# Approaches to Integrate Climate Change in Agricultural Finance

## Case Study Analysis


The Energy and Resources Institute
*Creating Innovative Solutions for a Sustainable Future*

CICERO

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# 1. Introduction

Agriculture is the backbone of economic growth for many economies, especially the developing countries that generate three quarters of the world's agricultural value (FAO 2013). The sector employs and provides livelihoods to 2.5 billion people, often among most vulnerable populations living in poverty. The sector is also responsible for a quarter of total global greenhouse gas (GHG) emissions, such as carbon dioxide, nitrous oxide and methane, which increase with agricultural production levels. This steady increase in GHGs from agricultural production can be attributed to various factors including (i) the doubling of world's population from 3.7 billion in 1970 to over 7 billion in 2014 (UN 2014), (ii) the increase in emission intensive practices such as intensive tillage, stubble burning and excessive use of fertilisers, and (iii) increased wealth and meat consumption, which results in more ruminants.

Bennetzen, Smith, and Porter (2016) found that the developing regions of South and Southeast Asia and Central and South America are currently responsible for 80% of the world's agriculture-related emissions. The sector, therefore, presents a focused and impactful opportunity to mitigate region's emissions by promoting adoption of sustainable agricultural practices.

While agriculture is a driver of climate change, it is also extremely vulnerable to its impacts. The extent of the impacts of climate change on agriculture depends on the regional or local variation in temperature, rainfall, crops, soil, and agricultural practices. Even the slightest variation in climate variables can lead to crop losses or cause a decline in livestock productivity. For instance, Lobell and Field (2007) found that a change in climatic factors has reduced wheat and maize crop yield across the world, while Schlenker and Roberts (2009) indicated that extreme heat events can have a negative impact on the yield of corn and soybean. There have also been instances where extreme weather events have led to extensive damage to crops and huge economic losses for entire sectors. After conducting an analysis of 78 post-disaster need assessments in developing countries, FAO concluded that about 25% of the total impact of climate-related disasters between 2003 and 2013 was borne by the agricultural sector. The climate impacts can also be indirect in nature, causing pest infestation, soil degradation, increased livestock mortality, and increase in crop water demand (since evapotranspiration rate increases with temperature and the soil moisture level declines).

Agriculture has adapted to the changing climate for centuries. However, the rapid pace of climate change is putting pressure on agricultural systems that increasingly require adaptation strategies. Fan, Fei, and McCarl (2017) provide a number of agricultural adaptation strategies being implemented globally to make the sector climate resilient. These include shifting the crop sowing time, increasing pesticide treatment, adopting climate-resilient crops, and altering the time and amount of water for irrigation.

More frequent and more intense climate-induced natural disasters, such as floods and cyclones, destroy standing crops and cause significant damage to rural infrastructure and irrigation systems. According to FAO (2018a), there were 260 natural disasters per year in developing countries during 2005–2016 (climate and weather related as well as geophysical and biological), which is an 11% increase over the preceding decade. The agricultural sector is particularly vulnerable to natural disasters. This brings the need for disaster risk mitigation measures to the forefront as an immediate step to prevent large, unforeseen loss and damage in this sector.

Several countries have committed to reducing their agricultural sectors' contribution to climate change and investing in climate resilience. Out of 162 nationally determined contributions (NDCs) submitted by countries, almost 104 parties have pledged to reduce emissions in agriculture, while 127 parties have included it as a priority area for adaptation (CGIAR CCAFS 2017). For almost 55 developing countries with major agriculture economies, the adaptation finance requirement is in the order of US$3 billion per annum (Richards, Gregersen, Kuntze, *et al*. 2015), while IFPRI (International Food Policy Research Institute) has estimated finance requirements to be much higher at about US$7 billion per annum.

Adaptation investments, specifically in agriculture, offer an opportunity to leverage both climate and sustainable development benefits. However, the benefits of adaptation are difficult to quantify in monetary terms and take time for impacts to show up, and this acts as a barrier to raising current adaptation investments and mobilizing them in future (Pillay, Aakre, and Torvanger 2017; IFPRI 2017). According to Global Landscape of Climate Finance 2017, adaptation finance contributed to only 16% (US$22 billion) of the public climate finance in 2015–16. The majority of this finance was used in the water sector and a small share of US$4 billion went into the agriculture sector (CPI 2017).

## Overview of agriculture sector in India

Almost 70% of the rural population in India is dependent primarily on agriculture for their livelihood, amongst which 82% of farmers are small and marginal (FAO 2019). The sector was responsible for 16.2% of gross GHG emissions in India in 2014 (UNFCCC 2019), with cropland-based agricultural activities accounting for 24% of India's total methane emissions.

Despite the significance of the agricultural sector in the Indian economy, it has long been characterized by financial distress and rural indebtedness at the farmers' level. Cooperative credit societies, established for a cluster of villages, were considered the best way to extend agricultural finance. However, this form of financing has since been criticized due to the extremely high and unregulated rates of interest charged by the microfinance institutions, which has served only to increase the debt of farmers. To help farmers move towards more stable income streams and a formal financial system, the government has deployed a range of measures, such as minimum support prices, loan restructuring, and subsidies on farm inputs under various agricultural schemes and programmes. However, the efforts have provided only a short-term fix, which is evidenced by persistent debt rates among farmers. These short-term solutions have addressed financial emergencies. However, they have failed to address the cause of loan defaults or taken effective measures to mitigate the underlying risk in the agriculture

### Agriculture sector's challenges in accessing finance

***In developing countries, the agriculture sector has historically faced significant barriers to accessing finance due to the following reasons:***

1. Lack of collateral for bank loans. Farmers generally lack assets, besides their land, which can be offered as collateral to guarantee loans. Even if the farmers have some form of collateral available, its quality and quantity are seldom suitable for lending institutions requirements. Many banks, as part of their risk mitigation processes, require third party guarantees, which small farmers cannot provide.
2. Lack of timely finance. Farmers' financing needs are highly time sensitive in line with crop cycles, but finances are generally not available when needed the most, resulting in low productivity and high financial losses.
3. Lack of financial literacy. Small farmers are largely unaware of the terms for loans and finance schemes and procedures for repayments, payouts, and subsidies awarded to them.
4. Lack of access to financial institutions. Long wait times and inefficient processes that require several long-distance trips to the bank for submission of required documents result in lost wage days for farmers and translate to very high transaction costs for farmers seeking loans.

Adding climate change-related risks and issues to the mix worsens access to suitable finance even further. Bank officials lack the capacity to properly forecast and quantify the impact of climate risk on agriculture due to factors such as insufficient data on weather parameters and lack of assessment tools.

sector. The issues of this already fragile sector's issues are exacerbated by climate change. The assessments by the Indian Network of Climate Change Assessment (INCCA 2010) project a decrease in the frequency (number of days) of rainfall by 2030, but a substantial increase in its intensity. A similar trend has been predicted for extreme weather events in the Arabian Sea, where the storms are projected to become more intense. An FAO (2018b) study projects India, along with West Africa, to have the highest fall in agricultural production by 2050. Such projections indicate an extreme risk to the Indian agriculture sector and an immediate need to mobilise investments in climate resilience.

With this context, this report attempts to collate proven practices for climate finance in the agricultural sector from around the world.

# 2. Study methodology

1. **Literature review.** An extensive review of the existing literature citing recent approaches and agriculture financing models was carried out.
2. **Long list of cases.** A total of 22 potential cases were identified spanning across various developing countries and covering a range of financial instruments in order to reflect the diversity of actions being taken up globally to address the issues of the agriculture sector's adaptation to adverse climate impacts.
3. **Shortlisting the cases.** Ten cases were shortlisted on the basis of three parameters: relevance (or potential) to climate actions for adaptation, the potential for scaling up or replicating such interventions in India, and the availability of sufficient information from secondary sources.
4. **Preparation of case studies.** This was followed by the detailing of the shortlisted case studies to get an overview of the challenges faced by farmers in accessing finance and the approaches being employed to increase the financial access and build climate resilience.
5. **Identification of climate resilient measures.** A number of measures promoting climate resilience were identified that countries should consider while preparing future agriculture finance projects in order to increase its uptake, acceptance, and benefits among the stakeholders involved.

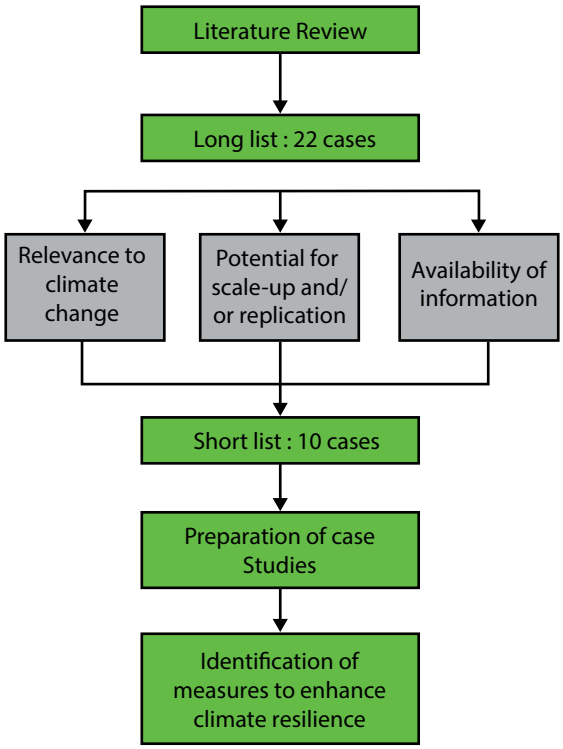


**Figure 1:** Methodological approach adopted for the study

# 3. Global Case Studies : Financing Climate Smart Agriculture

Table 1 summarizes 10 approaches designed to mobilize finance and improve resilience for small agricultural producers in Asia, Africa, and South America. The purpose of the study is to provide an overview of the common financial and climate challenges that small agricultural producers face and the financial products and interventions leveraged to address these challenges.

It is reflected through the cases that the state and central governments often take the lead in addressing initial financial barriers by providing funds or risk mitigation through grants and loan guarantees or through enabling legislation. These interventions help engage private sector actors and mobilize private funding by reducing perceived or real risk.

Each case features financial instruments or approaches that increase the liquidity of agricultural value chains. The public and private instruments include climate insurance, remote technical assistance and impact verification, proxy credit scores, and mandatory public green infrastructure set-asides, each designed to grant small farmers access to finance they need to invest in climate resilience and adaptation.

Overall, the cases generate a range of benefits for all the stakeholders involved, especially farmers. They have not only improved the farmer's access to finance, but also helped them manage climate risks, reduce emissions from production, increase crop yields, and consequently income levels. With small agricultural producers in India facing similar climate and financial stresses, the detailed case studies in the next section may provide some applicable lessons.

**Table 1: Snapshot of case studies**

| S. No. | Case study | Financial instrument | Approach to reduce risk | Key stakeholders | Role | Financial benefits | Key challenges |
|---|---|---|---|---|---|---|---|
| 1 | AFRICA Climate-Smart Lending Platform | Fund/finance facility | Technology | Local lenders, smallholder farmers | Helps local lenders provide climate-smart lending products such as climate-smart credit, environmental interest rates, and eco-credit systems | Tailored products reduce financial risk for lenders and farmers | The platform is totally dependent on grants |
| 2 | Malawi, Africa Drought insurance | Crop insurance specific to droughts | Weather risk management | Farmer associations, banks, Malawi Meteoro-logical Services, World Bank's Commodity Risk Management Group | Providing inputs like technical capacity building and data to establish a robust drought index | Improved financial security of farmers with production focused on high value-added products | Lack of available data for creating indices |
| 3 | China Sustainable grazing | Voluntary carbon markets facilitated by FAO's Verified Carbon Standards | Lowering of costs | Small herder communities, FAO's VCS, government or private investors | Initial investors provide funding to small herder communities to establish sustainable grassland management | Additional income opportunities by sale of sequestered carbon in VCM. | Initial source of sustainable grassland financing is unclear. Unclear about who owns the carbon credits; farmers or investors? |

**Table 1: Snapshot of case studies**

| S. No. | Case study | Financial instrument | Approach to reduce risk | Key stakeholders | Role | Financial benefits | Key challenges |
|---|---|---|---|---|---|---|---|
| 4 | Ethiopia Credit Guarantee Services | Providing guarantees as an instrument to reduce credit risk | Managing risk of default and price fluctuations | Coffee farmer cooperatives, local banks, common fund for commodities and Rabobank International Advisory Services | To provide access to post-harvest coffee processing machinery | Improvement in income of farmers due to high productivity of coffee | Short-term duration of bank loans, lack of active participation of farmer cooperatives |
| 5 | Global Big Data, Small Credit | Credit access through digital footprint as proxy for credit score | Technology | Small farmers, lenders | Technology that helps farmers get access to finance | Banks increase client base and farmers get access to finance. | New approach to credit and could be risky/very inaccurate |
| 6 | Gujarat, India SKY Scheme | Capital cost subsidy to finance solar pumps | Managing risk of default and technology related uncertainties | Farmer cooperatives, Centre and state governments | Promote the use of solar irrigation pumps | Increased returns and decreased financial risk of farmers through provision of feed-in-tariff | Risk of overuse of groundwater by selling excess water to other farmers at high price, lack of awareness on solar pumps among farmers |
| 7 | India Warehouse receipt financing (WRF) | Loans for farmers in exchange for their crops which are stored as collateral in a verified warehouse | Value chain finance | Small farmers, banks, certified warehouses, buyers | Promote efficiencies along the supply chain and reduce losses for small farmers | Farmers get access to storage and a good price for crops; banks can invest with lower risk | Lack of awareness among farmers regarding WRF |

**Table 1: Snapshot of case studies**

| S. No. | Case study | Financial instrument | Approach to reduce risk | Key stakeholders | Role | Financial benefits | Key challenges |
|---|---|---|---|---|---|---|---|
| 8 | Kenya Strengthening Adaptation and Resilience to Climate Change | Interest free loans, grants and guarantees for climate-oriented start-ups to reduce perceived risk. | Managing risk of default and weather risk management | Climate start-ups; KCIC, REACT, FICCF | Incubator to help climate-related start-ups launch business and attract investors | Provides support to climate-oriented start-ups through seed funding | Raising initial seed funding for the incubators |
| 9 | Mindanao, Philippines Weather-index based insurance | Loan and weather-index based crop insurance, specific to corn and rice. | Weather risk management | Farmers, Government corporation (Philippines Crop Insurance Corporation) | Measures weather parameters through stations in Mindanao, farmers paid if rainfall is above or below normal rainfall levels. | Farmers receive a financial coverage for the losses incurred due to climate change | Complexity of weather indices, lack of awareness among farmers on insurance products |
| 10 | Peru, South America Watershed conservation | Tariffs on monthly water bills to establish green infrastructure investment funds | Price risk management | Water utility companies (partially public), local governments, agricultural communities | Water utilities place earmarked tariff on monthly water user bills to generate investment funds for green infrastructure projects | Sustainable source of funds from water users earmarked for pre-approved projects | |

## 3.1. Africa: Climate-Smart Lending Platform

### *Problem statement*

Smallholder farmers worldwide are particularly vulnerable to climate hazards, which include drought, flooding, and desertification, among other things. Investments in climate resilient farming practices (also known as climate-smart agriculture) can help protect livelihoods and – in some cases – increase productivity and incomes, but access to appropriate financing instruments is a common challenge for smallholder farmers. Although smallholder finance is growing in scale and currently accounts for US$50 billion globally (Dalberg 2016), there is still a significant financing gap between smallholders and lenders with smallholder lending portfolios. This is often because these investments are considered risky and climate risk is not well understood or documented.

