Financing Climate-Resilient and Smart Agriculture for Small Holder Farmers in Asia-Pacific Region

APRACA Centre of Excellence (ACE)- NABARD

Bankers Institute of Rural Development (BIRD), Lucknow

An ISO 9001:2015 Certified Institution

APRACA Centre Of Excellence - NABARD

"APRACA Centre of Excellence- NABARD", has been established by National Bank for Agriculture and Rural Development (NABARD), India, in 2018. The Centre is housed at Bankers Institute of Rural Development (BIRD), Lucknow, India. The Centre is one of the four APRACA Centres of Excellence (ACEs) in Asia-Pacific region.

- ACE-NABARD on Linkage Banking in BIRD Lucknow, India
- ACE-BI on Islamic Banking, Indonesia
- ACE-BK on Women Empowering, Iran
- ACE-ADBC on CEREFA, China

Aims and Objectives

The Centre aims to disseminate insights into international best practices, innovations, and cutting-edge developments happening in Asia-Pacific Region in the areas of rural, agriculture and microfinance as well as policy and development. The Centre promotes the efficiency and effectiveness of rural finance and improve access to financial services through a network of knowledge sharing and learning, capacity-building, research and exchange of expertise.

Activities

The Centre brings theme-based publications, organizes international webinars and conducts international training programmes.

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Chairman's Message

Smallholder farmers in the Asia-Pacific region face significant challenges due to adverse climate change effects including erratic weather patterns, extreme temperatures and increased frequency of natural disasters. To enhance their resilience and productivity, adoption of climate-resilient and smart agricultural practices is crucial. The preferred practices include usage of drought-resistant crops, efficient irrigation systems, precision farming technologies, sustainable land management techniques etc.

Financing climate resilient agriculture practices requires adoption of targeted strategies to address the unique needs and constraints of smallholder farmers in the Asia-Pacific region. Innovative financial products tailored to the needs of smallholders, public-private partnerships for resources and expertise to support climate-resilient agriculture, providing training and technical assistance to farmers for effectively use of new technologies or practices, improving farmers' access to markets and value chains for fair prices are a few strategies that may aid smallholder farmers to implement and scale up climate-smart practices.

The APRACA Centre of Excellence (ACE)-NABARD, established at Bankers Institute of Rural Development (BIRD), Lucknow, India, has brought out the sixth issue of its publication on the theme “Financing Climate-Resilient and Smart Agriculture for Smallholder Farmers in the Asia-Pacific Region”. The publication includes articles, case studies and success stories from Asia Pacific countries which highlight the progress made by the respective nations and also lists out areas which require more attention.

I hope that policy makers and institutions in the APRACA member countries would find the articles and case studies useful and the compilation will serve as a source of inspiration and guidance for all stakeholders

Shaji K. V.
Chairman
NABARD

Foreword

Asia-Pacific Rural and Agricultural Credit Association (APRACA) is an association of finance related institutions in the Asia-Pacific Region involved in rural, agriculture and microfinance as well as policy and development.

APRACA has joined hands with NABARD, which is a member institution, to have a regular working relationship by way of establishing the APRACA Centre of Excellence -NABARD (ACE-NABARD) with focus on linkage banking. This centre, established in year 2018, is housed at Bankers Institute of Rural Development (BIRD) Lucknow, India.

ACE-NABARD has been instrumental, through its publications, in sharing the innovations, best practices and success stories on themes relevant to APRACA member countries. To serve this objective, I am pleased to share with you the sixth publication by ACE-NABARD on the theme "Financing Climate-Resilient and Smart Agriculture for smallholder farmers in Asia Pacific Region". I am sure the experiences shared through this publication will certainly aid in enhancing our understanding of supporting smallholder farmers in adapting to climate challenges and embracing smart agricultural practices.

This publication would not have been possible without the help of individuals and organizations who have contributed to this, and I would like to use this opportunity to convey my profound gratitude to them. I acknowledge the contributions of the Authors from the institutions i.e. NABARD India, Land Bank of the Philippines, Microcredit Regulatory Authority Bangladesh, Regional Development Bank Sri Lanka and Samunnati India for sharing their valuable articles, case studies and success stories on the given theme. I appreciate the efforts of team members of ACE-NABARD, BIRD Lucknow for bringing out a quality publication.

Nirupam Mehrotra
Director
BIRD

13 September 2024

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Field Inshights

Promoting Climate-Resilient Livelihoods for Tribal Families – A NABARD Initiative

M K De

Abstract

National Bank for Agriculture and Rural Development (NABARD), India, recognizing the socio-economic challenges faced by tribal communities in India, initiated the Tribal Development Fund (TDF) in 2003-04, focusing on sustainable livelihood models tailored to the needs of marginalized tribal families. With a corpus of ₹ 50 crore initially, the TDF aimed to replicate successful orchard-based programs nationwide. Over the years, the program expanded significantly, with 1,026 projects sanctioned to date, benefiting approximately 6.27 lakh tribal families across 29 states and Union Territories. These projects, implemented in collaboration with 414 Project Implementing Agencies (PIAs), encompass activities such as orchard development, soil conservation, water resource development, human resource development, and community health initiatives. The success of the TDF projects is evident in the establishment of orchards featuring a variety of horticulture crops and non-timber forest products, along with initiatives promoting diversified livelihoods, organic farming, smokeless chullahs, and clean drinking water. Moreover, partnerships with corporates under their CSR initiatives have further leveraged funding for project implementation. The TDF projects align with 8 Sustainable Development Goals directly and 6 indirectly, contributing to both the upliftment of vulnerable tribal communities and long-term environmental protection. Moving forward, the program aims to integrate Geographical Indication products, increase agro-ecological principles, promote FPOs, assess carbon sequestration benefits, and strengthen health components for enhanced food and nutritional security. Through these interventions, NABARD endeavors to empower tribal communities, foster environmental stewardship, and pave the way for a resilient and sustainable future.

A tribe is *a group of people who live together and share a common language, culture, or history*. They generally reside on the forest fringes and their livelihoods are dependent on forest resources. In India, tribes are given special status under the Constitution of India and focus is accorded by the Government to uplift the standard of living of downtrodden people. These tribals depend on natural resources for fuel woods, indiscriminate deforestation and unscientific harvesting of forestry resources for their living. The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, gives rights to tribes to use the natural resources which

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ensures conservation of forest and ensuring the livelihoods and food security for forest dwellers.

NABARD's focus on marginalized communities, particularly tribals, in India is evident through its implementation of sustainable livelihood models, such as orchard-based programs. Originating in Gujarat and Maharashtra in the 1990s under the Adivasi Development Programmes (ADPs), these initiatives received external aid from KfW, Germany, benefiting around 33,500 tribal individuals.

Recognizing the success of these programs, NABARD established the Tribal Development Fund (TDF) in 2003-04, initially with a corpus of ₹ 50 crore sourced from annual profits. This fund aimed to replicate the orchard-based model nationwide. Starting with just 11 projects in 2005-06, the initiative has grown significantly, with 1,026 projects sanctioned to date.

The expansion of the program underscores its effectiveness in addressing socio-economic challenges faced by tribal communities. Through collaboration with external partners and leveraging internal resources, NABARD demonstrates a commitment to inclusive growth and sustainable development, ultimately benefiting tribal populations across India.

The objective of the programme is to:

1. Create replicable models of integrated development of tribal families **on participatory basis** through adoption of sustainable income generating activities based on potential of the area and the tribal needs;
2. To build and **strengthen tribal institutions,** which would enable the communities to be partners in policy formulation, execution of programs and improving social and economic status; and
3. Build and strengthen producers' organizations.

NABARD has recently made strategic decision to target the most marginalized segment of the tribal population, known as Particularly Vulnerable Tribal Group (PVTG). These PVTGs, which include 75 tribes spread across 18 States requires special attention to integrate into mainstream.

TDF programme so far

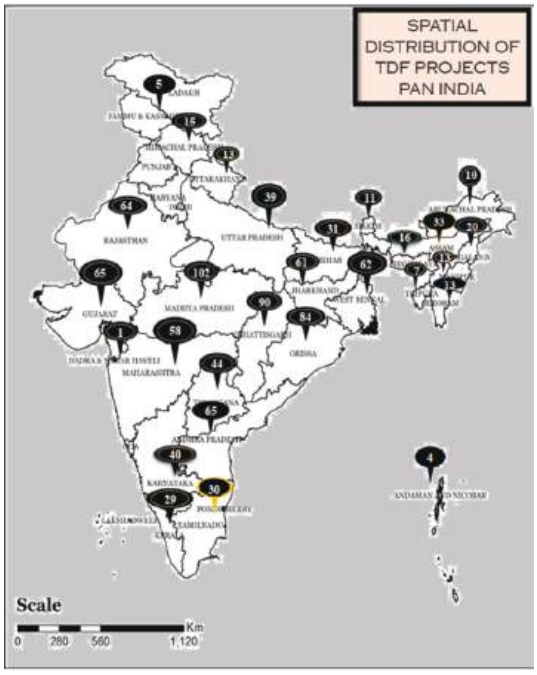
During last 2 decades, 1026 projects covering 29 states and Union Territories have been sanctioned under TDF covering approx. 6.27 lakh tribal families and 5.84 lakh acres of land. The total financial commitment for these interventions is ₹ 2827.43 crore and so far, NABARD has implemented project intervention to the extent of ₹ 2053.27 crore. Out of the 1026 projects, 518 have been successfully completed and 347 projects are ongoing. At present, the programme is being implemented in partnership with 414

Project Implementing Agencies (PIAs). Around 2.77 crore trees have been planted in these orchards, which have a potential of sequestration of 6.08 lakh tonnes of carbon dioxide per year.

