; (i) the use of digital platforms can significantly lower operational costs by automating processes, reducing paperwork, and enabling remote transactions. (ii) Enhanced distribution networks, such as partnering with local agricultural cooperatives or leveraging mobile banking agents, to extend the reach of financial services to remote rural areas without the need for costly physical branch expansions, and (iii) Portfolio diversification by offering a range of products tailored to different farmer segments and agricultural value chains, which allows the financial institutions to spread their risk and potentially cross-subsidize less profitable products with more lucrative ones.

Improved farmer data: Access to accurate and comprehensive farmer data can improve the implementation and sustainability of financial products by, (i) reducing information asymmetry and transaction costs, (ii) enhancing the financial sector's ability to map out farmers' risk profiles thereby improving lending decisions, (iii) advanced data from satellite imagery, mobile phone usage patterns, and digital transaction histories, can provide valuable insights into farmers' productivity, financial behavior, and creditworthiness, which can be used to create a more holistic view of a farmer's financial health and potential.

5.3 Government and Policy interventions

Creating a favorable policy environment: Government engagement plays a crucial role in fostering an enabling environment for the development and scaling of locally suited financial products. Effective policies can create a regulatory framework that can encourage financial institutions to serve rural areas and agricultural sectors.

Government engagement: Government subsidies and reinsurance services can significantly reduce the cost of insurance premiums and interest rates on agricultural credit, thereby enhancing the affordability of these services to smallholder farmers. Development initiatives such as ClimBeR can also leverage the government extension networks to disseminate information about financial products and provide financial literacy training. Government backing can also lend credibility to new financial instruments. Finally, governments can support the development of digital platforms and enhanced distribution networks, reducing transaction costs for both farmers and financial service providers.

In Zambia, the ClimBeR Initiative is in the final stages of formalizing an agreement with the government to integrate its RCC into the government's Sustainable Agricultural Financing Facility (SAFF). This collaboration is aimed at leveraging government support to scale financial solutions and improve financial inclusion for many smallholder farmers (Mascarenhas et al. 2024).

6. Conclusion

The financial innovations implemented under the ClimBeR initiative demonstrate significant potential to address critical barriers to financial inclusion for smallholder farmers and enhance their resilience to climate risks. The three innovations, Risk Contingent Credit (RCC), Climate-Credit Scoring, and Area-Based Yield Index Insurance (ARBY) highlight the transformative power of bundling credit, insurance, and climate-informed decision-making tools to create inclusive and scalable financial solutions. The RCC product has shown promise in mitigating credit default risks for both farmers and lending institutions, while simultaneously encouraging greater investment in agricultural inputs and enhancing productivity. Climate-Credit Scoring has effectively integrated climate analytics into traditional credit evaluation, increasing access to credit for underserved farmers and reducing non-performing loans. The ARBY insurance model, leveraging advanced satellite-based systems, offers a scalable, data-driven solution to mitigate climate risks and address gaps in conventional insurance systems. However, the social distribution of benefits underscores the importance of ensuring equity in implementation. Marginalized groups especially younger women, youth, and farmers with limited education continue to face systemic barriers to accessing financial tools, highlighting the need for inclusive design, gender-sensitive outreach, and capacity-building programs. Addressing these disparities is crucial for achieving broad and equitable impacts. The impacts of these innovations extend beyond individual households. By increasing access to financial services and fostering trust between farmers and financial institutions, these tools strengthen community resilience, enhance food security, and promote economic stability. The integration of social equity principles into the design and implementation will further amplify their transformative potential, enabling more smallholder farmers to overcome climate challenges and thrive. As these financial tools continue to evolve, it is essential to address both demand-side challenges, such as limited financial literacy and trust, and supply-side constraints, including private sector risk appetite and digital readiness. By refining these innovations and scaling them sustainably, ClimBeR and its partners can lead the way in creating resilient agricultural systems that leave no farmer behind.

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