### *The solution*

Studies modeling the potential impact of climate-smart agriculture (CSA) have suggested that farmers could increase profits by a factor of two to four during climate hazards as compared to farmers that have not invested in climate resilience. Investing in CSA has also been linked to reduced exposure to climate-induced credit default for lenders.

The Climate-Smart Lending Platform 'F3 Life' is a web-based platform that uses a suite of tools and products designed to address the gap in financing, risk management, and technical expertise needed between smallholder farmers and lenders. Led by banks and financial institutions, the Platform helps local lenders apply CSA lending products such as climate-smart credit, environmental interest rates, and eco-credit systems that will encourage investment in and implementation of better climate resilient farming practices. This increased access to finance will help farmers increase profits, minimize losses due to climate impacts, and reduce the credit provider's exposure to climate risk.

The long-term goals of the Platform are threefold: (i) to harness private finance to facilitate investment in CSA, (ii) to create strong incentives for farmers to adopt CSA practices, and (iii) to incorporate CSA metrics into the credit scoring systems of financial institutions.


1. **A farmer signs a loan and land management agreement**
   Smallholder farming clients gain access to credit in order to develop their farming enterprise, on the condition that they adopt climate smart farming practies
2. **Repayment and Implementation**
   The farmer implements the required climate-smart agricultural and land management practices on their land
3. **Monitoring**
   F3 Systems are used to monitor implementation of climate-smart practices
4. **Climate Smart Credit Scoring**
   When a farmer complies with the climate-smart requirements of their loan agreement, they are provided with a score which boosts their credit score
5. **Results**
   With implementation, farmers build their resilience to climate change and protect agricultural lending portfolios from climate change risk

**Figure 2:** Process of Climate-Smart Lending Platform

*Source: Climate-Smart Lending Platform and F3 Life: Climate-smart credit, environmental interest rates and eco-credit systems, 2017*

The Climate-Smart Lending Platform promotes the following tools and approaches:

1. **Impact models.** The Platform provides financial models that demonstrate how CSA credit systems can help lenders reduce default risk induced by climate hazards and increase coverage of debt for clients.
2. **Credit products and process designs.** The Platform works with lenders and aggregated groups of smallholder farmers (e.g., cooperatives) to develop loan products for fixed assets and working capital that address the social and financial needs of stakeholders. Loan terms and conditions outline requirements for investment in climate resilience that will reduce credit default risk. They may include preferential loan terms for women. The products include climate-smart credit, eco-credit, and environmental interest rates.
    - **Climate-smart credit.** It introduces agricultural and land management practices that build climate resilience into loan terms. As part of the loan agreement, the farmer signs a land management agreement that requires that borrowers apply climate-smart agricultural practices to the land. This helps to reduce borrowers' vulnerability to climate hazards and lenders' exposure to climate risk.
    - **Eco-credit.** In this financial product, farmers in need of commercial debt are eligible to receive credit to reward provision of ecosystem services or goods. The Climate-Smart Platform has developed systems for watershed management, soil conservation, and even coastal fisheries management.
    - **Environmental interest rates.** The Climate-Smart Platform has also developed 'environmental interest rates,' which includes environmental interest as well as financial return into the calculation of an interest rate on a loan to eligible borrowers. These loans are intended to contribute to the restoration of degraded farmlands and forest landscapes.
3. **Cost-efficient monitoring systems.** The Platform uses mobile technology as a remote monitoring tool that allows lenders to verify borrowers' compliance with the CSA farming practices outlined in the terms of their loan.
4. **A climate-smart credit-scoring tool.** The Platform offers a climate-smart credit risk scoring tool, which combines cash flow analysis with climate risk factors and information about the farm in question to arrive at an overall credit score for the borrower and broader portfolio. The score is intended to provide lenders with the information they need to reduce default and climate risk in their lending portfolio.
5. **Advisory service, training, and technical assistance.** It is provided to help lenders adopt and implement new systems.

Coordination of the Platform is funded with grants. The coordination team helps develop partnerships and raise funding for new CSA projects. It also helps share best practices and lessons across projects.

### *Implementation*

**Project initiation:** The Climate-Smart Lending Platform, developed by F3 Life, Financial Access, the International Union for Conservation of Nature (IUCN), and the Climate Policy Initiative's Global Innovation Lab for Climate Finance, was a winner of the Global Innovation Lab for Climate Finance in 2016. The Platform also has support from the Netherlands, the Sophia Foundation (Project Sophia), and FONERWA for initial development

**Status:** The Platform is being rolled out in three phases. In Phase 1 (2017–2021), a series of projects are being developed in collaboration with financial institutions and implementing partners in three different geographies and crop contexts (nine projects in total) to prove the climate-smart lending case. Each project is funded with grants and concessional loans to develop the initial climate-smart loan products and monitoring tools that will feed into credit risk scoring tools. The second and third phases will focus on commercialization and mainstreaming, and so no concessional financing is envisaged.

**Beneficiaries:** The project will help lenders provide 'climate-smart' financial products to smallholder farmers by incorporating climate-smart and sustainable land management tactics into loan terms and credit scores. It will also help lenders manage climate risk and reduce costs in smallholder finance by providing targeted technical assistance and building a reservoir of climate data associated with loans.

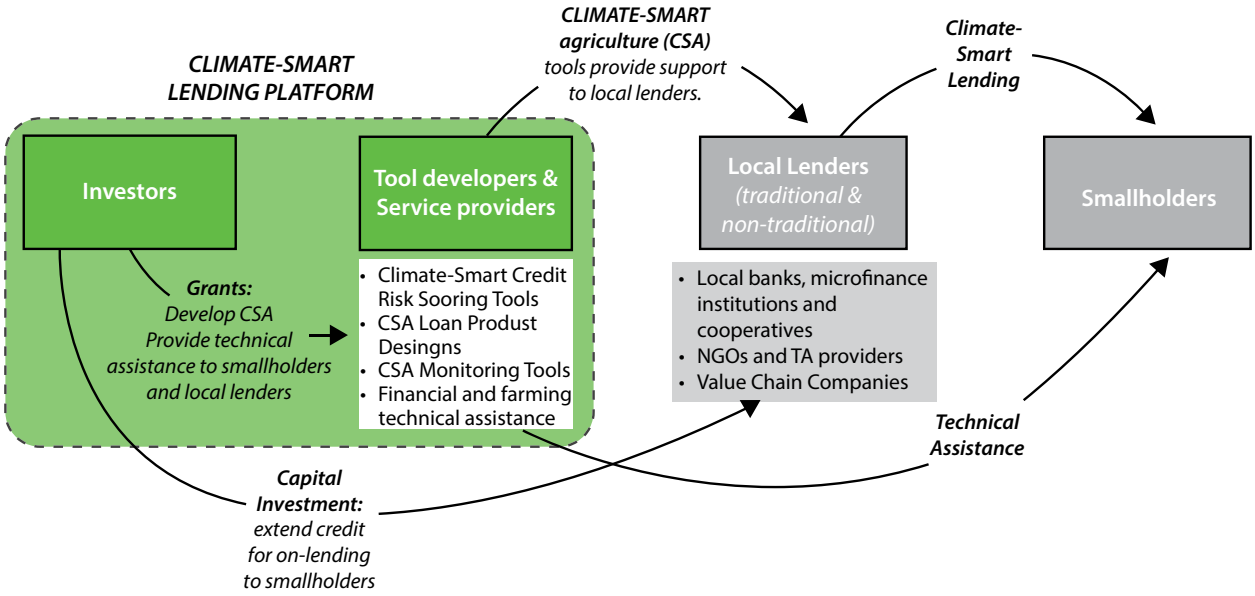


**Figure 3:** Design of Climate-Smart Lending Platform

*Source: Details available at https://www.climatefinancelab.org/project/climate-smart-finance-smallholders/, last accessed on 2 September 2019*

## *Expected impacts*

This project is still in the initial phases of implementation, and there are no demonstrable impacts yet. However, the expected impacts include increased climate resilience of farmers in participating regions and reduced climate risk for participating bank's agricultural lending portfolios. The broader effects of climate-smart lending may include healthier soil and higher long-term productivity rates as well as a larger client base for banks.

## *Replication potential in India*

### Technical scale-up potential

Replication potential for the climate-smart lending project is high in India due to similarities in social, economic, and climate vulnerabilities and regulatory context and targets. India faces substantial threats of desertification and land degradation to agricultural productivity. Mapping and analysis done by the Ministry of Environment, Forest and Climate Change, Government of India reveal that 96 million hectares of land in India is undergoing the process of land degradation, representing 29% of the total geographical area of the country during 2011 to 2013.[1] The demand is clearly there, and government support for this issue already exists. Government has taken several initiatives aimed at sustainable agriculture and food security, including the National Mission for Sustainable Agriculture, which focuses on new technologies and practices of cultivation, crop varieties that have enhanced carbon dioxide capture potential and are less water consuming and more climate resilient. The National Initiative on Climate Resilient Agriculture focuses on natural resource management, improved crop production, livestock and fisheries, and institutional interventions. The government has a Soil Health Card Scheme and has set up 100 mobile soil testing laboratories across the country. This Platform may allow local lenders in India to participate directly in the existing initiative, reducing initial barriers to replication.

### Scope for financial engineering

Banks in India would need to receive intensive capacity building on climate-smart agriculture and the financial materiality of climate risk. Many actors, such as the GCF, UNDP and others, are already providing this kind of capacity building to enhance access of small agricultural producers to finance.

The long-term financial sustainability of the project seems to rely on grants that fund a third-party non-profit to run

[1] *Details available at http://www.moef.gov.in/sites/default/files/India1.pdf, last accessed on 2 September 2019*

the Platform's administration. If this were to be replicated in India, grants would have to be secured to develop and run the Platform.

**Scope of private finance**

Banks and financial institutions can partner with the Platform to assess needs, develop financial tools, and identify priorities in the Indian market. Farmers and banks, supported by the Platform, could take measures to enhance the capacity and technical awareness of the farmers to secure access to finance. This would also help farmers better understand the climate vulnerability of their crops and take suitable measures to mitigate these risks.

## 3.2. Malawi: Drought insurance

### *Problem statement*

Malawi is a least developed country with a population of about 13 million and situated in Southern Africa. The livelihood of 80% of the population is based on small-scale subsistence farming (Torvanger, Narbel, Pillay, *et al*. 2016). Thus, the population is highly exposed and vulnerable to climate change impacts and extreme events that reduce crops, such as floods or droughts. A serious flooding event occurred in spring 2019, where 0.7 million people needed food assistance (Department of Disaster Management Affairs 2019). The current system to manage crop failures is not sufficient and crop failures are expected to increase due to climate change. This means that insurance schemes aimed at farmers could have a high value in Malawi.

### *The solution*

In 2005, the Malawian government in partnership with the World Bank's Commodity Risk Management Group embarked on developing the concept and application of a loan and index-based weather insurance programme to mitigate the risks of drought faced by smallholder farmers (Torvanger, Narbel, Pillay, *et al*. 2016; Hess and Syroka 2005; Meze-Hausken, Patt, and Fritz 2009). This drought insurance product sought to build on the current micro-credit schemes for smallholder farmers while investigating the requirements and barriers to implementing insurance products related to weather.

Before the pilot on the weather insurance programme could be launched, identification of the commodity to test the concept and sites for implementation were examined. Drought sensitivity is a key selection criterion, but factors such as the cost of inputs, crop value, crop suitability for smallholder farmers and others are included as well. This was investigated in consultation with the National Smallholder Farmers' Association of Malawi.

**Insurance scheme and financial model**

The partners for the micro-insurance pilot included stakeholders with technical expertise on the design of the insurance product and smallholder farmer associations that provided access to seed inputs while also acting as intermediaries with farmers. In addition, Malawian financial institutions participated as loan underwriters and the Malawian meteorological service as providers of climate data to establish drought and flood risks in the region (Figure 4) (Torvanger, Narbel, Pillay, *et al*. 2016).

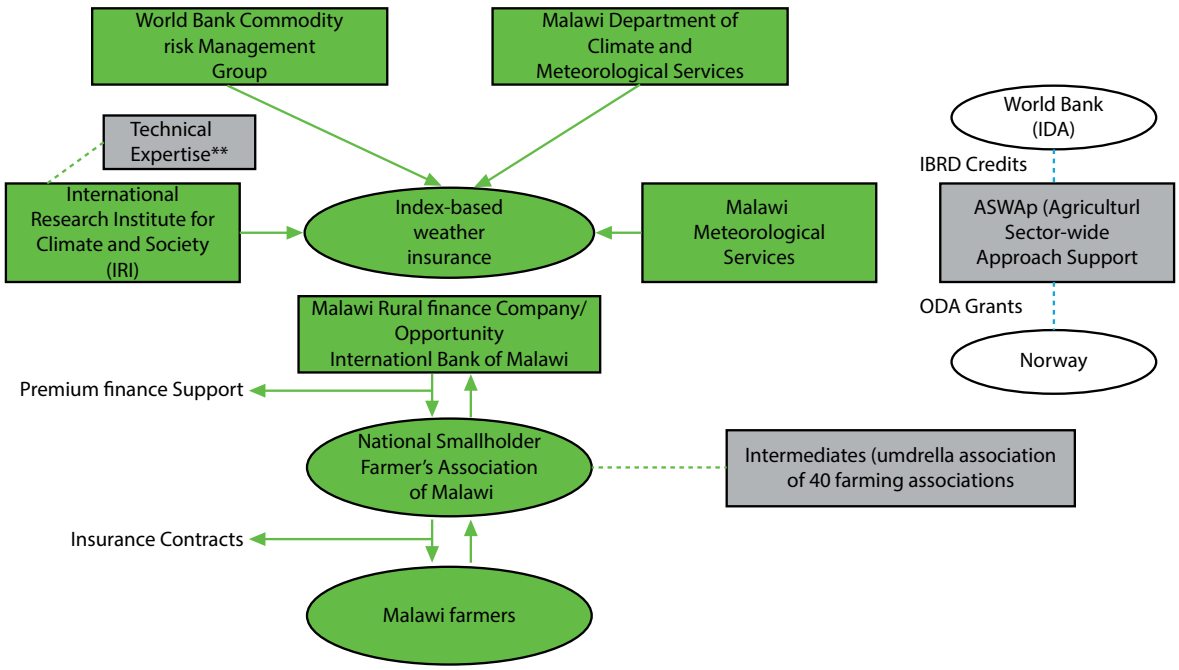


**Figure 4:** Partner landscape of drought insurance in Malawi (** indicates that the form of financial support is uncertain)

*Source: Torvanger, Narbel, Pillay, et al. (2016)*

### *Implementation*

**Project initiation:** The drought insurance product was piloted in 2005 by the World Bank with the Malawi Department of Climate Change and Meteorological Services as a participating partner. The pilot aims to transfer the financial risk of catastrophic drought that adversely impacts the government's budget to the international risk markets. Two micro-finance institutions, namely, the Malawi Rural Finance Company (MRFC) and the Opportunity International Bank of Malawi (OIBM), participated as loan providers.