To expand the coverage of landless tribal farmers, 14 non-orchard projects have been sanctioned covering 4572 families with financial assistance of ₹ 33.91 crore. Further, 179 FPOs (Farmer Producer Organizations) have been promoted under TDF covering 0.43 lakh families, which are engaged in income generation activities such as, agri-input/agri-service centers, aggregation and marketing of agri. produce, custom hiring center, processing and value addition, agri-allied activities, etc.

Geographic spread

As per the Census 2011, majority of tribal population of India is situated in central and eastern parts of the country. Accordingly, majority of TDF projects have been sanctioned and implemented in major tribal populated States. Madhya Pradesh (102), Chhattisgarh (90), Odisha (84), Rajasthan (64) and Jharkhand (61) have major share of projects. Out of the total 1026 projects, 123 projects have been sanctioned in Northeastern Region (NER) of the country. Assam (33), Nagaland (16) and Meghalaya (14) have sanctioned majority of the projects. One of its kind projects is being implemented in the UT (Union Territory) of Ladakh, covering 219 families and having apple and apricot as main crops.



Activities

- Orchard development - a core component
- Soil conservation in orchard areas
- Water resources development
- Human resource development – SHG / Capacity building / training
- Community Health initiatives
- Processing & Marketing of produces.
- Holistic Approach

Fruits of labour in TDF projects

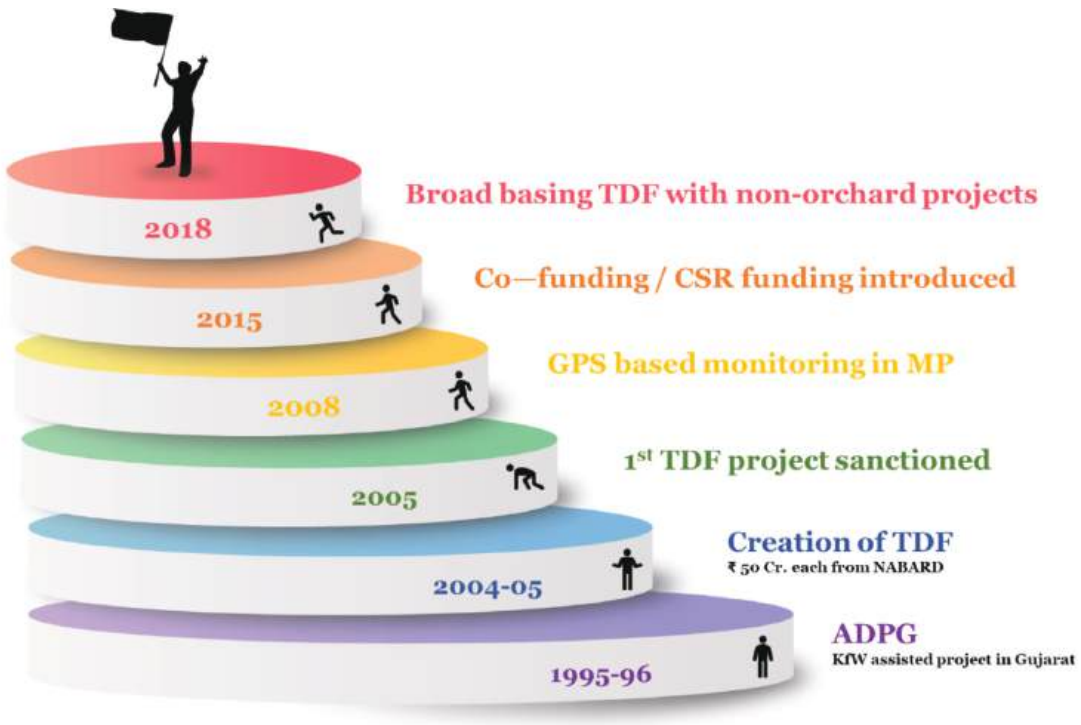
The TDF projects primarily involve establishment of orchards of horticulture crops suitable to the agro-climatic zone. So far, orchard of mango, cashew, guava, aonla, sapota, orange, banana, litchi, pomegranate, apple, apricot, walnut, peach, pineapple, coconut, cardamom, passion fruit, etc. have been developed throughout India. Some plantation crops like coffee, rubber etc. have also been included in few orchards. Forestry plants like Teak, Drumstick, Casuarina, Bael, Mulberry, Willows, Glyricidia, Sesbania, Leucaena etc. have been taken up as border plants. Further, various Non-Timber Forest Products like medicinal plants, bamboo, apiculture, sericulture, lac cultivation, etc. have

also been components of many TDF projects. To support landless tribal beneficiaries in the project, non-orchard-based projects have also been attempted. Non-orchard based TDF projects were sanctioned in Chhattisgarh (apiculture), Tamil Nadu (sericulture and animal husbandry), Telangana (micro-enterprise development), and West Bengal (pig and goat rearing).

Corporate collaborations:

The success of TDF projects has encouraged partnerships with the Corporate Social Responsibility (CSR) wings of various corporates. So far, 72 projects have been sanctioned with participation of 29 Corporates under their CSR initiatives. An amount of ₹ 86.69 crore has been leveraged from corporates for these projects, against NABARD's committed amount of ₹ 144.63 crore.

Major Milestones:



SDGs that TDF projects

Tribal development projects address 8 Sustainable Development Goals directly and 6 goals indirectly. Thereby offers scope for addressing dual objective of upliftment of vulnerable section of the society and taking care of long-term goal for environmental protection.

Climate lens and tribal development:

1. **Orchard development:** The original model for tribal development is development of perennial horticulture crops so that the orchard gives a sustainable income to the tribal families. These permanent assets also gules the families to their homes thereby reduced migration. In an ideal orchard 60 to 80 fruit plants are planted alongwith 200 to 250 border plants. These plantation of 2.5 crore plants give a scope for 6 MT CO_2 equivalent per year and plays an important role in carbon sequestration and climate change mitigation.
2. **Local species of crops:** It also encourages crops that are adaptable to local areas. Emphasizing the importance of native species over exotic ones ensures resilience to climate variations, safeguarding against unpredictable weather patterns.
3. **Intercrop:** In the time-tested model, intercrop is taken in the space available in between the rows of orchard crops. These steps help build organic carbon in the soil and also reduce soil erosion in the project areas.
4. **Soil and water conservation:** The project allows need-based soil and water conservation measures to effectively utilise the rainwater received during the rainy seasons. The major activities are farm bunding, contour trenches, water harvesting structures, gully plugs, check dams, etcetera. These complementary measures further fortify resilience against climate-induced challenges, promoting efficient water management and preserving precious natural resources.

5. **Water Resource Development:** The orchard-based livelihoods mainly located in barren and marginalised lands depends on the water resources available locally. The structures such as water harvesting tanks, farm ponds, percolation tanks help in reducing extraction of ground water. Water resource development lies at the heart of these initiatives with a focus on harnessing local water sources through innovative solutions. By reducing reliance on groundwater extraction and promoting recharge mechanisms, these efforts ensure water security for both agricultural needs and community consumption.

The efficient method of irrigation like drip and sprinkler give scope for conservation water have bearing on climate resilience. In few of our projects, especially co-funded by TATA CINI Trust, solar water pumps are used to lift water from perennial water sources. Even portable solar pumps are also being used for efficient use of resources.

Low-cost water resources

6. **Diversified livelihoods:** The programme addresses the livelihoods requirement of landless families through creation of livelihoods with animal husbandry and rural MSME activities. Diversifying livelihood opportunities is another key aspect of empowering tribal communities. By fostering animal husbandry and supporting rural micro-enterprises, these initiatives create a safety net against unforeseen circumstances, empowering families to withstand economic shocks and build sustainable futures.

Pitcher Irrigation – low-cost efficient method

7. **Nutri-garden**: The nutri-garden promoted under the programme gives source of nutrition to otherwise malnourished population. The *poshak Vatika* provides enough sources of vegetables and fruits to take care of nutrition and surplus can generate livelihoods to the community.

8. **Organic farming:** Many of our orchards developed under the programme are grown organically without use of synthetic fertiliser and chemicals. Embracing organic farming practices not only promotes soil fertility but also reduces dependency on harmful chemicals, fostering a healthier ecosystem for generations to come. The

Agro-ecological approach (Jiva) programme over TDF projects acts as icing on the cake.