**Status:** The scheme potential signs of success in the early phases - but was discontinued a few years later. By 2014, most of the lending institutions stopped providing crop insurance coverage to smallholder farmers due to several consumer-related, institutional and infrastructural hurdles.

**Beneficiaries:** The project kick-started with an initial involvement of 900 small-scale groundnut producers who received financial support from locally based microfinance institutions. Within a few years after inception, the project coverage was expanded to include crops such as maize and tobacco. Weather index insurance provided an effective risk protection mechanism to these farmers against the often highly disruptive drought events. Since Malawi was an agro-based economy, the scheme promoted economic growth with knock-on effects on food security and poverty improvement. By the end of the 2009, the programme had covered about 2500 farmers and possessed a transaction value of US$2 million (IRI 2007).

**Expected Impacts**

The targeted farmers were able to afford the insurance owing to higher crop yields (e.g., groundnut). For this insurance product, the trigger for payouts or the selected index was the requirement for water, which was a weighted sum of cumulative rainfall during the 130-day growing period (Hess and Syroka 2005).

The envisioned benefits of the Malawi scheme were as follows:

- Farmers were able to focus their farming on higher value-added products as additional capital was provided by the loan scheme since the insurance scheme reduced the risk.
- Farmers could invest in better seeds and improved irrigation technology, which could increase their productivity.
- Higher agriculture productivity would lead to greater profits, which would allow greater financial security in less favourable seasons.

The total payout estimated for the pilot was US$40,000 based on nearby weather station data (Tadesse 2015). During the pilot phase, several gaps were identified, including concerns over the robustness of rainfall data from only one rainfall station used to decide payout triggers, poor seed quality decreasing crop yield, and also side selling to those offering a higher price than the National Smallholder Farmers' Association of Malawi (NASFAM). The loan and insurance scheme was expanded to include other crop types during 2006–2009.

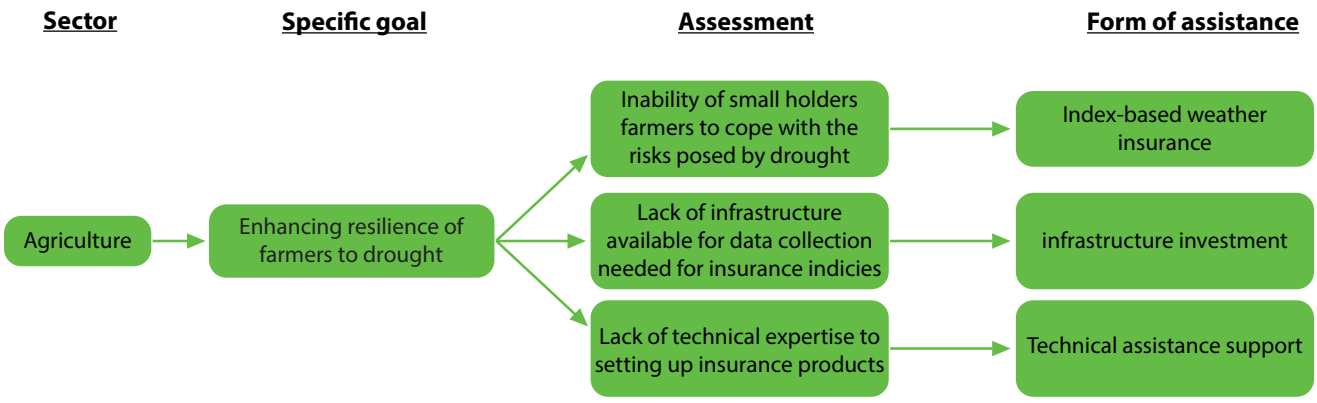


**Figure 5:** Financial instruments appropriate to investment in agriculture in Malawi

*Source: Torvanger, Narbel, Pillay, et al. (2016)*

The weather index-based insurance scheme has faced several challenges and pitfalls in Malawi (Makaudze 2018). The demand from smallholder farmers turned out to be low due to lack of understanding of the insurance programme and insurance premiums, liquidity constraints and premiums considered expensive, lack of trust in the programme, and preference for a Farm Input Subsidy Programme (FISP). Farmers prefer group-based premium payments. A common misconception is that an insurance premium is a form of investment, and farmers are disappointed when there is 'no return on investment' (Makaudze 2018). Talking about future (crop) catastrophes (and paying for insurance) is seen as inviting bad omens. Since microclimate effects and damages can vary considerably over small distances, there is a risk that damages to a farmer's crop do not trigger the index to justify indemnity payments. The weather index-based programme is dependent on enough data from weather stations, but there are a few stations, some stations are not suited for index insurance, and the historical data series are short. Furthermore, leading insurance companies acknowledge that capacity constraints are a concern. Another challenge is that financial institutions prefer cash crops (e.g., cotton and tobacco), whereas the Malawian government seeks to improve resilience to climate change risks and food security, and since food crops (staple cereal grain like maize) has a large share.

## *Learning from good practice*

According to DRFIP (2012), the major conclusions from the weather index-insurance programme in Malawi are that such programmes can manage only some of the risks faced by farmers; require enough reliable, timely, and high-quality weather station networks; and require an enabling legal and regulatory framework. Moreover, stakeholder education and outreach is essential to establish successful insurance programmes.

**Complementary investments**

Complementary investments are required to strengthen the institutional landscape to ensure that micro-insurance schemes are viable products for smallholder farmers. The Malawian government supported by the World Bank and Norway introduced the Agriculture Sector Wide Approach (ASWAp), which invests in new weather stations in Malawi to improve data robustness owing to a lack of rainfall stations. Additional investments for improved farming practices, better input provisions, and commodity sale can enhance the effectiveness of micro-insurance.

**Credibility and trust**

There is a risk of higher payouts and premiums associated with traditional insurance schemes since farmers may allow their crops to fail in order to obtain a payout. In addition, it is difficult to attribute the cause of the crop failure as this could be a result of bad farming practices and not the prevailing environmental conditions. Establishing payouts based on relationships between environmental variables and crop failure can reduce insurance malpractice and ensure that farmers have an incentive to promote productive farming management while being covered against climate risks.

## *Replication potential in India*

Agriculture in India is heavily dependent on the annual monsoon, which may become increasingly uncertain due to climate change. Variations in rainfall account for more than 50% of India's crop yields (CGIAR and Future Earth 2013). In 2003, the first weather index-based insurance programme was introduced for Indian farmers. In the state of Bihar, the Indian Farmers Fertilizer Cooperative and Tokio General Insurance have offered a weather index-based crop insurance scheme. Public and private programmes now offer weather index-based insurance in many Indian states that cover a variety of crops. By 2012, up to 12 million farmers with a farming area of more than 15 million hectares, covering 40 different crops, were insured against losses related to weather (CGIAR and Future Earth 2013). To achieve widespread implementation of weather index-based insurance schemes, India has made massive investments in the weather station infrastructure, with 10,000–15,000 additional stations installed (Makaudze 2018).

**Technical scale-up potential**

The scale-up potential for weather index-based insurance programmes is huge in India. This is due to the importance of agriculture and the dependency of crops on precipitation and the monsoon. In addition, such insurance programmes have had relative success in the past 15 years, with broad support from the government and organizations. Furthermore, such insurance schemes have been facilitated by massive investments in new

weather stations, which are critical components in weather index-based insurance.

**Scope for financial engineering**

Weather index-based insurance schemes have existed for some years in India, but they can be further developed and their potential can be increased with better integration and co-evolution with other programmes to support agriculture and management of climate risk. They can also be integrated with more programmes to build capacity among farmers, their organizations, and in the financial sector.

**Scope for private investments**

A number of private weather index-based insurance programmes already exist in India, but the scope for further growth in private investments seems large alongside the overall potential for such insurance schemes in India.

## 3.3. China: Three Rivers Sustainable Grazing

The Three Rivers Sustainable Grazing Project is a pilot project in the Qinghai province of China that uses funds generated through voluntary carbon markets to restore the degraded grazing land of smallholder herder communities and sequester carbon in the soil. Improvement in soil, water, and nutrient retention builds resilience to climate change, increases productivity of the land, and improves livelihoods of the communities.

### *Problem statement*

China has made tremendous strides in improving food security for its growing population, but this has come at the expense of the environment in certain areas. High concentration of sedentary livestock holdings has led to overgrazing, soil compaction, and erosion, thus reducing soil's productivity and capacity to absorb both water and carbon. This has adverse effects on both the livelihoods of the smallholder herder communities and the environment.

Sustainable grassland management is required to remediate this problem of overgrazing and the resulting land degradation but affected communities often cannot finance necessary activities. Grassland restoration activities have costs that include materials and labour for grass planting, fencing, and animal housing as well as lost income due to temporary destocking.

Carbon sequestration as a result of restored grasslands can generate income opportunities through voluntary carbon markets. However, the high costs of carbon measurement and monitoring have presented challenges for sequestration projects that tend to keep smallholder herder communities out.

As outlined above, the problem statement addressed by the Three Rivers Sustainable Grazing Project can be broken down into the following three components:

1. Land degradation and vulnerable livelihoods reduce productivity of the soil and therefore income of communities and reduce soil carbon sequestration.
2. Limited financing for remediation activities constrains communities' ability to respond to land degradation and vulnerable livelihoods.
3. Absence of cost-effective carbon accounting methodologies constrains communities' ability to participate in voluntary carbon markets.

### *Solution*

The Three Rivers Sustainable Grazing Project is a pilot project that aims to address the challenges outlined above by using funds generated from participation in voluntary carbon markets – facilitated by a Verified Carbon Standard (VCS) – to invest in sustainable grassland management. This approach will provide sustained, long-term financing for and beyond the initial cost of transition to sustainable grassland management. It will also reduce emissions, increase soil water retention and productivity, and improve climate resilience.

**Invest in sustainable grassland management.** Reducing grazing pressure on overstocked areas, sowing improved pastures, and improving pasture management (i.e., rotation of grazing animals between summer and winter pastures) are all key components of grassland restoration and sustainable grassland management. These practices can help lock more carbon in soils and biomass, increase the water-holding capacity of the soil, and enhance grassland biodiversity. Improving soil moisture and nutrient retention in soils leads to building resilience to climate change in the medium and long term.

**Finance activities with funds generated through voluntary carbon markets.** Carbon sequestration from improved grassland management presents sustained, long-term opportunities for financing through voluntary carbon markets. This revenue stream can be used to support the initial transition to sustainable grassland management practices, thereafter becoming a supplementary income source for smallholder herder communities.

**Use FAO's Verified Carbon Standard (VCS) to lower the cost of carbon accounting.** Carbon accounting typically relies on direct measurement, which makes it often too costly for smallholder herder communities. To address this key constraint, FAO developed a carbon accounting methodology and validated it under the Verified Carbon Standard. This methodology uses biogeochemical models and careful activity monitoring to estimate soil carbon pool changes. It quantifies emission reductions from a range of activities, including improving the rotation of

grazing animals on degraded pastures and restoration of severely degraded grasslands.

This approach reduces the costs of measurement and verification, thereby helping farmers access to carbon markets and, by proxy, new sources of finance to restore grasslands, increase production and incomes, and reduce food insecurity.

## *Implementation*

**Project initiation:** The Three Rivers Sustainable Grazing Project is set in the Qinghai province in the northern China. It uses funds mobilized from the voluntary carbon market to invest in land restoration for smallholder yak and sheep herder communities.

**Status:** The 'Verified Carbon Standard methodology' is applied to the Three Rivers Sustainable Grazing Project to restore degraded grasslands in Qinghai province. The average annual mitigation potential in the first 10 years of the implementation is an estimated 63,000 tons of $CO_2$ equivalent per year. The VCS methodology measures and counts emission reductions from a range of activities, including improved rotation of grazing animals between summer and winter pastures, limited grazing animals on degraded pastures, and restoration of severely degraded grasslands.

The research and planning phases of the project were funded by FAO, ICRAF, the Institute of Environment and Sustainable Development in Agriculture (CAAS), and the Northwest Institute of Plateau Biology. Investors and the Qinghai government are currently discussing co-investment opportunities for implementation of the project.

**Beneficiary:** The project involves participation by 271 households. This approach benefits herders by generating long-term sustainable income flows. In the first 10 years, herders will have fewer but more productive livestock. In the beginning, herders will be compensated for their losses, with compensation being decreased progressively until the year 10. After the first 10 years, households will be able to increase the herds beyond the preliminary levels without the risk of overgrazing. Yak- and sheep-herding households select a combination of land management options, such as grazing intensity, grass cultivation, and animal husbandry, chosen to fit their specific land use. The restored land will provide more productive grazing land for cattle, thereby improving community livelihoods. Participating households also have access to a package of complementary measures, such as the introduction of improved feeding, winter housing, post-farm processing, and marketing activities.

**Expected impact**

Grassland restoration plays an important role in building resilience to climate change and is also linked to increased productive potential of the soil. The project's goal is to increase productivity and build climate resilience in smallholder herder communities by restoring degraded grazing land and sequestering soil carbon. On average, the potential annual carbon capture in the first 10 years of the project was estimated at 63,000 tons of carbon dioxide equivalent per year. This high level of mitigation potential is due to heavily degraded grazing land (38% of the project area), which can be cost-effectively restored by employing sustainable land management practices. In addition to the above, the project will support herders with introduction to improved feeding methods, winter housing, post-farm processing, and marketing activities.

## *Learning from good practice*

**Sustainable finance model**

This approach generates long-term sustainable income flows for herders. In the first 10 years, herders will have fewer but more productive livestock. Given that the land is currently 48% overstocked, considerable reductions in income are expected in the early stages, with incomes expected to grow in the following years. In the beginning, herders will be reimbursed for their losses, with compensation being decreased progressively until the year 10. The project's capacity to deliver economic returns is important because it increases the likelihood of voluntary herder enrolment and improves the synergy between climate change mitigation and rural development objectives.

## *Replication potential in India*

**Technical scale-up potential**

Replication and scale-up potential for the Three Rivers Grazing Project is high in India due to similarities in social, economic, and climate vulnerabilities; regulatory context and targets; and the existence of a voluntary carbon market. The grassland carbon accounting

methodology will be applicable to sustainable grazing projects in India; the country has the largest cattle and buffalo population in the world (about 300 million) that faces multiple challenges, including diseases, inadequate food supply, and climate change.[2] Another factor making the technical implementation potential of this project in India crucial is the existing government awareness of and investment in this issue.