9. **Smoke-less Chullah:** As a part of the women development programme, smokeless challahs were provided to the tribal families. These intervention gives scope for healthy kitchen for women in families. Similar activities, like use of transparent roofing materials allows bright light into houses where they live. Innovative solutions like smokeless stoves and bio-gas plants not only improve indoor air quality but also alleviate pressure on forests, promoting a cleaner and greener environment.

Smoke-less chulha

Solar lamp

10. **Clean Drinking Water:** Under health component, clean drinking water is made available through water ATM and treatment of portable water. Access to clean drinking water, facilitated through water treatment facilities and community-driven initiatives, safeguards public health and reduces the incidence of waterborne diseases.

In essence, empowering tribal communities through sustainable development initiatives not only uplifts livelihoods but also fosters environmental stewardship. By embracing a holistic approach that prioritizes community participation and embraces indigenous knowledge, we pave the way for a brighter and more resilient future for all.

Way forward

The suggested way forward for the TDF programme encompasses several strategic interventions aimed at enhancing the livelihoods and well-being of tribal communities. Let's break down each suggested action:

- **Mapping of Geographical Indication (GI) Products:** This involves identifying and cataloging products unique to specific tribal regions, both agricultural produce and handicrafts, which could qualify for Geographical Indication status. This recognition can help protect the traditional knowledge and cultural heritage associated with these products while also potentially increasing their market value.

- **Integration with TDF Projects**: Once GI products are identified, integrating them into TDF projects can provide tribal communities with additional income opportunities and strengthen the cultural identity of these communities.
- **Increasing Agro-ecological Principles**: Incorporating agro-ecological principles into the design of TDF projects can help promote sustainable farming practices that are both environmentally friendly and economically viable in the long term.
- **Promoting Farmer Producer Organizations (FPOs)**: FPOs can play a crucial role in enhancing the bargaining power of tribal farmers, facilitating access to markets, and ensuring the sustainability of agricultural initiatives within project clusters.
- **Preparation of Banking Plan**: Developing a banking plan tailored to the needs of project areas can improve access to financial services and credit for tribal communities, fostering entrepreneurship and economic development.
- **Geo-tagging of Projects**: Geo-tagging TDF projects and overlaying them with geo-tagged post-harvest infrastructure can provide valuable spatial data for monitoring and evaluation, as well as for optimizing resource allocation and planning.
- **Assessment of Carbon Sequestration**: Evaluating the carbon sequestration potential of tribal lands and integrating carbon trading mechanisms can provide an additional source of income for tribal families while incentivizing sustainable land management practices.
- **Promotion of Traditional Technical Knowledge**: Recognizing and promoting traditional technical knowledge can empower tribal communities, preserve cultural heritage, and foster innovation in sustainable development initiatives.
- **Strengthening Health Component**: Enhancing the health component of TDF projects, particularly by incorporating initiatives such as Poshak Vatika (Nutritional Gardens), can improve food and nutritional security among tribal populations, addressing key health challenges and promoting well-being.

By implementing these interventions, the TDF programme can work towards holistic and sustainable development that respects the cultural heritage and ecological integrity of tribal communities.

NAFCC project for Sustainable Agriculture Development in Mizoram, India

Pankaja Borah

Abstract

Agriculture in Mizoram is mostly subsistence in nature and a major percentage of area is under jhum cultivation. To address the issues such as decrease in crop productivity, accelerated soil erosion and land degradation, a pilot project titled "Sustainable Agriculture Development through Expansion, Enhancement and Modelling" was implemented in 4 districts of Mizoram covering an area of 11,700 hectare targeting about 13,000 beneficiaries, with the financial support of ₹10.38 crore from NABARD under National Adoption Fund for Climate Change (NAFCC). The overall objective of the project was to augment the livelihood of rural communities through enhancing resilience of agriculture covering crops and livestock to climatic variability and climate change. The project helped in making the agriculture more productive, sustainable, remunerative and climate resilient. Farmers got higher production and encouraged to adopt improved agronomic practices for higher farm productivity, improved soil treatment, increased water holding capacity, enhanced soil carbon storage, etc. More than 200 farmers abandon Jhumming. Implementation of the project also helped in increasing forest area by 78 hectares. Use of IPM and Farmers' Field School were significantly utilized to tackle the incidence and outbreak of the pest like Fall Armyworm(FAW) on Maize crops. The projects brought development to the farmers economically and socially.

The project interventions were (a) Weather forecasting framework, (b) Networking Training & Capacity building, Awareness, (c) Conservation measures for improvement of soil and water regime in the hill area, (d) Water harvesting & Management, (e) Measures for enhancement of crop production & productivity and (f) Farm Mechanization (Custom Hiring Centre).

1. Project Details

The economy of Mizoram is predominantly agrarian, with more than 60% of the workforce engaged in agriculture. However, agriculture is predominantly subsistence in nature and a major percentage of area is under jhum cultivation with relatively shorter cycles of 4 to 5 years as compared to the ideal period of 10 years. This has led to decrease

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in crop productivity, accelerated soil erosion and land degradation [Ravindranathetal (2010) made a district wise assessment of all districts in North Eastern Region (NER) including those in Mizoram based on their projected increases in temperature and change in their total rainfall. According to the assessment, Aizawl, Mamit and Kolasib are projected to have an increase in temperature to the tune of 1.7 to 1.8 ^{o}C between 2021-50. Similarly, Serchhip and Kolasib are projected to be most vulnerable in terms of increase in precipitation due to Climate Change]. With the objective to address these issues, a pilot project titled ***"Sustainable Agriculture Development through Expansion, Enhancement and Modelling"*** was implemented in the Mizoram with the financial assistance from National Adoption Fund for Climate Change (NAFCC). The project aimed at improving livelihood interventions through various methods like water harvesting, improved crop production practices, soil conservation practices and capacity building of stakeholders.

The project was implemented in an area of 11,700 hectare in 4 districts namely, Aizawl, Kolasib, Serchhip and Mamit in the state of Mizoram which targeted at improving the livelihoods of about 13 thousand beneficiaries. The total grant assistance of ₹ 10.38 crore was sanctioned by NABARD for the implementation of the project under NAFCC over a period of 5 years which was implemented by the Department of Agriculture, Government of Mizoram.

2. Project Objective and Activities

The overall objective of the project was to augment the livelihood of rural communities through enhancing resilience of agriculture covering crops, livestock and fisheries to climatic variability and climate change through development and application of improved production and risk management technologies. This includes activities such as:

- To demonstrate site-specific technology packages on farmers' fields for adapting to current climate risks
- Selection of promising crop genotypes with greater tolerance to climatic stress
- Promotion of best practices for climate resilience through demonstration in three agro climatic zones
- Strengthening of infrastructure at Krishi Vigyan Kendras (KVKs) for climatic change research activities
- Capacity building & training (Training of staff, field functionaries & farmers)

3. Finalizing households for the project implementation

This activity was the first and foremost step towards initiation of the project activities. It helped in indentifying the vulnerability of the region and selecting individual farmers

and farming communities of the project areas which were vulnerable to climate change due to the low productivity from their traditional practice of jhumming, high incidence of pests and diseases and low access to irrigation facilities. Villages and beneficiary households under the project were selected based on the following criteria:

- Area of village under Jhum cultivation
- Low productivity of agriculture.
- Jhum cycle was less than 8 years
- Occurrence of frequent flash floods
- Low access to potable water
- Low access to irrigation (less than 30% of the total cropped area)
- Food production was deficit
- High incidences of pests and diseases in crops
- Biodiversity in forests was poor
- Significant population had kutcha roofs on their houses

Within the villages, criteria for selecting beneficiary households were as under:

- Assessment of household incomes i.e., BPL etc.
- Source of income
- Food self sufficiency
- Jhuming households

Selection of beneficiaries for different interventions of the programme was made on the basis of actual needs of the farmers and the farming community and accordingly 151 number of households most vulnerable to climate change were selected for implementation of the project.

4. Details of Various Interventions

a. Weather forecasting framework: It involved establishment of Automatic Weather Stations(AWS) for seasonal climate forecast at four locations in 3 districts, namely Kolasib, Serchhip and Aizawl. This aimed to augment the crop production by helping the farmers to take weather based decisions to carry out agricultural operations. It was proposed to disseminate the advisories through mobile with a tie-up with a suitable Technology Service Provider (TSP). For this purpose, the information generated from the AWS from the project area was linked to the TSP for agro advisory services. Accordingly, farmers were able to take suitable decision

with regard to input planning and farm management in the wake of changing climate. From climate change adaptation point, it was one of the inputs to cope with the situation and remain better prepared using the tested technologies for adaptation available on ground.

Photo 1 & 2: Automatic Weather Stations(AWS) established under NAFCC in Mizoram

b. Networking Training & Capacity building, Awareness: During the project period, 48 trainings and demonstrations and 3 workshops were conducted on the following topics at different locations within the project area to impart awareness to the targeted farming communities and the extension workers regarding various interventions. A total of 1260 farmers were benefitted from the trainings and workshops on the following topics.

- Climate change- causal and harmful effects
- Jhumming & its effects on environment
- Livelihood activities to replace jhumming
- Sustainable agriculture development.
- Integrated Pest and nutrient management
- Improved Rice cultivation practices
- Soil and water conservation measures
- Permanent farming


Photo 3 & 4: Capacity building and training to farmers

c. **Conservation measures for improvement of soil and water regime in the hill area:** This involved two different interventions aimed at improving soil productivity and reducing soil and water erosion.

   i. **Construction of terraces:** Converting slope areas to bench terraces to considerably reduce soil loss and erosion, increase crop productivity and further provide assets for permanent farming to the farming families. An area of 100 ha was treated covering 103 farmers of 26 villages under this intervention.

   ii. **On Farm development (in situ moisture conservation):** Wet Rice Cultivation (WRC) plots have been manually prepared in 51 villages covering an area of 5 thousand ha which has benefitted 2500 farmer. Bunds were made and levelling was done for better crop cultivation. This resulted in lesser loss of fertile soil and wastage of limited available water.


Photo 5 & 6: Construction of terraces in slope regions


Photo 7 & 8: Construction of Wet Rice Cultivation (WRC) plots

d. Water harvesting & Management: Water harvesting and management gave significant impacts towards decline in jhum cultivation area and increase in income of farming families of the project area. Many farmers could grow vegetables and other crops during Rabi season by utilizing water stocked in the tanks during monsoon. Two activities were taken up under this intervention, namely, construction of water harvesting structure and renovation/restoration of water tank. A total of 170 water harvesting structures were constructed to help 170 farmers and 700 water tanks were renovated in 68 villages of 4 districts.


Photo 9 & 10: Water Harvesting Structures under NAFCC in different districts of Mizoram

e. Measures for enhancement of crop production & productivity: This intervention aimed at introducing better and more productive method of farming to change the traditional system of cultivation. The activities taken under enhancement of crop production and productivity were:

i. System of Rice Intensification (SRI)

ii. Improved Rice cultivation on hill slope

iii. Direct Seeded Rice cultivation

iv. Adoption of IPM for improving crop yield, preparedness to tackle pests and diseases outbreak and capacity building

v. Farmers' Field School

Photo 11: System of Rice Intensification (SRI) in Mamit district

Photo 12: Integrated Pest Management training at Serchhip district

f. Farm Mechanization (Custom Hiring Centre): Three Custom Hiring Centres were established in Kolasib, Serchhip and Mamit districts under which tractors and other farm implements were made available to the farming communities for different agricultural operations like ploughing, levelling, transportation of inputs and farm produce. Due to this, the cost of production decreased and income of farmers increased.

Photo 13: CHC Zophai, Bairabi, Kolasib District

5. Monitoring and Assessment

Monitoring and Evaluation was done by NABARD and Department of Agriculture in collaboration with DoE&F (Environment & Forests Department), Govt. of Mizoram.

Regular review meetings and monitoring visits were conducted by the NABARD during the implementation period. Release of installments were made after utilization of previous installments and production of audited Utilization Certificate followed by field verification by NABARD. Half yearly and annual reports were published every year by DoE&F, Govt. of Mizoram. Project review and monitoring meeting were held on a quarterly basis to ensure the timely completion of the project. End term evaluation was done by an external evaluator at the end of project cycle.

6. Impact of the project

a. **Environmental Sustainability:** Environment of the state gained from this intervention due to several environmental protection measures for developing resilience and adaptation to climate variability. Soil health improved through application of organic manure, which is a key input for maintaining plant nutrients. There was decline of around 9% of Jhum area from 2016-17 to 2019-20 due to the implementation of the project and more than 200 farmers were reported to abandon Jhumming. Implementation of the project also helped in increasing forest area by 78 hectares. One of the reasons for the remarkable decline in jhum area was due to construction of hill slope terraces for permanent farming and on-farm development of WRC areas under this project. Carbon sequestration through agro-forestry models had a positive impact and was a sustainable source of eco-system service for the community. Water harvesting structures, percolation tanks, etc. helped not only to arrest run off and minimize water loss, but also to maintain the soil moisture regime and hence reduced plant morbidity and mortality. Climate forecast data through AWS and crop advisory based on the weather data, were integrated in the design parameters to make the watershed remains resilient in aggravated climate scenario. Use of IPM methods with capacity building training on safe and judicious use of pesticides was imparted to the farmers. Successful management of incidence of Fall Armyworm (FAW) on Maize crops was a remarkable achievement. Mizoram experienced incidence of Fall Armyworm on Maize crop during 2019-20 and 2020-21. The work items under the project namely, Integrated Pest Management (IPM) and Farmers' Field School were significantly utilized to tackle the incidence and outbreak of the pest. The area infested by FAW, as reported in July, 2019 was 3409 ha and the level of infestation was estimated as 68%. Out of this only 38 ha was damaged and the level of infestation was reported as 0.80%. The possible value of loss estimated at the initial incidence of Fall Armyworm i.e., ₹ 20.00 crore was reduced to ₹ 11.97 lakh only after all possible efforts.

b. **Economic & Financial Sustainability:** The project helped in making the agriculture more productive, sustainable, remunerative and climate resilient. Farmers got higher production and cropping intensity encouraging improved

agronomic practices for higher farm productivity, improved soil treatment, increased water holding capacity, enhanced soil carbon storage, etc. Terraces were utilized for permanent farming which led to increase in income over jhumming by up to ₹ 9 thousand per year. On site farm development by Wet Rice Cultivation (WRC) method led to 3 to 10% increase in rice production and income in the districts. An increase in production and productivity was seen in SRI method of rice cultivation over traditional system with less seed requirement and time.

c. **Livelihood Generated:** More than 6500 man-days of employment were generated with the construction of agriculture infrastructure like water tanks, automatic weather stations, custom hiring centres, Terraces, etc. which helped all the stakeholders by generating income.

d. **Infrastructure Development:** Agricultural infrastructure like 4 Agro-Weather Stations (AWS), 700 Water Harvesting Tank, 100 hectares of Hill slope terraces and 3 Custom Hiring Centres were constructed which continues to give long term recurring benefits to the stakeholders. Water stored in Water Harvesting Structures were utilized for irrigation during dry season. Vegetables and other crops were grown during Rabi season. There was an increase in production and income ranging from 2 to 10%.

7. Statements and testimonials of beneficiaries of the Project

i	"This scheme (NAFCC) has helped the farming community in our village tremendously. It had helped the benefitted farmers in increasing their income through adoption of new and improved technologies like SRI, Improved Jhum etc. The productivity has greatly increased through on farm development, construction of Water Harvesting Structure etc. This scheme brought development to the farmers economically and socially".		H.Rodingluaia Chairman Joint Village Council, Mamit.
ii	"We have learnt new and improved method of crop cultivation as well as pests and nutrient management through Farmers Field School".		Lalhruaitluangi, Tuahzawl, Mamit District

iii	"I cultivated 1.0 Hectare of land at Damdiai Zau, Hortoki. One of the hurdles in growing paddy and vegetables at Damdiai zau is insufficient water. After having Water Harvesting Structure from NAFCC I could cultivate vegetables. During 2018 I could not continue to store water due to leakage of my WHS, causing difficulties in land preparation and growing crops. Assistance for repairing of WHS was given to me for repairing of my WHS and now I can get sufficient water for my crops".		HC.Lalhliri D/o Nunhlima (L) Hortoki (Damdiai) Kolasib District
iv	"Our family occupation has been simple and primitive method of wet rice cultivation in a small area without any improvement and the yield also very low. The concern Department launched and selected me to adopt improve method of rice cultivation, i.e. SRI method of cultivation. With the guidance of the Department expert team, we adopted SRI method following their instruction, resulting in two times higher in production and productivity of our rice. I thank the concerned Department especially expert team who instructed and guided me practically".		*Lalremthara* *Samlukhai* *(Changte)* *Aizawl District*

Conclusion: The project impacted Agriculture in Mizoram India, especially small and marginal holders, to be more productive, sustainable, remunerative and climate resilient.

Poultry Farm Boosts Romblon's Egg Supply with LANDBANK Support

Pamela Louise Y. Nhyler

With support from LANDBANK, brothers Alex and Raymond Abelido were able to establish Tierra del Sur Farms, Inc., in San Agustin, Romblon, which is currently the largest commercial poultry farm in the province supplying around 54 thousand fresh farm white eggs daily.

SAN AGUSTIN, Romblon – With its local small-scale poultry farms having limited egg production capacity, this province mainly relies on imported chicken eggs to fully sustain the daily requirements of consumers, restaurants and other local businesses.

Bulk of Romblon's egg supply are shipped from other areas in the country, making its supply vulnerable to transportation disruptions caused by adverse weather conditions and other unexpected delays. These constraints were in full display during the previous imposition of lockdown measures and travel restrictions at the height of the COVID-19 pandemic.

Local businessmen and brothers Alex and Raymond Abelido saw this demand-supply gap as an opportunity to establish Tierra del Sur Farms, Inc., a commercial poultry farm to help strengthen local egg production and cut down egg imports.

"Growing Romblon's poultry production is part of our vision to build a more sustainable food system in Romblon. This is our contribution towards ensuring food security in the province," said Tierra del Sur Farms President and CEO Alex Abelido. Branching out

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from their existing construction business, the Abelido brothers faced the challenge of venturing into agriculture and building the largest poultry farm in the province to-date.