**Scope for financial engineering**

The Indian Ministry of Environment, Forests, and Climate Change recently set up a Voluntary Carbon Market (VCM), with World Bank support, as part of their implementation strategy to meet their NDC targets. In October 2015, India launched a digital monitoring and information system that now monitors India's CDM portfolio and has developed a REDD+ methodology for the voluntary carbon market specific to the Indian context.[3] These initiatives would make agricultural financing through VCMs feasible because the infrastructure already exists.

**Scope for private finance**

The initial source for sustainable grassland financing is unclear and seems to require willing private sector investors and government grants. Following initial investment, the question about the carbon credits remains: Do they belong to the farmer communities or the investors? This may make a difference in the investor interest and participation.

[2] *Details available at http://www4.unfccc.int/ndcregistry/PublishedDocuments/India%20First/INDIA%20INDC%20TO%20UNFCCC.pdf, last accessed on 3 September 2019*

[3] *Details available at https://www.giz.de/en/worldwide/42183.html, last accessed on 3 September 2019*

## 3.4. Ethiopia: Enabling smallholder coffee producers through credit guarantee schemes (CGS)

### *Problem statement*

Coffee production is integral to the economy of Ethiopia and has provided a source of income to 15 million small farmers in the country. The crop is particularly sensitive to temperature and rainfall, which makes the coffee farmers highly vulnerable to climate extreme events like drought or heat waves. A way to improve the resilience of farmers is by increasing their livelihoods, which will give them the financial means to invest in climate adaptive strategies. Thus, a pilot programme was started to improve the post-harvest processing of coffee beans, which allowed farmers to produce superior coffee and thereby improve their livelihoods and climate resilience. The beneficiary farmers were provided with raised drying beds and pulling machines to aid in the coffee washing process. It was found that this washed coffee was of a superior quality than sun-dried beans and fetched a higher price in the market. The quality of the coffee produced, in combination with the ideal soil and climatic conditions, helped revamp the coffee industry in Ethiopia. However, there was an issue regarding the sustainability of the project results, primarily because smallholder farmers may not always have access to coffee cooperatives and are resource-poor. Thus, they are considered as high credit risk and not able to access the financing required to acquire and maintain the equipment needed in the processing of coffee post-harvest. They also do not have access to proper information that could help them better negotiate their place in the supply chain.

### *The solution*

A risk-sharing agreement was signed between the Common Fund for Commodities (CFC) and the Rabobank Foundation, a 'credit guarantee scheme (CGS)', to guarantee half the losses incurred by individual farmers provided loans to buy processing equipment. Farmer cooperative groups that conducted the processing, purchase, and export of coffee were also targeted. In addition, technical support was provided to farmers to ensure the application of proper agricultural and processing practices to provide them an uninterrupted flow of market information.

The Rabobank International Advisory Services also provided technical assistance to local banks to aid them in lending to smaller coffee farmers. The loan officers were trained to help them better understand the coffee value chain. In addition, technical assistance was provided to coffee cooperatives and unions to familiarize them with good corporate governance and improve their financial literacy.

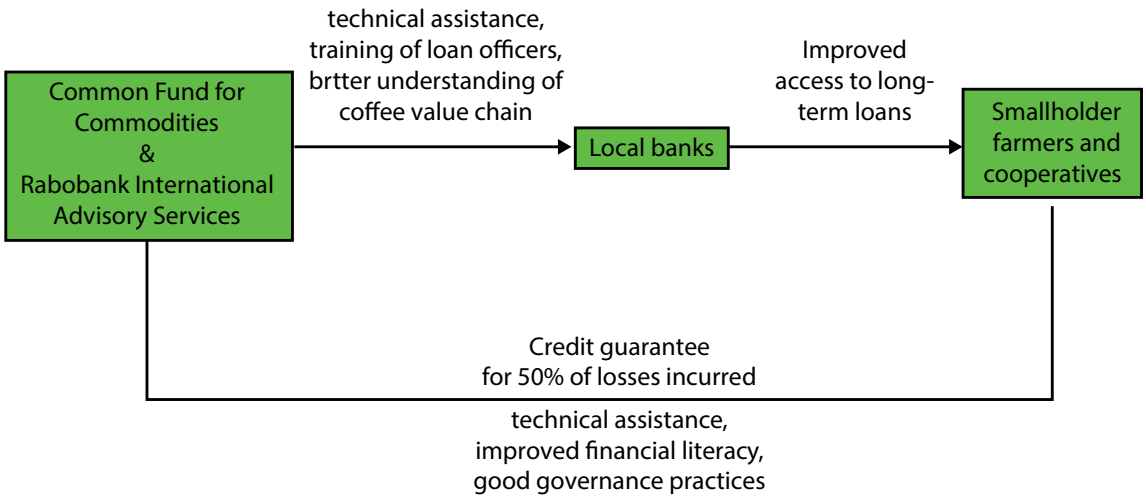


**Figure 6:** Model representing working of credit guarantee scheme for Ethiopian coffee farmers

### *Implementation*

**Project initiation:** The credit guarantee scheme was developed as an agreement between Common Fund for Commodities (CFC), International Coffee Organisation (ICO), CABI Africa, and Rabobank Foundation. The Rabobank International Advisory Services was also involved in the scheme, providing technical assistance to local banks. The scheme was a five-year project (2011–2016). The farmers included in this project were regularly supervised by ICO and CFC in order to maintain uninterrupted and efficient operations. In addition, the Ethiopia Commodity Exchange (ECX) was established in 2008 to regulate all coffee auctions in the country and provide real-time, credible pricing information to farmers through a variety of platforms, such as TV, internet, radio, and electronic information boards.

**Status:** More than 23 cooperatives in Ethiopia have received commercial loans provided through the credit guarantee services and benefitted from them. This has removed the risk associated with smallholder farmers and allowed them to focus on delivering quality products. The strengthening of the cooperatives and unions has helped scale up the production of coffee in Ethiopia, with all farmers adopting the recommended processing guidelines. They have established dedicated committees to manage and monitor the quality of coffee and have used the bank loans to invest in equipment such as wet mills, which help in the washing of beans after harvest and improve the quality of coffee beans. According to the Ethiopian Coffee and Tea Development and Marketing Authority, the coffee export increased by 21.78% from 2017 to 2018, indicating the high demand for Ethiopia's superior quality coffee (Communicaffe International 2018).

**Beneficiary:** The project's stated objective is to improve access for smallholder farmers and their cooperatives to commercial loans to purchase and install improved coffee processing equipment and to purchase and export the resulting high quality coffee produced. More than 23 cooperatives in Ethiopia have received commercial loans provided through the credit guarantee services and benefitted from them.

**Expected Impacts**

The project provided the following benefits to smallholder farmers:

1. Enabling better access to commercial loans for smallholder coffee farmers
2. Scaling up of improved agricultural and processing practices by non-cooperative union farmers
3. Bolstering of primary cooperatives
4. Improving access to market and production information
5. Enhancing coordination, monitoring, and supervision of projects involved

### *Learning from good practice*

**Credibility and trust**: Owing to the real-time market prices broadcast by the ECX, there has been an increase in the level of credibility associated with the coffee supply chain. The high-quality coffee beans have led to a rise in international prices. This has incentivized the rural areas in Ethiopia to create primary market centres, making these local markets more competitive and transparent. Farmers can now choose the traders to whom they wish to sell, leading to increased trust in the process.

**Capacity building:** Along with the credit guarantee scheme, Rabobank International Financial Services also helped build the capacity of banks by training loan officers to better understand the complexities of the coffee value chain. Over 100 development agents were trained on the various aspects of coffee production, such as processing, quality, marketing, and management (CABI 2017). These agents went on to help farmers adopt the best practices to ensure high quality and quantity of coffee beans. Finally, Rabobank also held group discussions, field demonstrations, lectures, and training sessions for farmers so as to facilitate the sharing of ideas and experiences.

### *Replication in India*

**Scope for financial engineering**

Although India has attempted to make credit available to poor farmers at low rates, the schemes have been largely unsuccessful. In their study of potato farmers in West Bengal, Maitri, Mookherjee, Torero, *et al*. (2018) found that only 5% of farmers obtained bank loans. The remainder obtained loans from informal lenders and MFIs (microfinance institutions). This is because banks in India require collateral for lending, which most smallholder farmers are unable to provide. Thus, they are forced to get loans from other sources, oftentimes paying interest rates

of 30–50%. A risk-sharing agreement, as signed in Ethiopia, with support from multilateral financial institutes, accompanies with technical guidance for farmers and key stakeholders, might help reduce the perceived risk of small farmers, thereby enabling them to obtain loans at lower interest rates and invest in better equipment and agricultural practices.

**Technical scale-up potential**

Studies show that when Indian farmers were provided with real-time wholesale market price information, they were able to negotiate a better deal with the middlemen and earn a higher livelihood. This also led to increased competition within the village market, improving the transparency of the sale process. This is similar to the outcomes of the Ethiopia case, where the ECX broadcasts real-time price information for farmers, thereby increasing the credibility of the process. Such a system, if implemented in India for specific key crops, could help improve the gains of farmers and reduce their dependency on middlemen.

**Scope for private finance**

Modernization and adaptation of agricultural processes suffer mainly from lack of finance due to high upfront investments. A well-designed and comprehensive credit guarantee scheme, along with targeted subsidies, could incentivize farmers to also invest in improved farming practices and thus mobilize part of the financing required in the form of private financing for climate adaptation.

## 3.5. Global: Big Data – Small Credit

### *Problem statement*

A large number of consumers in emerging markets have limited access to formal financial services, not the least to unsecured credit. Technological progress has made possible a new type of credit assessment that could bring affordable credit to hundreds of millions of consumers in emerging markets (Costa, Deb, and Kubzansky 2015). This new field is referred to as 'Big Data – Small Credit' (BDSC). Costa, Deb, and Kubzansky (2015) estimated that the BDSC market could approach between 625 million and 1 billion consumers in emerging economies. In India, 400 million persons borrowed money in 2014, but only one out of seven had access to formal loans. Of the 650 million adults in India, 80% have a mobile phone and more than 240 million have access to the Internet and social media. The BDSC technology has the potential to enable 100–160 million new consumers in India to gain access to formal credit (Costa, Deb, and Kubzansky 2015).

A number of small-scale farmers in India are likely to have limited access to formal bank loans, and improved credit assessments could facilitate improved credit availability to this group. Some of the new credit availability could be used for climate change related investments, such as improved irrigation systems or new crop varieties to handle droughts, and changes in agricultural practices in response to changes in weather patterns.

### *The solution*

#### BDSC scheme

The core idea of the BDSC technology is to use digital footprints from smartphones, such as phone calls, text messages, internet activity, social networks use, and use of prepaid cards use, to assess risk and the creditworthiness of consumers. These algorithms use anonymized phone call data records and text message patterns. This information can be useful in predicting people's willingness and ability to pay back loans. Consequently, the information could facilitate quicker and often cheaper bank loans (Costa, Deb, and Kubzansky 2015; World Bank 2016).

### *Implementation*

**Project initiation:** 'Big Data – Small Credit' is a technological progress that has introduced a new type of credit assessment because of which affordable credit can be extended to hundreds of millions of consumers in emerging markets.

**Status:** Microfinance banks have an outstanding lending of about US$100 billion to around 200 million clients, but the majority is for urban populations (Brookings 2018). Gro Ventures, Farm Drive, and Grameen Foundation have designed models explicitly aimed at the agriculture sector (Jamal, F., 2016). Typically, urban customers need small and short-term loans, whereas farmers need longer term loans, repayable after the crops have been harvested (Safira and GrowAsia 2017). The drivers for default risk for smallholder farmers are varied. Lending money to farmers is challenging because they are spread out in thinly populated areas that are costly to serve, have few realizable assets to serve as collateral. Furthermore, the digital footprint of rural populations is often weaker and less reliable than that for urban populations. Some models have started to test the usefulness of various climatic and geographic data as well as value chain and market data (Table 2).

*Lenddo* and C*ignifi* are among the new fintech (financial technology) companies providing credit assessment services. Cignifi was established in 2012 with headquarters in the United States and offices in Brazil, Mexico, Singapore, and Bangladesh. Lenddo was established in 2011 and is active across 20 countries in Latin America, South Asia, and Southeast Asia. Offices in India were opened in 2016. The company has given banks, lending institutions, utilities companies, and worldwide credit card providers access to its technologies. In India, Lenddo's customers are large and mid-size banks, non-banking financial institutions, and e-commerce firms.

#### Expected Impacts

The Initiative for Smallholder Finance (ISF) has estimated that smallholder farmers require US$200 billion to grow and improve their life, but they access only US$50 billion (Brookings 2018). Farmers with access to finance that can be used to invest in fertilizers and better quality seeds could potentially increase their yields and incomes by more than 25%.

### *Learning from good practice*

#### Sustainable finance model

BDSC can make formal bank and credit services available to hundreds of millions of people in developing countries.

**Table 2: Using geographic, climatic, value chain, and market data to assess borrowers**

| Data category | Example indicators | Potential sources | Advantages | Disadvantages | Examples |
|---|---|---|---|---|---|
| Geographic (physical and human) | • Location/agroecology<br>• Farm size/herd size/ crops<br>• Soil health/ moisture<br>• Climate patterns<br>• Age and sex distribution<br>• Socio-econocmic distribution | • Satellite data<br>• Agriculture research institutes<br>• GPS/geo-location applications | • Enables verification/ validation of application data without deployment of staff to visit<br>• Enables assessment of exposure to climate risks<br>• Enables estimation of yield potential, which can underpin assessment of production risk | • Weather, agro-ecology, and satellite data often found at high levels of aggregation, and need to be disaggregated to the level of individual farms | • Telephone Farmers<br>• Planet Labs<br>• Digital Globe<br>• Aware<br>• Acre Africa<br>• Getchee<br>• IPRS<br>• The Climate Corporation<br>• Geotraceability |
| Value chain/market | • Input quality/supply<br>• Output/yields<br>• Market prices | • Input suppliers<br>• TA providers<br>• Buyers/traders<br>• Coops/ Aggregators<br>• Value chain support services | • Provide detailed insight into production and marketing potential and challenges, which can guide more accurate assessment of risk<br>• Suppliers/offtaker data enables identify verification | • Value chains are so unique and the risks, costs, opportunities of each so different that most need to be mapped individually-time and resource intensive | • Agricultural Loan Evaluation System<br>• Agrilife<br>• Hurudza<br>• MFarm<br>• Soko Shambani<br>• Scanntech<br>• Gro Ventures<br>• Icow<br>• FarmDrive |

*Source: Smallholder Finance (2016)*

Farmers are among potential users of BDSC credit assessments, and they may use this credit to invest in climate-related projects.

**Transformational impact**

There are no specific incentives from BDSC to invest in climate-related projects in agriculture, either for improving resilience to climate change impacts or for adapting to changing conditions. However, given that incentives for climate-related investments for farmers are provided through government programmes or other schemes, BDSC can enable more climate-related investments in agriculture. Many farmers in developing countries are likely credit constrained, indicating that they could be beneficiaries of BNSC credit assessments. To facilitate BDSC implementation in agriculture, more collaboration with non-traditional actors with data on agricultural borrowers, more digitization of data, and loans with longer tenure (3–4 years) would be useful (Smallholder Finance 2016).