In 2023, the Land Bank of the Philippines (LANDBANK) extended credit assistance amounting to P160 million ($2.76 million) to re-finance the construction of facilities in their farm in Romblon.

The LANDBANK loan helped put up necessary facilities such as four poultry buildings, as well as feeds and tools warehouses, workers' quarters and an organic fertilizer plant. Part of the loan also supported the acquisition of ready-to-lay chickens and covered the purchase of chicken feeds, among other operational expenses.

Not long after having 25 thousand laying hens at the beginning of their operations, Tierra del Sur Farms, Inc. now has around 60 thousand laying hens in their Romblon farm producing about 54 thousand eggs daily. These eggs are distributed to the different island municipalities of the province, including Tablas Island.

Locals are now able to buy eggs at a much cheaper price, with each piece sold at a farm gate price of P7.00 ($0.12) compared to imports that cost around P10.00 ($0.17) per piece. Having locally produced eggs likewise ensures quality and availability in the province, as compared to imported eggs which could take days to reach the province.

Tierra del Sur Farms, Inc. is able to produce over 250 thousand eggs daily, distributed in the islands of Romblon and other parts of the country, including Batangas, Rizal, and Manila.

With the success of their Romblon poultry farm, Tierra del Sur Farms, Inc. likewise sought the assistance of LANDBANK in expanding their operations to Calatagan, Batangas. They availed a P430 million ($7.41 million) loan to finance the construction of poultry buildings and support facilities such as an organic fertilizer plant, sewage treatment plant, and warehouses.

The Batangas poultry farm houses around 250 thousand laying hens in seven fully automated and mechanized poultry buildings. It produces about 200 thousand eggs daily, shipped to various trade partners in Batangas, Rizal, and Manila.

“We would like to thank LANDBANK for its support as we achieve our goals of empowering local communities and ensuring food security. We look forward to their continued support as we plan to expand the reach of our operations even further to

neighbouring provinces," said Raymond Abelido, Tierra del Sur Farms, Inc. Corporate Treasurer and manager.

As of end of March 2024, LANDBANK's outstanding loans to the poultry sector has reached P15.5 billion ($270 million) to finance the production of chicken and duck eggs, breeding of poultry, and sale of poultry meat and products, among other projects.

Building a sustainable circular economy

As part of Tierra del Sur Farms, Inc.'s advocacy to operate with minimal ecological footprint, the farm prides itself on employing sustainable methods for waste management to reduce environmental impact and protect natural resources.

Through a sewage treatment plant also financed by LANDBANK, the farm recycles wastewater as drinking water for their chickens, thereby reducing costs and preventing water pollution.

LANDBANK's assistance likewise enabled the farm to construct an organic fertilizer plant to produce their own fertilizer from chicken manure. These fertilizers are sold to local farmers to help improve soil quality and agricultural production.

Tierra del Sur Farms, Inc. was also recently recognized for the good quality of their fertilizer and tapped by the Philippine Coconut Authority (PCA) through a joint venture to supply organic fertilizer to coconut farmers nationwide.

Their new collaboration aims to boost coconut production while promoting proper poultry waste management, as the Abelido brothers work towards making their business more sustainable and self-sustaining.

ABOUT LANDBANK

LANDBANK currently operates a total of two Branches in the Province of Romblon, complemented by seven ATMs and one cash deposit machine, to facilitate accessible, convenient, and secure banking services.

LANDBANK is the largest development financial institution in the country promoting financial inclusion, digital transformation and sustainable development to benefit Filipinos. The Bank is present in all 82 provinces in the country, committed to provide accessible and responsive financing to drive the agriculture sector's productivity and competitiveness, while championing sustainable development in the countryside.

Conclusion

With LANDBANK's support, Romblon province of Philippines strives towards sustainable food security with climate friendly package of practices.

Sustainable Agricultural Development in Bangladesh: Policies, Institutions and Challenges

Md. Rabiul Islam

Abstract

This article examines the dynamic and evolving landscape of agriculture in Bangladesh, focusing on the sector's diminishing contribution to the GDP despite its significant employment share. According to the Bangladesh Labour Force Survey 2023, agriculture engages about 31.78 million people, constituting roughly 45% of the total labor force. However, its share in GDP has sharply declined from 28% in 1990 to just 11.20% in 2023, as reported in the Bangladesh Economic Review 2023. This reduction in GDP contribution is occurring alongside increasing food insecurity among agricultural households, with about 26.43% facing food insecurity and 0.94% experiencing acute crises. The article also discusses the broader implications of climate change on agriculture, highlighting a projected significant reduction in crop yields due to temperature increases and other environmental stresses. For instance, a 4-degree temperature rise could slash rice production by 28% and wheat production by 68%. These challenges are compounded by high greenhouse gas emissions from agricultural practices, emphasizing the urgent need for sustainable solutions. A substantial portion of the article is dedicated to exploring the potential of climate-smart agriculture (CSA) to enhance productivity, resilience, and sustainability in the agricultural sector. It reviews various governmental and non-governmental initiatives to promote CSA practices, such as investments in sustainable technologies and systems that reduce environmental impacts and enhance food security. The findings indicate a critical need for strategic interventions to improve agricultural practices, enhance financial support structures, and promote innovative technologies that can withstand the adverse effects of climate change. The proposed strategies include: diversifying crops, enhancing the role of microfinance institutions in facilitating access to credit and insurance and fostering adopting climate-smart practices to ensure the sector's sustainability and resilience.

Keywords: *Agricultural Finance, Climate Finance, Microfinance, Agri Insurance, Climate Change, Microfinance institutions*

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Introduction

According to the resolution passed by the UN General Assembly in November 2021, Bangladesh is scheduled to exit the category of least developed countries (LDCs) on November 24, 2026. This landmark transition marks approximately five decades since Bangladesh initially joined this group of developing nations in December 1975, (Graduation of Bangladesh, Nepal, 2021). The attention on graduating Least Developed Countries (LDCs) is largely centered on the Human Assets Index, as well as the Economic and Environmental Vulnerability Index. Within this context, agriculture commands significant focus due to its substantial role.

Bangladesh Quarterly Labour Force Survey 2023 shows approximately 31.78 million people are employed in agriculture, representing about 45% of the total labor force in Bangladesh (Quarterly Labour Force Survey, 2023). The agricultural sector constitutes the most significant portion of the labor force and is a primary source of household dependency throughout the country. However, its contribution to the gross domestic product (GDP) has been diminishing.

The contribution of agriculture to GDP has decreased from 28% in 1990 to just 11.20% in 2023 (Bangladesh Economic Review, 2023), making it a minor contributor to GDP compared to the other two critical sectors: services and industry. Workers in the agricultural sector face more incredible hardships than those in other sectors, often struggling to secure sufficient food.

According to the Food Security Statistics 2023, one in every four households, or 26.43%, that depend on agriculture for their income experience food insecurity. Furthermore, approximately 0.94% of these farming households face extreme food crises or acute insecurity (Food Security Statistics, 2024).

Bangladesh is in a critical state of food insecurity, with nearly a quarter of its population vulnerable to insufficient daily food consumption. Based on the 2022 census, about 41 million people are moderately or severely food insecure, with the highest rates observed in the hilly regions such as Chattagram and Sylhet and the northern regions including Rajshahi and Mymensingh (Food Security Statistics, 2024).

According to the World Bank, the global agrifood system is responsible for one-third of all emissions. If food waste were a country, it would rank as the third highest emitter globally, consuming 70% of the freshwater ("World Bank Climate-Smart Agriculture," n.d.). The system is projected to lose one-third of its GDP by 2050 due to climate change, which may also reduce arable land for crops by 18%. Furthermore, over the next 30 years, 13.3 million people could become internal migrants due to agriculture-related issues, water scarcity, and rising sea levels (Key Highlights: Country Climate and Development Report for Bangladesh, 2022, October 31).

A projected 4 ºC increase in temperature could decrease rice production by 28% and wheat production by 68%. This reduction highlights the urgent need to enhance crop productivity, notably as agricultural land diminishes due to infrastructural projects (Shamsuddoha, M.C.R.K., 2008).

Additionally, rice cultivation, fertilizer-induced farming, field residue burning, livestock production, and manure management contribute approximately 50 million tonnes of CO_2 annually (Sapkota, T.B., Khanam, F., Mathivanan, G.P. et al., 2021). Given these trends, the risks associated with climate change are likely to exacerbate, posing a significant threat to the vast population dependent on these systems.

2. The Context

2.1 Climate Condition in Bangladesh

According to the Global Climate Risk Index 2021, Bangladesh is ranked as the seventh most disaster- and risk-prone country in the world, highlighting its vulnerability to both disasters and climate change (Global Climate Risk Index, 2021). For instance, Cyclone Sidr in 2007 destroyed 0.69 million hectares of cultivated croplands and killed over 460 thousand livestock and poultry (Bangladesh Agriculture Insurance Analysis, 2018).