**Credibility and trust**

BDSC technologies are based on patterns of big collections of indirect proxy data that have a limited or uncertain correlation with creditworthiness and as such prone to failure in some cases. This means that some loans will fail and not be paid back by borrowers. The interesting question, though, is whether the risk of failing loans based on BDSC credit assessments is higher that the risk in cases where borrowers are in direct contact with banks and the banks use direct data on creditworthiness, such as work position, income, wealth, and debt.

## *Replication potential in India*

**Technical scale-up potential**

The technical replication potential in India is sizeable, considering the large number of likely credit-constrained smallholder farmers. Many farmers own a smartphone or they will buy one over the next few years.

**Scope for financial engineering**

The scope for financial engineering through BDSC to enable climate change related investments depends on this technology being supplemented by government programmes that incentivize such investments in agriculture, particularly investments foremost aimed at adaptation to impacts of climate change.

**Scope for private climate-related investments**

The scope for private climate-related investments in the agricultural sector in India is good since BDSC would make many investments in agriculture bankable and thus provide an opening for commercial banks and microfinance banks.

## 3.6. India: Suryashakti Kisan Yojana Scheme, Gujarat

### *Problem statement*

Since the onset of Green Revolution, India has increasingly relied on groundwater for irrigation. The government provides heavy subsidies to farmers for grid-based thermal power that rolls down to almost free electricity, which serves as a perverse incentive, both for overuse of electricity and groundwater. On this backdrop, increasing the deployment of solar pumps in agriculture offers a huge opportunity to address the complexities of the energy–water nexus in India, while also reducing the carbon intensity of the agriculture sector. However, making use of this opportunity seems challenging due to the high cost of solar pumps, which is almost 10 times the cost of a conventional pump.

### *Solution*

Several pilot projects were undertaken and are still under implementation to devise viable models to increase the penetration of solar pumps in the agriculture. One such successful pilot that culminated in a state-wide scheme in 2018 – *Gujarat's Suryashakti Kisan Yojana (SKY)* – was the Solar Pump Irrigators' Cooperative Enterprise (SPICE).

**SKY scheme**

The Suryashakti Kisan Yojana (SKY) is a subsidy scheme launched in June 2018 by the Government of Gujarat (GoG) to augment the objective of the nation-wide KUSUM Scheme of promoting solar power in agriculture and making the farmers self-reliable. The project envisions to cover 33 districts of Gujarat, targeting almost 12,000 farmers who are currently using grid electricity for irrigation. The subsidy provided in SKY will be used to encourage farmers to give up their farm electricity connections and instead switch to solar-based power, which will be provided by a separate feeder. With an investment of ₹ 870 crore (~US$120 million) in the first phase, the government plans to build about 137 feeders and install solar photovoltaics with a capacity of 175 MW. By building on Dhundi SPICE, SKY also allows farmers to make more money by evacuating and selling the surplus energy to local utilities for 25 years under a power purchase agreement (PPA). Installation of solar PV system with a capacity higher than the contracted load (1.25 kW/hp) ensures that farmers generate additional power and money.

**SKY financial model**

SPICE model consists of mainly four elements. Figure 7 shows how these elements have been integrated into the SKY financial model.

- **Capital cost subsidy.** SKY provides a 60% subsidy, with 30% each contributed by central and state governments. The farmers pay 5% upfront and 35% through a loan (taken by the government on behalf of the farmer), which has to be repaid to the government within 7 years.

### Dhundi SPICE: Pilot Project

The IWMI-TATA Water Policy Program (ITP) conducted a small pilot in Dhundi village in Gujarat. ITP started the Dhundi Solar Pump Irrigators' Cooperative Enterprise (SPICE) pilot project in January 2016 with six farmers. Given the large upfront investment required for solar pumps that makes it unaffordable for farmers, the pilot model provided about 90% capital cost subsidy to make it a viable option. It also urged farmers to form a cooperative – SPICE, which would use solar power not only for irrigation but also to sell the surplus energy to MGVCL under a 25-year power purchase agreement (PPA). The model has successfully increased additional income of these six farmers as about INR 950,000 (US$13754.8) was earned by SPICE by selling electricity by August 2018. It lowered GHG emissions as the SPICE farmers consumed 46% less energy than average, while also making the farmers self-reliant by providing an affordable and reliable source of irrigation. Two elements of the model that make the pilot sustainable are the (i) gradual phase down of capital cost subsidy by giving farmers an opportunity to sell excess electricity and (ii) provision of sustainable incentive like a Green Energy bonus and a Water Conservation bonus that encouraged the efficient use of energy and water, respectively. By December 2016, SPICE had added three more farmers and the subsidy was brought down further in the subsequent years.

- **Sale of surplus electricity.** Under the 25-year PPA, farmers receive a feed-in tariff (FiT) of ₹ 3.5 per kWh sold to local utilities. They also receive an evacuation-based incentive (EBI) of ₹ 3.5 per kWh for the first 7 years by the state that aids in the repayment of loan. Farmers will be credited the revenue on surplus power after the deduction of the monthly instalments for the loan.
- **Resource conservation.** The opportunity cost of the solar power, of being able to sell excess power to the grid, and EBI component, which allows farmers to sell the excess electricity generated, pushes the farmer to minimize the use of electricity and groundwater to increase their income generation potential.
- **Generation of renewable energy credits (RECs).** Since DISCOMs buy green power of farmers, they generate RECs that can be sold in the market to generate profits. They can also help DISCOMs to fulfil their mandated renewable purchase obligation.

## *Implementation*

**Project initiation:** The Suryashakti Kisan Yojana (SKY) Scheme was introduced by the Government of Gujarat in June 2018.

**Status:** The scheme is currently in its early stage of implementation and likely to have an impact on the same lines as the Dhundi SPICE project.

**Beneficiary:** Estimates from GVCL[4] show that about 14.8 lakh farmers are connected to the grid, with almost 27% of the electricity produced being supplied to them. The huge reliance on electricity leads to a variety of issues, such as a high carbon footprint, inefficient use of cheap electricity, and a low balance sheet of electricity distribution companies (DISCOMs) providing high farm power subsidies. To increase the penetration of solar pumps, the first milestone for SKY is to bring the maximum number of farmers on a given agriculture feeder. Various awareness campaigns are being organized to build a more robust model based on the feedback received by farmers on the issues faced by them. Once a desired number of farmers are convinced, the second milestone will be to build these feeders in the targeted districts. As of now, two out of the five planned SKY feeders have been established in the Rajkot district.[5]

**Expected Impacts**

Although the SKY scheme is in its early implementation stage, its likely impact could be on the same lines as the Dhundi SPICE project.

## *Learning from good practice*

SKY financial model has the following elements that make it attractive, feasible, and sustainable:

- **Additional risk-free income generation stream:** Solar energy serves as a remunerative crop that ensures a climate-proof and risk-free source of irrigation and also helps generate income for farmers. Farmers earn extra income both by pooling excess green energy into the grid and selling irrigation services in local markets. This reduces their vulnerability to losses due to climate extreme induced crop failure.
- **Improving financial viability of DISCOMs:** The SKY model looks financially viable to DISCOMs due to its benefits of not just generating additional income but also saving the existing government mandated expenses. Solar pumps will also provide an opportunity to phase down farm power subsidies provided by government and DISCOMs, thus reducing their burden.
- **Sustainable utilisation of resources:** Provision of FiT and EBI pushes the farmers towards minimal and efficient utilization of groundwater and motivates them to eventually deploy energy-efficient pumps.
- **Reducing subsidy burden on the government:** Solar pumps are currently promoted in India by providing huge capital cost subsidies ranging 70–90% across states (Dekker 2015), which makes it fiscally unsustainable for the government. Selling green energy at an attractive FiT offers a great opportunity to phase down subsidy gradually by increasing income of farmers.

[4] *Gujarat Vij Corporation Limited*

[5] *As per DeshGujarat. 2018. Details available at https://www.deshgujarat.com/2018/07/07/two-feeders-of-sky-inaugurated-in-rajkot-presentation-given-to-farmers/*

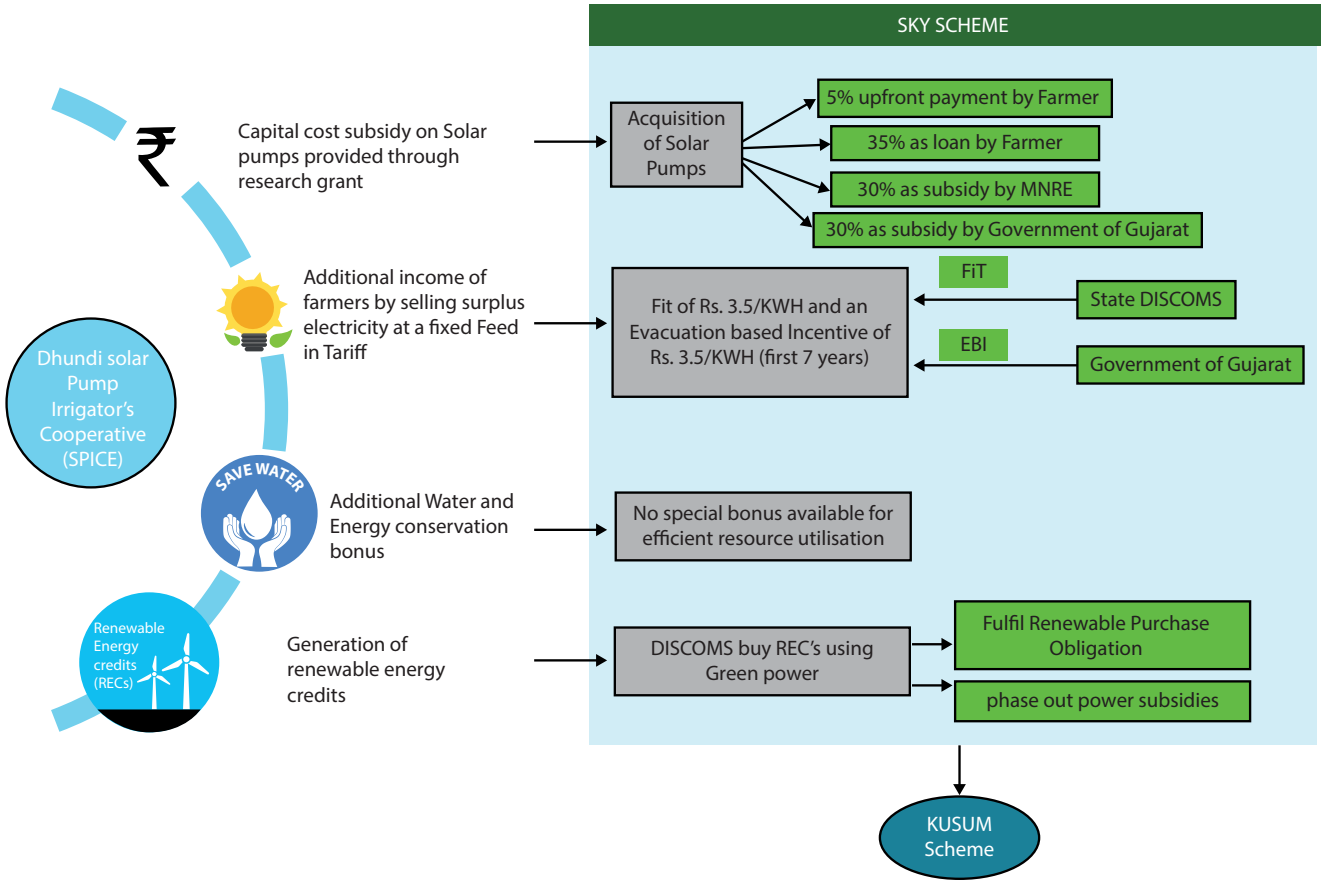


**Figure 7:** SKY financial model

### *Scale-up potential in India*

Agriculture offers two major opportunities to promote adoption of solar pumps in India; high dependence on electric/diesel pumps and unreliable irrigation services due to climate vagaries, with only 48% of the country's net sown area receiving irrigation. A major push to solar irrigation in India came after the formulation of the Kisan Urja Suraksha evam Utthaan Mahabhiyan (KUSUM) in March 2018 by MNRE that aims to install solar pumps, utilize the energy for irrigation, and sell the surplus to the DISCOM. Integrating the KUSUM scheme with existing state level subsidy schemes in Bihar, Rajasthan, and so on can help kick-start the transformation. The potential to increase the penetration of solar pumps in India depends on the following factors:

- **Technical scale-up potential.** India has among the best conditions in the world to capture and use solar energy (World Bank 2016). This potential has been realised by making significant efforts to expand the use of solar energy by developing solar cities. The government can give impetus to its solar agenda by exploring and creating opportunities to reap multiple benefits from solar initiatives. For instance, the existing solar pump set-up attached to a grid/micro-grid can be scaled up to produce power for homes, especially for districts that are not electrified.
- **Scope for financial engineering.** Various states in India are offering schemes that provide capital cost subsidies to promote the use of solar pumps. Such schemes do offer immediate benefits for engaging farmers but might prove unsustainable for governments in the long run. Creating a distinction in subsidy, with medium and large farmers getting an interest-based subsidy while small and marginal farmers getting subsidy without the need for repayment (Agrawal and Jain 2018), can help save government expense.


Quick return on invest within 8-18 months

12 hours of power in contrast to 8 hours earlier


Reduction in GHG emissions due to replacement of thermal electricity with solar

Performance guarantee on solar PV's for 7years.

Insurance on Solar PV's by Government

Prevent groundwater overuse

Improved transmission and grid efficiency

Maximum utilisation of existing grid infrastructure

◊ **Scope for private finance.** The success of SPICE has made it evident that support schemes like SKY can ensure economic viability of solar pumps, which has increased confidence among the private sector. An ongoing effort by the Indian government on promotion of solar pumps through members from different countries also paves way for increased participation of the private sector.

The scaling up of a scheme like SKY in India would require an extensive mapping of states/districts to understand viability of solar pumps, followed by an analysis of risks associated with the technology as explained below:

- **Specificity of solar technologies.** Before deploying solar pumps at a larger scale, it becomes essential to differentiate and map areas with high and low solar potentials. A solar pump might work effectively in areas with high groundwater levels but might not work in others with a low groundwater level. A context-specific experimentation of technical specifications of solar pumps is a necessity.
- **Risk of theft.** One of the problems associated with the use of solar technology is the risk of theft or fidelity with solar panels. To avoid this and ensure that the panels remain secure, project developers should also include the cost of fencing in the capital cost subsidy.
- **Risk of overuse of groundwater.** Absence of direct water conservation incentives, besides the EBI component, and the prevailing relatively low FiT rates, might encourage farmers to sell water to other farmers and gain more profit instead of saving electricity. It is, therefore, necessary to provide a reasonable FiT with proper resource conservation bonuses initially.