The impact of climate change on livelihoods and living conditions in Bangladesh is undeniable and globally recognized. Bangladesh is particularly susceptible due to its geography, including the low-lying southern coastal areas and river basins. Moreover, agriculture in Bangladesh contributes significantly to its vulnerability by generating approximately 19 to 29% of the total greenhouse gas emissions (Bringing the Concept of Climate-Smart Agriculture to Life, 2018).

Investments in climate-smart agriculture in Bangladesh reveal an emission intensity that significantly deviates from the global median in several categories. For instance, emissions from eggs, various types of meat (buffalo, cattle, sheep), and milk (buffalo, cow, goat) are higher by 337%, 464%, 158%, 94%, 131%, and 564% respectively. In contrast, emissions from rice, paddy, non-rice cereals, chicken meat, goat meat, and sheep milk are lower by -48%, -15%, -46%, -32%, and -7% respectively (Climate Smart Agriculture Investment Plan, 2019).

The livestock sector alone emits an estimated 7.1 GT of CO_2 equivalent per year, accounting for 14.5% of human-induced greenhouse gas emissions (Moving towards Sustainability: The Livestock Sector and the World Bank, 2023, March 30). Additionally, approximately 62% of the coastal region is already affected by salinity, with predictions of intrusion reaching 8 km inland by 2030. By 2040, cropland in the southern region could shrink by 18% and by 6.5% annually (Bangladesh Climate Smart Investment Plan Investment Opportunities, 2019).

Given the escalating concerns of food insecurity and rapid climate change, new agricultural practices must be adopted urgently. Some techniques endorsed by the F.A.O. show promise in climate-smart agriculture in Bangladesh.

2.2 Climate Smart Agriculture

The Food and Agriculture Organization (FAO) defines climate-smart agriculture (CSA) as "agriculture that sustainably increases productivity enhances resilience (adaptation), reduces/removes greenhouse gases (mitigation) where possible, and enhances achievement of national food security and development goals" (Food and Agriculture Organization of the United Nations, 2010). The implementation of CSA is advocated globally, particularly in regions most vulnerable to the adverse effects of climate change.

The World Bank describes CSA as an integrated approach to managing landscapes—including cropland, livestock, forests, and fisheries—that addresses the intertwined challenges of food security and climate change ("Climate Smart Agriculture," World Bank). Additionally, the World Bank outlines that CSA effectively achieves three core objectives: boosting productivity, enhancing resilience, and reducing greenhouse gas emissions ("Climate Smart Agriculture," 2024).

2.3 Benefits of Climate Smart Agriculture

The European Commission has extensively researched CSA's benefits, reporting that it can increase production, provide real-time data and production information, improve livestock health, reduce water consumption and production costs, enable accurate farm and field evaluations, and decrease the environmental, energy, and climate footprint ("Future of Food and Farming," European Commission, 2017).

If even half of these potential benefits are realized, CSA could significantly slow the rate of climate deterioration. In response to guidance from the FAO and the World Bank, along with local agricultural experts, Bangladesh has shifted towards more environmentally friendly seed production and developing modern forecasting systems to better prepare farmers for adverse weather conditions.

The National Agricultural Policy 2018 recommends technologies conducive to sustainable production, such as controlled seed production and advanced weather forecasting systems, which are made accessible at the local level to develop appropriate crop calendars (National Agricultural Policy, 2018).

2.4 S.D.G. for Agriculture

Moreover, the Sustainable Development Goals (SDGs), particularly SDG2, aim to "End hunger, achieve food security and improved nutrition, and promote sustainable agriculture." This goal underscores the importance of supporting sustainable agriculture, empowering small farmers, promoting gender equality, ending rural poverty, ensuring

healthy lifestyles, addressing climate change, and integrating these efforts within the broader framework of the 17 SDGs in the Post-2015 Development Agenda ("Food Security and Nutrition and Sustainable Agriculture," Sustainable Development United Nations).

Given these objectives, CSA emerges as a crucial strategy for addressing challenges that conventional agricultural practices cannot meet. However, the success of such initiatives largely depends on the availability of adequate financing for agriculture, particularly for innovative practices like CSA.

2.5 Climate finance

Climate finance refers to local, national, or transnational financing drawn from public, private, and alternative sources of financing that seeks to support mitigation and adaptation actions that will address climate change (Introduction to Climate Finance, 2024).

Climate financing structure encourages in mobilizing green investments to address climate change, environmental issues, and sustainability. It channels financing to achieve Environmental, Social, and Governance (ESG) objectives for sustainable economic development

Climate finance mobile funds from public, private, and other alternative sources to support countries in implementing low-carbon initiatives, reducing emissions, and facilitating adaptation to climate change effects. (Climate Finance in Bangladesh: tackling adaptation and developing resilience in the agricultural sector, 2023).

2.6 Global Climate Finance

Global Climate Finance mechanisms such as the Global Environment Facility (GEF) Trust Fund and the Green Climate Fund (GCF) play significant roles internationally.

FAO and GCF joined hands in 2016, and since then, they have invested in impact projects for the agriculture, forestry and fisheries sectors to be more efficient, sustainable, and resilient to climate change. GCF and FAO fund exceeds USD 1 billion. (Green Climate Fund approves new projects worth $145.3 million for climate action in Bolivia, Cambodia, and The Philippines, 2023)

GCF, a bi-product of the Paris Agreement, is the most significant climate-related fund in the world. GCF portfolio allocation in grants is 52% (USD 4.15 billion) for adaptation and 48% (USD 3.77 billion) for mitigation. GCF report shows 228 projects already approved by their 36th board meeting, and the total amount stood at USD 12.8 billion with USD 35.5 billion of co-financing mobilized (Twelfth report of the Green Climate Fund to the Conference of the Parties to the United Nations Framework Convention on Climate).

The GEF has 186 (participants, 2024) member countries and a fund of 21 billion USD. (GEF Trust Fund Financial Report, 2023).

3. Current state of Climate Financing in Bangladesh

3.1 Government subsidies and finances

The government has allocated 16 thousand crore Bangladeshi Taka (BDT) to subsidize fertilizers and other agricultural activities and 150 crore BDT for seed production in the fiscal year 2022-23 (Bangladesh Economic Review, 2023). Although there is substantial governmental support for agriculture, there is currently limited support for developing agriculture insurance. This year, the budget for the Ministry of Agriculture is approximately USD 1.5 billion, with the majority of resources directed towards subsidies for agricultural inputs such as fertilizers, seeds and irrigation (Bangladesh Agriculture Insurance Analysis, 2018).

Subsidies in agriculture have been a longstanding practice, predominantly focused on fertilizers and, to a lesser extent, on seed production. The government is anticipated to dedicate 259 million USD to climate co-benefits, promoting the adoption of climate-smart practices among farmers and processors, including clean cooling technologies along the value chain (Moving Towards Sustainability: The Livestock Sector and the World Bank, 2023).

The government is adopting a forward-looking approach, aligning with global food policy initiatives to foster positive changes in the sector. Additionally, farmers themselves are innovating to combat adverse weather conditions. Some locally developed practices have gained international recognition and are now being adopted worldwide.

3.2 Prevailing practices

Among these practices, Bangladeshi farmers have been pioneering methods like herd farming, floating vegetable gardens, and the organ system to address climate challenges. Recent practices include adopting salt and submergence-tolerant high-yielding crop varieties, drip irrigation, Alternate Wetting and Drying (AWD) and deep urea placement (Climate Smart Investment Plan, 2019).

In December 2014, the FAO designated Bangladesh's floating garden hydroponics system as a globally significant agricultural heritage. In parts of Bangladesh severely affected by floods, where water stagnation is prolonged, farmers have utilized floating agriculture for over three centuries, considering its economic, environmental, and social benefits (Floating Garden Agricultural Practices | Globally Important Agricultural Heritage Systems, n.d.).

Experts have identified significant CSA technologies, including water management, crop stress tolerance, intercropping, organic inputs, and conservation agriculture,

which collectively account for almost 50% of all climate-smart technologies across 33 countries (Bringing the Concept of Climate-Smart Agriculture to Life, 2018).

A World Bank project estimates substantial efficiency gains through CSA in the long term. This includes achieving rice self-sufficiency with production per person maintained at 2015 levels, doubling non-rice crop production, increasing livestock product output by 16% to 17%, and doubling fish products by 2040 compared to the business-as-usual scenario. By 2040, CSA could increase farm-level incomes by 23% (420 billion Bangladeshi Taka) and reduce reliance on rice from 41% to 34%, enhancing the profitability of all crops across divisions. CSA implementation could reduce 2015 emission levels by 13% by 2040 (Climate Smart Investment Plan, 2019).

Furthermore, under this plan, the government and the World Bank have partnered to invest USD 500 million in the Livestock and Dairy Development Project (LDDP), tailoring national development strategies to feed into ongoing strategy processes owned by each country. In Bangladesh, CSAIP results are being integrated into Delta Plan 2100 and informing the National Agriculture Strategy 2018 under formulation. This strategy includes adopting resilient crop varieties, varied cropping patterns, sustainable land management techniques, early warning systems, and new research to adapt the agricultural sector to climate change (Shahnawaz S. R., Roy Shubham, 2023).

3.3 Agricultural Credit in Bangladesh

According to a 2017 survey by the Bangladesh Bureau of Statistics (BBS), approximately 37% of the respondents had taken out loans for agricultural purposes. Among these, 63.28% secured loans from Microfinance Institutions (MFIs), 26.03% from banks, and about 7% from informal sources. MFIs have played a significant role in agricultural credit; in the fiscal year 2023, MFIs disbursed around 1248 billion BDT in agricultural loans, compared to 328.11 billion BDT disbursed by banks in the 2022-23 financial year (table 1). This indicates that M.F.I.s cover a significant portion of the agricultural credit market (Microfinance in Bangladesh, June 2023 & Agriculture and Rural Credit Policy and Program, 2023).

Apart from schedule Bank and MFI, two government-specialized banks also lend agri loans to farmers. The annual report of the Bangladesh Krishi Bank, designated for agricultural loans by the government of Bangladesh, indicates that in the financial year 2022-2023, approximately 86.11 billion BDT was disbursed in the agricultural and agro-based industries sectors. Similarly, the Rajshahi Krishi Unnayan Bank, another specialized bank nearing a merger mandated by the central bank, distributed around 9.76 billion BDT from July 2023 to December 2023. (Bangladesh Krishi Bank & RAKUB). These data also falls under the consolidated data of the bank provided by central bank.

Table 1: Agriculture Loan Disbursement by Banks (In Billion BDT)

Particular	FY19	FY20	FY21	FY22	FY23
Disbursement	236.16	227.49	255.11	288.34	328.29
Recovery	237.34	212.45	271.24	274.63	330.1
Overdue	669.16	60.6	58.65	498.02	527.04
Outstanding (June, 2023)	429.74	455.93	459.4	59.49	65.41

Source: Agriculture Credit Department, Bangladesh Bank & (Monthly Report on Agriculture and Rural Finance, 2024)

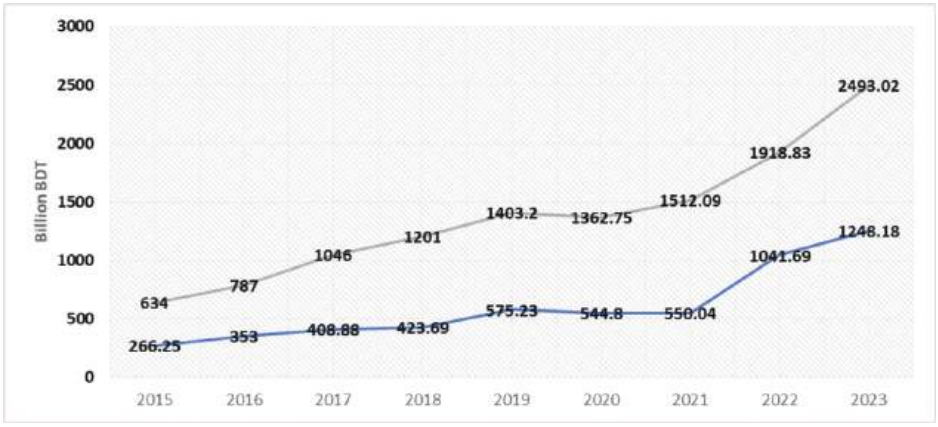
The central bank has mandated that banks manage 50% of agricultural loans through their channels, an increase from the previous requirement of 30% set in 2016 (Agriculture and Rural Credit Policy and Program 2023-24, 2024). Thus, including MFIs is crucial for effectively implementing climate-smart agriculture initiatives in Bangladesh.

Microfinance in Bangladesh 2023 reports that MFIs loan outstanding about 708 billion BDT in agriculture, representing 47.06% of their total loan portfolio, underscoring their significant focus on supporting agricultural activities. In contrast, the 2022 Financial Stability Report by the central bank shows that banks loan outstanding is 617.79 billion BDT to the agriculture sector, which accounts for only 6.42% of their total outstanding loans (Monthly Report on Agriculture and Rural Finance, 2024, & Microfinance in Bangladesh).

Furthermore, the outstanding balance of scheduled banks in agricultural loans, including interest, was 55,634.92 crore BDT at the end of January 2024, with the overdue amount standing at 9,031.63 crore BDT, representing 16.23% of the outstanding loans at that time. (Monthly Report on Agriculture and Rural Finance, 2024).

Additionally, data from Grameen Bank and ten large MFIs show an outstanding loan balance of 113,786.58 crore BDT Previously, it was observed that 47.04% of Microfinance Institution loans constituted agricultural loans in terms of outstanding loans or existing loans to borrowers. Furthermore, if loan disbursement is examined within a financial year, agricultural loans accounted for 50% of the total loan disbursed by the MFI. On the other hand Grameen Bank disbursed 58% of its loans to agriculture, forestry, livestock, and fisheries sectors in 2022, amounting to 13,322 crores BDT (Annual Report 2022, Grameen Bank). This pattern reveals that these ten MFIs alone hold potentially over 56 thousand crore BDT in outstanding agricultural loans, which significantly exceeds that of banks. Let alone other 721 fully licensed MFI. Moreover, the overdue amount for these loans is 4.74% which is much lower than scheduled banks (Monthly Report on Agriculture and Rural Finance, January 2024, Bangladesh Bank).

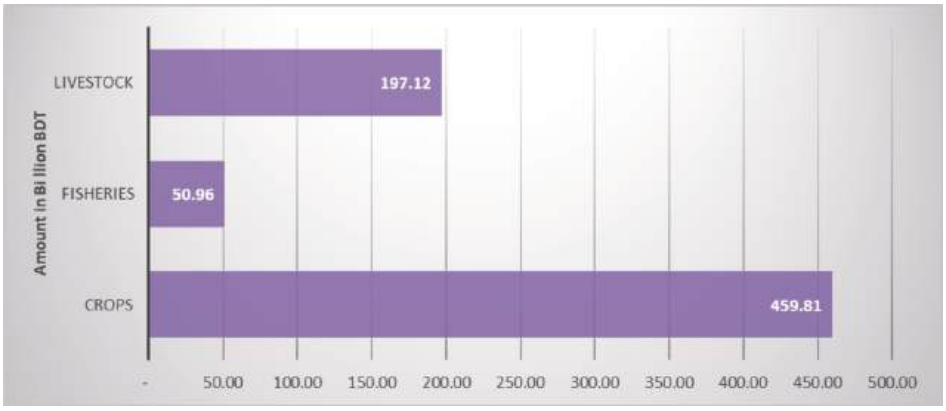
Graph 1 and 2 shows the concentration of agricultural loan to the total loan outstanding of the MFIs.



Graph 1: Agriculture loan through MFIs over the years

Source: Microfinance in Bangladesh, Annual Statistics, June 2023

In the fiscal year 2022-2023, agricultural loan disbursements accounted for 50% of the total loan disbursements by microfinance institutions.



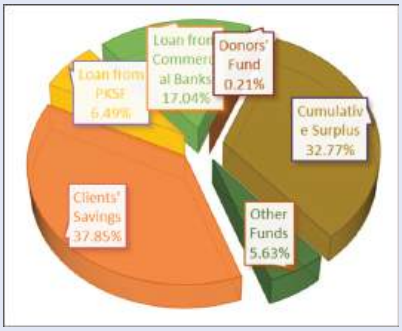
Graph 2: Agriculture loan outstanding of MFI in June 2023

Source: Microfinance in Bangladesh, Annual Statistics, June 2023

As of June 30, 2023, the outstanding agricultural loans to borrowers indicate that approximately 65% of the loans are allocated to crop-related activities, with around 28% designated for livestock endeavors, while the fisheries category comprises approximately 7% of the total.

Consequently, Palli Karma Sahayak Foundation (PKSF), a wholesale Funding institution, in its 2023 annual report, noted that the outstanding amount for 'Sufolon' (loans for agriculture) to partner organizations was 617.25 crore BDT In addition, The Kuwait

Goodwill Fund for sustainable agriculture was 229.85 crore BDT MFIs implement these initiatives. As these initiatives are implemented by MFI, MRA report includes all such loans under their consolidated report of the MFIs (Graph 3).