## 3.7. India: Warehouse receipt financing

### *Problem statement*

Agriculture is one of the sectors which are most vulnerable to climate variability and extreme events. It becomes even more critical for India to avert climate risks as the sector is the mainstay for almost 70% of the rural population (FAO 2018a) and highly dependent on monsoon rainfall. Also, mild to extreme perturbations in the climate system can impact agricultural yields to a great extent and lead to market price fluctuations that greatly affect the livelihood of farmers. In this situation, easy access to finance becomes crucial to transition towards climate-smart agriculture. However, formal institutions feel reluctant to provide financial credits to these farmers due to lack of transaction records. In addition, farmers do not receive a remunerable price for their produce as they are compelled to sell the perishable produce immediately after harvest due to inadequate storage, logistics, and financing.

### *The solution*

Lack of technological, financial, and market access to farmers has served as an entry point for *warehouse receipt system (WRS)* in India. WRS is an external financing mechanism that encourages scientific storage of post-harvest crops in a warehouse that serves as collateral to provide immediate financing to farmers. The warehousing facilities include all the subsidiary facilities and services, such as storage, transport, and handling and distribution of commodities.

The Warehousing (Development and Regulation) Act enacted by the Government of India in 2007 introduced the negotiable warehouse receipts (NWRs) and laid down procedures for development and regulation of warehouses, negotiability of warehouse receipts, and obtaining loans from banks. The Act came into force in October 2010 with the Warehouse Development and Regulatory Agency (WDRA) as the authorized agency to develop and regulate WRS in India. WDRA has made continual improvements to revise the warehousing regulations by simplifying the procedures, enabling digitization, and creating stringent monitoring and surveillance procedures and online management of NWRs (electronic or eNWR) through creation of two repositories.

The use of NWRs provides various benefits, such as increased liquidity in rural areas, access to low cost finance, short and efficient supply chains, incentives for high grades and quality, and better price risk management. These benefits encourage farmers to think beyond subsistence, enhance yields, and increase their returns. An efficient warehousing regime also creates a more healthy trade balance in agricultural commodities, which can eventually increase the domestic and global competitiveness of the Indian agriculture sector.

**Financial model of WRS**

The working of the WRS financial model is explained in Figure 8. It begins with the borrower depositing his produce into a warehouse for which he receives a warehouse receipt. The buyer pays to the lender once he obtains the produce from the borrower. Later the lender can redeem the receipt at the warehouse that reflects the payback of the loan.

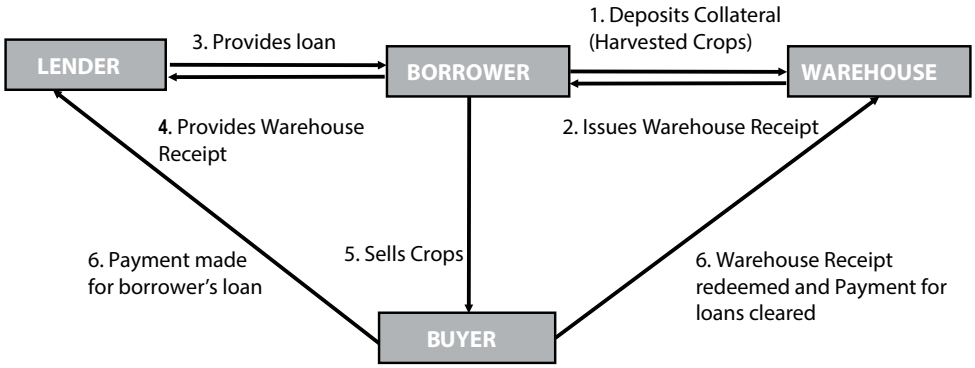


**Figure 8:** Working of a warehouse receipt system

*Source: Adapted from study on approaches to agriculture finance and risk management in the ECA region by Devajit Mahanta (as cited by Keshavan (2008))*

## *Implementation*

**Project initiation:** In India, the practice of lending against warehouse receipts received major impetus when NWRs were introduced under the Warehousing (Development and Regulation) Act, 2007. The act laid down procedures for development and regulation of warehouses, negotiability of warehouse receipts, and obtaining loans from banks. The act came into force in October 2010 with the Warehouse Development and Regulatory Agency (WDRA) as the authorized agency to develop and regulate WRS in India.

**Status:** WDRA has registered 1436 warehouses belonging to public sector, private sector, cooperatives, and individuals with an aggregated capacity of 57 lakh metric tons. To digitize the entire process of warehousing that includes registration, monitoring, surveillance, and management of NWRs, two repositories, namely, the 'Web Portal of Warehousing Development and Regulatory Authority' and 'Electronic Negotiable Warehouse Receipt (e-NWR) System', were launched in 2017. During the process of strengthening the warehouse processes, WDRA identified key challenges, and appropriate actions to address these challenges were taken up under the *Transformation Plan*[6].

**Beneficiary:** Warehouse receipt financing has emerged as a silent revolution in Indian agriculture. More and more farmers are using warehousing receipts as a tool to meet their working capital and consumption needs after the harvest season. WRF brings about benefits at both micro and macro levels for farmers and banks. WDRA has issued loans against NWRs to the tune of ₹1705.36 crore between 2011–12 and 2018–19.

**Expected Impacts**

The financial model of WRS has mitigated the risk on both banks and famers. For example, banks have built on a high level of fiduciary trust by creation of better lending conditions through the provision of liquid collateral from farmers that is stored in certified warehouses. Similarly, the goods deposited by farmers in warehouses are insured against all risks, providing an assurance to farmers that they do not hold any liability for losses caused due to any sort of commodity risk. In addition, WRS provides a range of benefits to all the stakeholders involved.

a. **Borrower (farmers).** Farmers can store their produce in an authorized warehouse as collateral against which they get access to funds in the form of loans immediately after harvest. They also get better price realization of their products since warehouses continually monitor market prices of commodities. Collateralization of produce, therefore, offers increased liquidity among rural farmers for next crop cycle and reduces their dependency on informal lenders.

b. **Lender (banks).** As WRS shifts the risk of payback from the borrower to the liquid collateral deposited, banks gain comfort and fiduciary trust, which gives them an opportunity to readily extend short-term credits to farmers and meet their priority sector lending targets. This eventually increases the reach of financial institutions to rural areas and opens up a new market for financial products.

c. **Warehouses.** The warehouse service providers benefit due to higher utilization of the warehouse capacity, which increases their net revenue.

d. **Buyer (exporters, traders, and processors).** NWRs have immensely benefitted buyers because goods do not have to be physically transferred from one location to the other while they are being sold to other buyers across the entire value chain. Such a negotiable instrument ensures that the produce can be traded, sold, exchanged, and used as collateral easily.

## *Learning from good practice*

1. **Ensuring effectiveness through an online monitoring, reporting and verification (MRV) system.** The online portal for electronic NWRs serves as a tool for monitoring, reporting, and verifying activities taking place under WRS. This is a dynamic portal that routinely provides updates on the number of registered warehouses, warehouse receipt

[6] *Details available at http://164.100.47.191/paperlaidfiles/CONSUMER%20AFFAIRS,%20FOOD%20AND%20PUBLIC%20DISTRIBUTION/English1.pdf, last accessed on 4 September 2014*

generation and transfer, and details of stock in each warehouse. The effectiveness of the system further increases as it has decreased fraudulent cases and reduced the time and effort for procedures.

2. **Awareness, capacity building, and training programmes.** WDRA has organized various awareness programmes to inform farmers about the benefits associated with the use of eNWRs and secured scientific storage of their produce in warehouses. Expert institutions have also conducted several training programmes targeting almost 1271 warehousemen to build their capacities about accreditation, commodity storage, and overall warehouse management procedures.
3. **Credibility and trust.** The credibility of NWRs has been built through a range of initiatives pertaining to the review of warehousing landscape in the country, revision of rules and regulations, provision of a robust monitoring system, and introduction of digitisation to ensure greater transparency and trust. The impact of such initiatives is reflected in greater participation and registrations with WDRA.

### *Potential for scale-up in India*

India loses about 2.8% of crops on account of post-harvest issues, amounting to ₹926 billion (US$14.33 billion),[7] which emphasizes the need and potential to transform agriculture by building on existing warehouse capacities. Warehousing is an important element of agriculture supply chains where the produce is collected, scientifically stored, and distributed to the point of consumption. Though WRS is used with high interest in the country, the sector is still grappling with issues pertaining to the quality and services provided by warehouses, lack of infrastructure, and skill gap of warehousemen, which need immediate attention. Scaling up the warehouse sector would require the careful consideration of the following:

- **Technical scale-up potential.** The abundance of small warehouses in India that generally have lower mechanisation and high inventory holding leads to high cost and storage losses. These warehouses can be scaled up through introduction of GPS tracking to enable real-time tracking to reduce vigilance cost and on-demand warehousing to optimize space.
- **Scope for financial engineering.** WRS can be coupled with other collateralized financing schemes such as repurchase agreements and factoring that lowers the risk on banks and suppliers, respectively.
- **Scope for private finance.** Private companies can partner with financial institutions to consolidate small warehouses to larger ones that can accommodate more inventories and receive financial benefits of economies of scale. Similarly, promotion of public–private partnerships can help leverage private sector funding to improve long-term investments in agricultural infrastructure.

Though WRS processes have been strengthened over time and managed to provide a nation-wide coverage, some challenges still remain unaddressed. There have been issues that have affected the growth of the warehousing sector in the pre-GST era that required warehouses to bear interstate taxes on sale of goods. This had led to establishment of small but multiple warehouses in contrast to large warehouses. However, the introduction of GST has replaced the interstate taxes and made it viable to consolidate functions of a small warehouse into larger ones. Another risk that might dwindle the interest of farmers in warehousing is the high minimum support price (MSP) promised by the government on crops. These challenges should be given due consideration in order for future decisions in the warehousing sector to be more welcomed by farmers and political groups.

[7] *Reducing post-harvest losses in India: key initiatives and opportunities by Rockefeller Foundation and Intellecap*

## 3.8. Kenya: Strengthening adaptation and resilience to climate change

### *Problem statement*

Kenya's Climate Change Action Plan (2013–2017) and National Adaptation Plan (2015–2030) highlighted the importance of the private sector in contributing to the growth of the country's green economy and thereby mitigating climate change. However, this endeavour is plagued by lack of information, both of the impacts of climate change on businesses and about the potential of climate-related financial opportunities. This has led to green businesses being perceived as a risky investment, and thus many climate-oriented start-ups in the country are unable to receive finances and struggle to commercialize their products. The Strengthening Adaptation and Resilience to Climate Change in Kenya Plus (StARCK+) programme (2013–2017) recognized this lack of financing as a market failure and aimed to address it by providing the capital and technical expertise required to incubate private sector businesses to enable them to effectively engage in climate-related initiatives.

### *The solution*

Three StARCK+ partners – Kenya Climate Innovation Centre (KCIC), Renewable Energy and Adaptation to Climate Technologies (REACT), and Finance Innovation for Climate Change Fund (FICCF), have directly worked with the private sector by investing in and supporting green innovations that are otherwise deemed too risky by commercial lenders. KCIC and REACT provide interest-free loans and grants for which FICCF provides guarantees that take on all liabilities experienced by financial providers. KCIC also provides technical assistance and capacity building to start-ups, including an incubation period during which products can be tested. The company profile of the private start-ups is promoted through networking, conferences, and exhibitions in order to gain future investors. This has reduced the risk associated with start-ups, while allowing them to develop and prove themselves.

**Business model**

KCIC provides a holistic approach to support businesses, including technical and financial assistance, as well as influencing national policies on climate and green technologies. On the other hand, REACT not only provides direct funding to start-ups, but also mobilizes the investments from the private sector to improve the outreach of the business and maximize the impact of their products. It aims to improve pro-poor solutions in Kenya, with a focus on three main themes: (i) technological or service solutions that reduce the vulnerability of farmers to extreme climate events, (ii) increased access of rural communities to clean, low-cost energy alternatives, and (iii) improved access to end-user financing for clean energy options. Finally, the FICCF supports climate-smart agriculture (CSA) though micro finance contracts with MFIs. The primary objective of the FICCF-CSA model is to focus on the financial inclusion of the BOP (bottom of the pyramid) by aiding the existing or new value chains. FICCF directly interacts with the private sector players and anchors the companies in the value chain. This support allows the private stakeholders to forge new networks and form informed opinions, thereby reducing the risks associated with the value chain.

### *Implementation*

**Project initiation:** StARCK+ was a United Kingdom's Department for International Development (DFID) climate change project. It was launched in 2013. The programme was divided into six components and managed by five contractors.

**Status:** StARCK+ was a 4-year programme (2013–2017) and followed the first StARCK programme (2011–2013), which supported a range of activities to assist Kenya with its climate actions.

**Beneficiary**: Since 2016, KCIC has supported 166 businesses that focus on renewable energy, climate-smart agriculture, and clean air and water. These businesses are undergoing their incubation periods. Of these, 24 businesses have been given proof of concept investments. REACT has supported a total of 13 green businesses till date, with an investment of $7.74 million in the form of soft loans, grants, and support services. FICCF has helped 73,695 farmers across Kenya to cope with climate change by shifting to climate-resilient products and using newer production technologies, as well as by providing services such as weather-based insurance.

**Impacts**

- KCIC funding has helped create a total of 1450 jobs in Kenya. It has also successfully lobbied the Kenyan

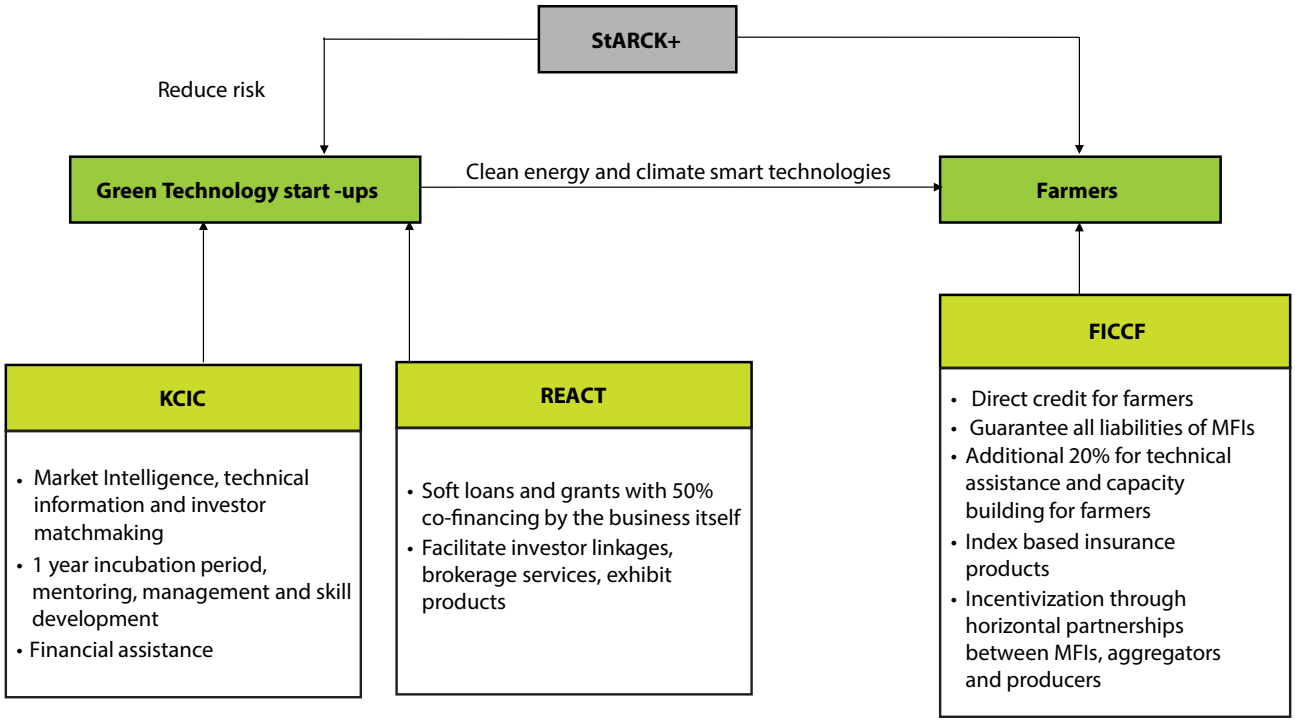


**Figure 9:** Business model of StARCK+ Kenya

government to adopt green technology policies. KCIC has aided in the formulation of the National Adaptation Plan (2015–2030) and the Kenya Climate Change Action Plan (2013–2017), both of which have highlighted the importance of the private sector in climate change actions.

- REACT-supported start-ups have provided off-grid clean energy solutions to rural areas, for example, isolated mini grids or solar home systems. One project, in particular, has had a transformational impact on climate adaptation in Tosheka, where farmers have been supported to raise silkworms fed on drought resilient castor plants. This is in place of the traditionally used but more climate vulnerable cotton plants grown in the region.
- FICCF has supported the planting of cassava and sorghum, which are more drought resilient. These two crops are now being produced on the commercial scale for export. There is a demand for sorghum from Japanese noodle producers as well as for the production of beer by the East African Breweries Ltd. FICCF has also provided technical and financial support to the Kenyan government in the formulation of the Kenya climate-smart agriculture framework programme.

## *Learning from good practice*

**Policy and legal framework:** StARCK+ has created an enabling environment at both national and local levels that has helped engage the private sector in developing a green economy.

**Mobilize funding through risk-free demonstrations and peer associations:** By providing grants and interest-free loans, REACT and KCIC remove the perceived risks associated with start-ups. This allows innovative models to develop and prove themselves before achieving full commercialization. In addition, private sector start-ups can benefit from networking and sharing of information. This not only can be used to obtain funding, but also create an open, competitive market for green innovation to thrive.

**Incubation process allowing the testing of new technologies in a secure manner:** The KCIC incubation process has ensured that businesses are provided adequate funding and a platform to test their products. This has allowed more ideas to reach fruition. Thus, private start-ups have been able to create innovative low-cost clean energy models and adaptation technologies and come up with various payment delivery systems that positively impact the rural poor of the country.

## *Replication potential in India*

### Technical scale-up potential

India has been providing incubation services to technological start-ups through central and state government grants. A number of incubation centres have been set up across the country, with around 300 companies having been supported so far through the Biotechnology Industry Research Assistance Council (BIRAC). Of this, 140 have been supported by BIRAC's flagship scheme "Biotechnology Ignition Grant" (BIG) at the pre-proof of concept stage. However, many of these businesses are unable to achieve widespread reach, primarily due to a lack of market intelligence for their products and a less number of investor linkages. Implementing a holistic approach, as seen in the StARCK+ programme, can help India identify and address these climate requirements and opportunities at multiple levels. StARCK+ has been able to scale down, identify opportunities, and promote innovation that strengthens at the grassroots level. Similarly, for India, national level policies for climate adaptation can also be scaled down to local levels, which can then be used to prioritize activities that support grassroots innovation while involving the private sector. This increased participation of the private sector could ultimately have a bottom-up effect, influencing national policies in a way that is even more representative of climate requirements.

### Scope for private finance

Through awareness building activities, StARCK+ has managed to involve all stakeholders, including farmers, low-income producers, and the private sector. This has ensured that there is more information available to all on the impacts of climate change on agriculture. A similar awareness drive in India, backed by a strong business case, could motivate private sector start-ups to form and focus on developing climate adaptation specific innovations, creating more accessible solutions for farmers to help them better plan their agricultural decisions and improve their resilience.

### Scope for financial engineering

StARCK+ provides an innovative way of scaling down national level policies to make them relevant at the local level. By supporting small-scale green start-ups, StARCK+ not only encourages the involvement of the private sector in green growth, but also ensures that villages in Kenya are provided with clean, sustainable resources. In India, most of the start-ups that are supported by BIRAC are involved in medical biotechnology. By increasing the focus on climate technologies and providing them with a complete incubation and market support package, India, too, can ensure that green start-ups in the country are able to effectively innovate and provide climate solutions for the rural population in the country. In addition to supporting green companies, StARCK+ also works to directly build the climate resilience of farmers by providing innovative climate finance solutions. For instance, by providing direct credit to low-risk farmers and guaranteeing the liabilities of MFIs that lend to high-risk farmers, FICCF has removed the uncertainty associated with agriculture in the country. Similarly, weather-based insurance provides a faster and more accurate method for evaluating crop losses and ensuring rapid payouts. Weather-based insurance schemes in India have been taken up so far only if they were compulsorily combined with loans and have favoured farmers with access to irrigation. Thus, many high-risk crops, such as fruits and vegetables, received low coverage. Even low-cost crops like pulses were given low coverage, due to these crops being farmed in dry areas. Thus, as seen in the case of StARCK+, there is a need for increased pro-poor products and lending as most farmers in India are small landholders. By picking certain climate-resilient crops and guaranteeing the liabilities associated with them, the government can not only reduce the risks associated with this crop, but also promote a shift to better agricultural practices. This has particularly been seen in the case of sorghum and cassava in Kenya. In addition, providing grants to MFIs, to educate farmers about the weather-based insurance and how it works, would improve the outreach of the insurance and reduce the risk faced by farmers due to uncertain weather events.

## 3.9. Philippines: Weather-based crop insurance in Mindanao

### *Problem statement*

In November 2013, Super Typhoon Haiyan swept across the island nation of Philippines, killing 6000 people, affecting 16 million, and causing damages to the tune of 361 billion Philippine pesos ($7.5 billion). Unfortunately, such destructive typhoons are a common occurrence in this developing nation, which experiences an average of 20 major storms every year and is the third most vulnerable country in the world to disaster risks. Farmers in the country are the most affected by these climatic events as they are one of the poorest groups in Philippines and depend solely on agriculture for their livelihood. There has been an increase in instances of weather-related extreme events in Philippines, highlighting the need for climate awareness and adaptation as well as disaster mitigation among farmers in the country.

In order to reduce farmer vulnerability to natural disasters, the Philippines government first introduced crop insurance in 1972. In 1978, the Philippine Crop Insurance Corporation (PCIC) was created to implement the various government insurance schemes. These schemes were designed to uplift the farming community by reducing the burden of loss due to disasters, disease, and pests. To make insurance more attractive, the government offered premium free schemes to farmers.

However, the PCIC soon faced significant issues in their implementation process. Most farmers were unaware of the schemes, with many believing there was no need for insurance. For those who did take it up, the procedure for assessing crop damage was a long, drawn-out manual process fraught with errors. Farmers had to wait interminably to receive their payouts, which were not always of the amount they deserved. In certain instances, studies found that farmers who were provided with premium free insurance went on to neglect their crops, secure in their knowledge of an inevitable pay-out.

### *The solution*

*The weather index-based insurance (WIBI) system* launched by PCIC in collaboration with the UNDP in 2014 in Mindanao aimed to address these weaknesses of traditional insurance products. The key objective was to address the vulnerabilities due to increasing fluctuations in climate and climate change instigated catastrophic events. The index was specific to rice and corn and was created by measuring various weather parameters through stations set up in different parts of Mindanao. Farmers insured under this scheme were paid if the amount of rainfall went above (flood) or below (drought) the index specified cut-off points. The project focused on the following three main strategies to increase the resilience of farmers to climate events:

1. **Creating an enabling environment.** This was done by increasing political support, strengthening the WIBI system through stakeholder engagement, improving farmer participation through subsidies on premiums, and partnering with private insurance providers and sellers.
2. **Strengthen the weather-based index.** Additional parameters were added to make the index accurate to local weather conditions. Farmer requirements were included to form a tailored insurance product. This created an automated system with improved accuracy and timeliness of payouts.
3. **Awareness on the insurance scheme.** Awareness was raised among stakeholders through workshops and circulation of literacy materials.

### *Implementation*

**Project initiation:** The project 'Scaling-up Risk Transfer Mechanism for Climate Vulnerable Agriculture-based Communities in Mindanao' or 'Weather Index-based insurance Mindanao Project' was implemented by United Nations Development Programme in partnership with the Philippine Government through the Philippine Crop Insurance Corporation (PCIC) and Department of Agriculture in 2014 in Mindanao. It was initially launched for a period of 3 years in 2014, with its stated objective being to strengthen the resilience of vulnerable agriculture-based rural communities in Mindanao through climate risk transfer mechanisms and productivity enhancement measures.

**Status:** The first phase of the project was completed in 2017. The successful implementation of the first phase of

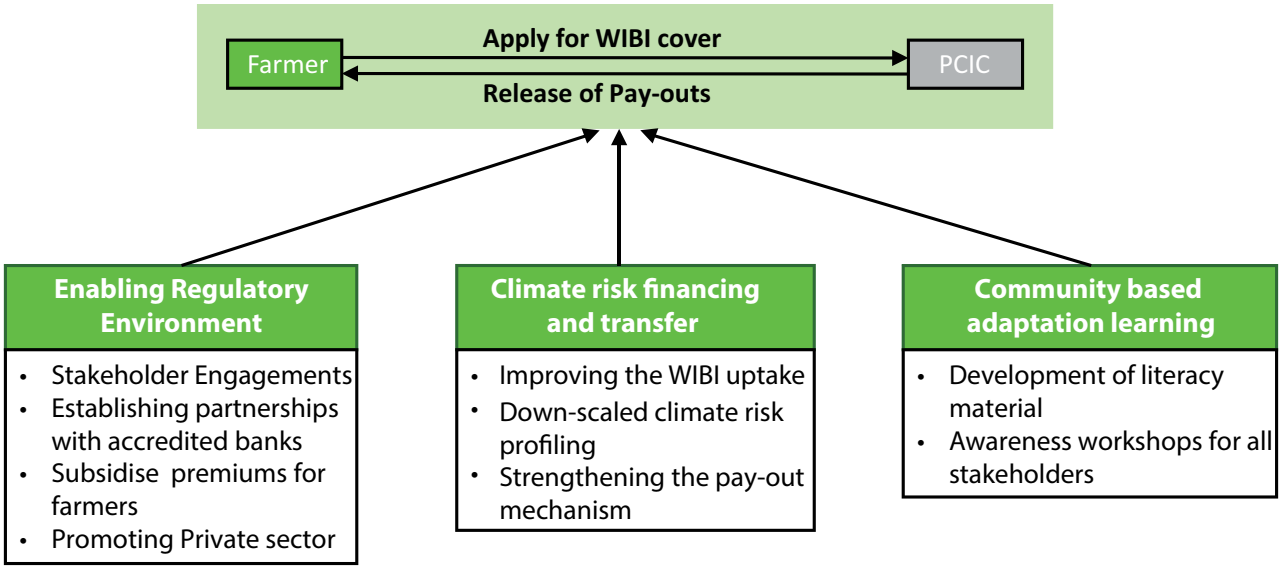


**Figure 10:** WIBI model, Philippines

the project and involvement of diverse stakeholders have strengthened the proposed second phase of the project, which will see an expansion to other parts of the country and the inclusion of more crops. The government of Philippines has shown a lot of interest in the WIBI scheme, which will help PCIC to take on WIBI-related liabilities in the next phase of the project as well.

**Beneficiary:** The programme offered two different covers to major insurable grain crops like rice against low rainfall and excess rainfall. For irrigated areas, it offered cover only for excess rainfall since such areas are not vulnerable to low rainfall. At the end of September 2016, insurance payouts amounting to PHP 900,000 ($17130.50[8]) was given to 103 farmers in the region.

**Impacts**

WIBI has offered significant benefits to farmers. Contrary to traditional insurance schemes that require time-consuming verification of damages, WIBI pays indemnities based not on actual losses, but also on the breach of a weather index that accurately reflects the weather conditions that lead to these losses. This allows farmers to collect insurance payouts without any hassle and use these payouts to buy seeds and equipment for the next cropping season. There was no reduction in crop yield of farmers insured in the first phase, which improved the resilience of these farmers and built their capacity to adapt and manage climate extremes.

### *Learning from good practice*

**Scientific transparency for gaining buy-in:** The weather data collected from the weather stations was made available to the public at regular intervals of 10 days. In addition, workshops were conducted for farmers to help them understand the index parameters used in determining insurance payouts. The farmers could, thus, apply the weather data to the index and validate the on-ground weather conditions. The farmers were also educated on the financial aspects of weather-based insurance to help them better understand the process.

**Collaboration between stakeholders:** Based on feedback from farmers and technical experts on the efficacy of the model during the crop growing season, the model was revised throughout the project period. In addition, the farmers were surveyed to understand how much premium they were willing to pay in the event of a reduction in government subsidies. Meetings were held with private sector banks to apprise them of the government guarantees for any liabilities incurred. This helped increase the involvement of the private insurance providers, thus improving the outreach of WIBI across Mindanao.

[8] *1 PHP = US$0.019*

### *Replication potential in India*

India was the first developing country to offer weather-based insurance to farmers. Launched in 2007, the Indian government's Weather Based Crop Insurance Scheme (WBCIS) was mandatory for all farmers borrowing from financial institutions and voluntary for those who were not. Owing to heavy subsidies offered by the government, and to the mainly mandatory nature of the scheme, a large number of farmers opted for this scheme. Under the WBCIS, private insurance providers were allowed to compete with the public insurance company Agriculture Insurance Company of India (AICI). There are currently 10 private insurers registered with the government, and the states are allowed to choose any one of them as their primary insurance provider. However, the improved transparency and the inclusive stakeholder engagement and capacity building model of Philippines' WIBI project could be leveraged to improve the existing Indian scheme.

**Scope for financial engineering**

Private insurers in India do not have the incentive to create simple, transparent indexes that can be easily understood by farmers as the uptake of WBCIS is mandatory. This has led to complex insurance contracts with many perceived loopholes that have reduced the trust of farmers in weather-based schemes. Creating a strong feedback loop that is inclusive of all stakeholders could help encourage the insurance design process. In Philippines, the farmer feedback was used to modify the index, leading to a more robust method of weather measurement. By appointing a technical team to assess the farmer preferences and requirements, the Indian government could then ensure the creation of a product tailor-made for farmers and only those private insurers who can provide this product are allowed to bid to become the insurance providers for any state.

**Technical scale-up potential**

The Mindanao WIBI project created a standardized protocol for the application of the index. This was done on the basis of intensive scientific studies carried out by the Philippine Rice Research Institute (PhilRice) as well as the experiences from the stakeholders involved in the project. The involvement of farmers in this engagement process increased their understanding and trust of the index. This standardized index will now be used in the second phase of the project, which is to be implemented across different geographical regions and different crops. A similar protocol, if created for India, could ease the implementation process of the insurance products and simplify the administrative aspects of these products, thus making them more viable for private insurance firms.

**Scope for private finance**

As seen in the case of Philippines, conducting workshops to educate the farmers ensuring that the weather data is easily available to them can have a positive impact on the farmers buy-in and level of trust and also make them more inclined towards weather-based insurance. Private insurers, supported by the Indian government, could take measures to enhance the capacity and technical awareness of farmers so as to get more customers. This would also help farmers better understand the climate vulnerability of their crops and take suitable measures to mitigate these risks.

## 3.10. Peru: Natural Infrastructure for Watershed Conservation

### *Problem statement*

The fresh water supply in Peru is being stretched past the capacity by rapid urbanization along the arid coastline, increases in productive activities in the highlands, and climate change. The combined impacts of climate change and ecosystem degradation have resulted in mounting water insecurity for both rural and urban communities.

The Andean glaciers are Peru's sources of fresh water. Glaciers help regulate water supply by storing water during the rainy season and releasing it during the rest of the year. Rising temperatures have accelerated glacial retreat in Peru, since 1970, tropical glacial volume has decreased by 40%. This reduction in volume represents reduced long-term supply of fresh water for local communities. Compounding this, unsustainable land-use practices such as overgrazing and the conversion of forests to pasture have reduced the capacity of soils to retain and filter water. Accelerated glacial melt, changes in land use, and the subsequent water scarcity have a host of long-term impacts, including decreased access to water for household consumption, sanitation and irrigation and reduced hydropower potentials.

### *The solution*

Investments in green or 'natural' infrastructure can help protect ecosystem services and long-term supply of fresh water.

USAID's 2017 Green Infrastructure Resource Guide defines green infrastructure as 'any engineered intervention that uses vegetation, soils and natural processes to manage water and create healthier built environments for people and the natural resources that sustain them.' Available green infrastructure solutions include protecting old growth forests and wetlands, reforesting areas with indigenous species, introducing conservation tillage and pasture management practices, and restoring grasslands and Andean terraces. All of these interventions bolster the capacity of natural capital – soils, forests, and rivers – to retain and filter water and often present a more cost-effective alternative to water management than more traditional grey infrastructure alternatives, such as water treatment plants, dams, or reservoirs. Green infrastructure – in combination with grey infrastructure – can optimize public and private investments to both mitigate and adapt to the effects of climate change, urbanization, and economic growth on Peru's water systems.

Nature-based interventions that promote conservation and ecosystem services, or green infrastructure, can help mitigate the damaged capacity of watersheds. Investment in green infrastructure can help to protect ecosystem services like water retention and filtration, thereby helping local communities adapt to the adverse impacts of climate change.

The Natural Infrastructure for Water Security (NIWS) project, funded by USAID and the Government of Canada, has set up public–private partnerships to finance these interventions that will safeguard water supplies, protect natural capacity for water regulation, and increase climate resilience. The project works with public sector utility companies to generate green investment funds and develop effective projects. SEDAPAL, the Lima utility company, has used proceeds generated from user tariffs to build a green infrastructure set aside into its monthly tariff for rate payers.

### *Implementation*

**Project initiation:** The Natural Infrastructure for Water Security project is funded by the United States Agency for International Development (USAID) and the Government of Canada with an investment of US$27.5 million. The project is implemented by Forest Trends with their consortium partners CONDESAN, the Peruvian Society for Environmental Law (SPDA), EcoDecision, and researchers from Imperial College London. The project was launched in June 2018 and has duration of 5 years.

**Status:** The project is currently under implementation. The project is managed by USAID. Recent Peruvian legislation allowed for payment for ecosystem services (PES), which SUNASS, the Peruvian provider for water sanitation services, has built upon. SUNASS has implemented a legal requirement for a portion of water tariffs received by utilities to go to watershed investments. In response, several utilities – including SEDAPAL, the Lima water utility – have built tariffs into monthly rates to establish green infrastructure investment funds. To date, more than $30 Million has been allocated by water utilities

for qualifying projects. SEDAPAL has a customer base of 11 million people, making it Peru's largest water utility. It has already announced that it will allocate more than $23 Million from user tariffs to natural infrastructure for water.

**Beneficiary:** The project will enable the Government of Peru to better manage its natural resources to increase water security and provide a sustainable economic future to its citizens, while also reducing migration and the risk of internal conflicts. The project will also help farmers by ensuring access to water for irrigation throughout the year.

### *Impacts*

As of 2017, 12 Peruvian utilities have assigned a portion of their tariffs to ecosystem services assessment, protection, and enhancement. The remaining 38 are expected to deliver and implement similar plans in the coming years, and many of those are receiving technical assistance and support from USAID, GCF, and other bilateral and multilateral funded programmes to do so. The focus of these ecosystem service assessment programmes is to develop master plans that incorporate and promote ways that natural or green infrastructure can complement or enhance existing grey infrastructure and vice versa. The existing commitment of funds across 12 utility companies exceeds $30 million, managed largely by SEDAPAL (Servicio de Agua Potable y Alcantarillado de Lima), the capital's water utility.[9]

By creating a self-replenishing fund for investment in green infrastructure, the legislation and supporting ecosystem service assessment and plans aim to (i) understand and link the grey and green systems that provide citizens and industry with clean water, (ii) find and implement least-cost solutions that enhance performance of complementary green and grey infrastructure, and (iii) protect and revitalize cultural heritage.

These funds are used to finance public investment projects (PIPs) that address water scarcity issues. To qualify for financing as a PIP, project proposals must meet detailed criteria. The criteria create a bottleneck in the process: while there is an abundance of proposed projects, most do not meet the qualification criteria. Currently, the project is in its second quarter of implementation in which companies are working with local watershed councils to identify potential projects and building their capacities to develop proposals that meet the pre-defined criteria.

### *Learning from good practice*

Several best practices emerge from this approach.

**Using legislation to secure a dependable flow of finance:** One of the most common challenges for programmes focused on environmental benefits is sufficient, dependable long-term funding. By passing legislation that allows the use of public funds for PES and mandating that a percentage of regular water user tariffs are used for green infrastructure projects, Peru has ensured that this programme is well funded. The next challenge may be in managing, investing, and reporting on the funds transparently and effectively.

**Using grey and green infrastructure strategically:** A strategic use of both green and grey infrastructure can help find the lowest cost solutions. For instance, taking a system approach to integrating green and grey infrastructure has helped Peruvian utilities reduce investment and maintenance costs, engage stakeholders along the entire watershed, and ensure the long-term sustainability of ecosystem services.

### *Replication potential in India*

#### Technical scale-up potential

Similar to Peru, India is experiencing sustained population, industrial, and agricultural growth, which, exacerbated by climate change and poor water resource management, is straining its water supply. The World Resource Institute's Aqueduct database shows that India and Peru can expect similar levels of water stress (high).[10]

India's agriculture, forestry and fisheries sectors account for 90% of the national water use because of poor water management systems and a focus on water intensive crops, such as rice, cotton, wheat, soybean, and sugarcane. Because these productive sectors make up such a substantial percentage of employment (approximately 50%), some of the state governments such as Punjab subsidize electricity costs for pumping

[9] *Details available at https://medium.com/world-ocean-forum/lessons-from-peru-innovative-ecosystem-based-management-in-the-andean-highlands-c7b1f4f192f5, last accessed on 5 September 2019*

[10] *Details available at https://www.wri.org/resources/charts-graphs/water-stress-country, last accessed on 5 September 2019*

groundwater or solar pumps. This has resulted in water overuse and declining groundwater tables. An assessment of ecosystem services at a watershed level and a focus on investment in green infrastructure to regenerate natural sources of water would benefit citizens and industry alike. There is ample opportunity and need for interventions that could complement existing grey infrastructure such as water distribution pipes and water treatment plants with lower cost and more sustainable green infrastructure solutions such as riparian buffers and wetlands.

**Scope of financial engineering**

Creating legislations or legalization of PES that sets aside a percentage of water user's tariffs for green infrastructure investments would serve as an innovative approach for the Indian government to manage water stress situation prevailing in states. This would specifically work well in urban centres of India that are experiencing water stress because the high concentration of water users would ensure steady generation of substantial funds, assuming the government is effective at collecting tariffs.

**Scope for private finance**

Utility companies can partner with private investors to develop green or grey watershed catchment or filtration projects that benefit both citizens and productive sectors along the water basin. This is in the financial interest of food and beverage companies, fisheries, forestry, and agricultural producers because they all rely on ready access to clean water.

# 4. Key measures to enhance access to climate finance for agriculture

The featured case studies highlight some of the most pervasive climate change issues and access to finance challenges prevalent in the agricultural sector of developing countries and showcase potential strategies for overcoming them. From these, the following is a summary of the observed best practices and related recommendations for programme developers:

### *A. Improve farmers' credit profile by strengthening their income generating potential and mitigating their production risks*

Limited access to finance for adaptation measures, primarily due to the credit risk profile of small farmers, is a key barrier for farmers across the world. Financial institutions often cannot provide small agricultural producers with access to finance due to a lack of perceived credit-worthiness, which is further intensified because of factors such as their inability to put up collateral. Devising approaches to alleviate this risk perception and improve the credit profile of farmers thus becomes essential. This can be done through risk transfer measures that shift a part of the primary risk away from farmers by providing insurance services, as done in the case of drought insurance in Malawi (Case 2) and weather index-based insurance in Philippines (Case 9), or through measures that enhance farmer income streams, as done in India's SKY scheme (Case 6). Financial institutions could also identify secure means to use the digital footprint of farmers to understand their ability to clear off loans, as done with the Big Data – Small Credit solution (Case 5). Such measures can help improve the credit risk profile of farmers, or the understanding of it, and increase their access to finance.

### *B. Develop understanding of climate risks and opportunities to attract private sector investments*

The climate risks specific to agriculture are difficult to predict in an accurate or timely manner, thus attracting private investments presents a big challenge for the sector. The opportunity to increase buy-in from the private sector towards mobilising climate finance can be explored with the help of certain tools to support investors' decision-making, for instance, in the Climate-Smart Lending Platform (Case 1) where the credit scoring system provided better understanding of the real lending risk and investment opportunity. Further, incubators for supporting and developing new business models and technologies, such as in Kenya's StARCK+ (Case 8), can strengthen the success rate of start-ups in the area of innovative agriculture practices and foster market growth. Also, targeted incentives can drive private investments, as was seen with the 'repayable grants' under StARCK+.

### *C. Strengthen farmers' capacity to understand and address climate resilience*

A pivotal first step to effective climate resilience in the agricultural sector is to build farmers' understanding of the impact of climate change on their productivity and available adaptation measures through targeted capacity building workshops. For instance, providing technical expertise on solar pumps to the farmers in India's SKY programme (Case 6) and building capacity and understanding on scientific crop preservation measures under India's WRF (Case 7) have significantly improved adoption of these solutions by farmers and enhanced their productivity. As a next step, appropriate incentives, such as climate-smart agriculture practice requirements to be incorporated in lender's loan terms and agreements through measures such as the Climate-Smart Lending Platform (Case 1) and as done for Malawi drought insurance to an extent (Case 2), can encourage adoption of climate-resilient practices.

### *D. Develop financial and government stakeholder's awareness of and technical capacities to address climate risks*

Policy and access to finance that facilitate and encourage investment in climate resilience are an important

counterbalance to building farmers' awareness and capacity. Secondary stakeholders, such as bank officials, government officers, service providers, and technology vendors, must have a baseline understanding of climate risks to be able to craft effective policies and financial products that respond to this demand. Some bank officers, particularly in vulnerable regions, are not properly equipped to assess climate risk in agricultural investments or develop products that can mitigate that risk. Online platforms that provide technical assistance for climate risk assessment and capacity building measures help build understanding. As demonstrated in the Africa's Climate-Smart Landing Platform (Case 1), this assistance can include ways to manage risk in lending portfolios through the use of specifically designed climate-smart credit products that help in increasing farmer incomes and decreasing the risk of loan default. In the case of Peru's Natural Infrastructure for Water Security project (Case 10), to establish the required public–private partnerships with utility companies, raising awareness was a critical step in the stakeholder engagement process.

### *E. Conduct pilot programmes to create an evidence base for assessing potential of an intervention and demonstrate viability of business models*

Piloting interventions that showcase the positive climate benefits of projects or introduce new technical solutions with the support of training sessions can help investors determine the market potential of new initiatives and provide valuable information about the types of risks associated with the project. Pilots like China's Three Rivers Sustainable Grazing helped build understanding of the potential of mobilizing funds from voluntary carbon markets (Case 3), while Ethiopia's CGS demonstrated the scope of economic gains to be generated by providing access to post-harvest machinery (Case 4). Thus, pilot schemes can be an effective measure for addressing investor concerns and lowering the risk perception of such projects.

### *F. Build demand aggregation platforms for small farmers to enable adoption of climate resilience solutions at scale*

Owing to the small size of their operations, individual farmers and smallholders lack the upfront investment required to transition to or invest in climate resilient inputs for their farms. As demonstrated in Ethiopia's CGS programme (Case 4) and India's SKY scheme (Case 6), establishing farmer aggregation groups or cooperatives helps pool resources, which can be leveraged to reduce borrowing costs for individual farmers. Cooperatives also strengthen farmers' ability to manage the impact of climate disasters and recover from them through, for example, shared storage and distribution services, as demonstrated in India's warehousing receipt financing scheme (Case 7).

# 5. Conclusion

Shifting climate trends and natural disasters have already incurred billions of billion worth of damage to crops and agricultural production. These trends are driving persistent food insecurity and displacement. The 2030 Agenda for Sustainable Development, with its focus on climate resilience and poverty alleviation, cannot be achieved without appropriate adaptation measures for the agriculture sector. This necessitates innovative strategies for targeted climate adaptation financing.

It is vital for disaster risk reduction and management to become an integral part of modern agriculture practices and for climate risks to be integrated into financial considerations of governments and financial institutions. Climate finance can act as a key lever for mobilizing finance for agricultural adaptation. However, with the global flows of climate finance being well below the required amount, it is necessary to target the investments in resilience, preparedness, and mitigation and increase the effectiveness of financing models. A wide range of initiatives are being designed and adopted to achieve these objectives worldwide that can be assessed for replication and scalability potential in different country contexts, including India. There is vast learning to be achieved from assessing these and understanding the replication potential of different models to a country's specific issues and conditions. For instance, in India, the traditional agriculture sector has a high risk and low returns perception. To change this view, innovative measures for enhancing income generation potential and improving the financial fundamentals need to be undertaken. Unlocking opportunities to leverage climate finance, while understanding and accounting for climate risks, will ensure that financing is channeled towards practices that address the existing issues in agriculture as well as promise sustainable development that improves resilience and mitigates future economic losses.

The current financial condition of the agriculture sector in India presents both public and private sector stakeholders a timely opportunity to replace short-term 'traditional finance' approaches with long-term climate finance strategies that emphasize risk mitigation and resilience.

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