Source of Fund	Amount Billion BDT
Clients' Savings	620.55
Loan from PKSF	106.44
Loan from Commercial Banks	279.40
Donors' Fund	3.49
Cumulative Surplus	537.29
Other Funds	92.26
Total	1,639.46

Graph 3: Sources of Fund

Source: Microfinance in Bangladesh, Annual Statistics, June 2023

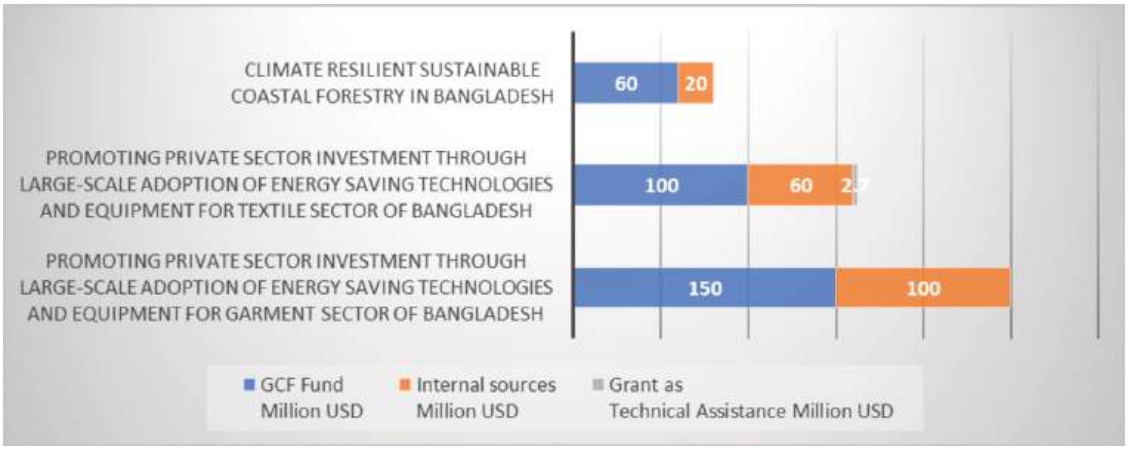
Banks and PKSF collectively contribute less than a quarter of the total funds available to MFIs. The predominant sources of funding for MFIs stem from client savings and the cumulative surplus. Additionally, MFIs have provisions to secure loans from governing bodies or individuals and surplus funds from project implementations also contribute to their funding pool.

Given MFIs' significant role in agricultural financing, regulatory bodies must create policies that foster an environment conducive to climate-smart agricultural practices. This approach will be crucial in directing agricultural credit toward supporting climate resilience for smallholder farmers.

3.4 The current state of climate financing in Bangladesh

The 2023-24 Budget Report on Climate Financing for Sustainable Development in Bangladesh shows that the government has allocated funds to 25 climate-related ministries or divisions totaling 37,051 crore BDT for the fiscal year 2023-24 against the previous year's allocation of 18,918.41 crore BDT (Green Climate Fund, 2024).

In a significant development, the Green Climate Fund (GCF) and Infrastructure Development Company Limited (IDCOL) have signed an agreement for concessional financing, USD 497.9 million in total. Two hundred fifty million will be invested in adopting energy-saving technologies and equipment for Bangladesh's garment sector, where GCF will provide USD 150 million and financial institutions and garment borrowers will contribute USD 100 million. Of other two projects, 167.9 million will be spent on the textile sector and USD 80 million will be used for coastal forestry (Green Climate Fund, IDCOL and Graph 4).



Graph 4: GCF and IDCOL climate Project

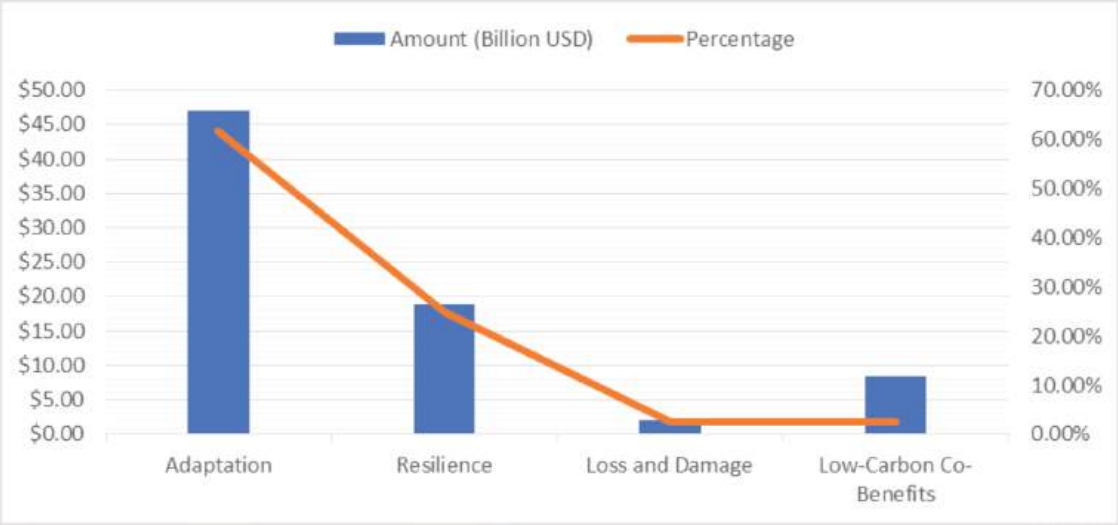
Source: Infrastructure Development Company Limited (IDCOL)

The Sustainable Finance Policy for Banks and Financial Institutions, enacted by the Bangladesh Bank in December 2020, emphasizes sustainable agriculture finance in connection with SDG1 and has developed green financing products. This policy underlines the importance of green finance in addressing Climate and environmental issues, managing risks, and reorienting the financial system to achieve environmental, social, and governance (ESG) objectives for sustainable economic development (Sustainable Finance Policy for Banks and Financial Institutions, 2020).

Despite the increased focus on green finance, only 20% of climate change funding in Bangladesh comes from international sources (Financing for adaptation in Bangladesh, 2022). The budget has allocated 4880 crore BDT for developing climate-resilient cropping systems and 3060 crore BDT to combat drought, salinity, submergence, and heat in 2023-24. 39 (Climate financing for sustainable development, Budget report 2023-24).

The government has initiated a Delta Plan 2100 for Bangladesh, under which the Mujib Climate Prosperity Plan anticipates significant investment opportunities. By 2030, the plan projects approximately $80 billion USD in investments aimed at enhancing climate resilience across various sectors, including energy, water, transport, supply chains, and value chains (Mujib Climate Prosperity Plan, 2021).

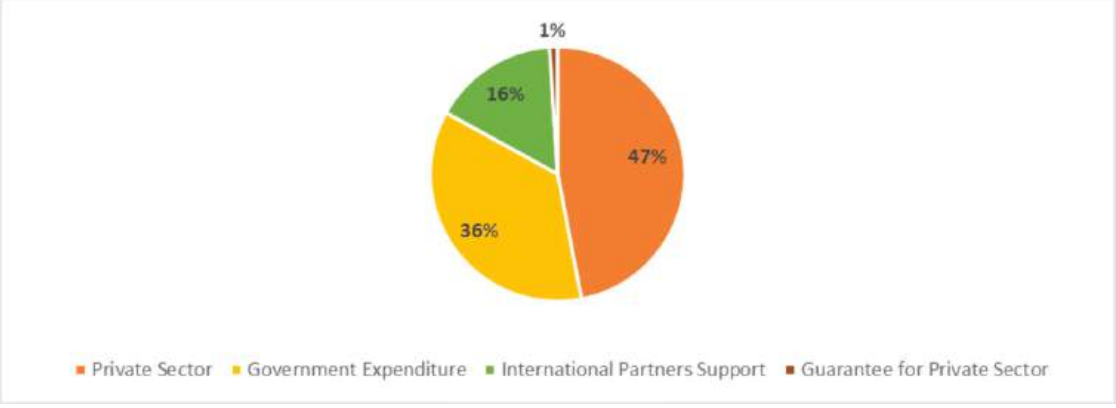
The Graph provides a breakdown of a $76.18 billion USD allocation across various climate-related initiatives. The largest portion, $46.93 billion (61.60%), is dedicated to adaptation efforts, highlighting a significant focus on adjusting systems and practices to mitigate the adverse impacts of climate change. Resilience initiatives, aimed at enhancing the ability of communities and infrastructures to withstand climate shocks, receive $18.87 billion, accounting for 24.80% of the total funds. Loss and Damage,



Graph 5: Investment allocation graph

Source: Mujib Climate Prosperity Plan, Decade 2030

which addresses the financial implications of irreversible climate impacts, is allocated $2.00 billion, constituting 2.60% of the budget. Similarly, Low-Carbon Co-Benefits, which support projects with additional climate benefits beyond primary objectives, are also funded at $8.38 billion, representing 2.60% of the total allocation. This distribution underscores a prioritization of adaptive and resilient strategies in addressing climate challenges (Graph 5).



Graph 6: Financing Breakdown

Source: Mujib Climate Prosperity Plan, Decade 2030

According to the Mujib Climate Prosperity Plan (2021), an expected investment of $83.55 billion USD by 2030 is projected, with a specific focus on climate and disaster

financing and management, as outlined in point 4. This segment will allocate funds to protect MSMEs, enhance productivity, and develop climate-resilient and nature-based agricultural and fisheries supply and value chains. It also includes national risk financing for food security, nutrition, and water supply. By 2030, $4.89 billion USD is designated for these initiatives under point 4. Of the total $83.55 billion USD investment, 47% will come from the private sector, 36% from government expenditure, and 16% from international partnership support (Graph 6).

3.5 Agri Insurance

Agricultural insurance is crucial in mitigating climate risks in Bangladesh. The Asian Development Bank (ADB) has piloted weather index-based crop insurance for rice farmers in drought-prone areas such as Rajshahi, utilizing parametric weather indices generated by the Bangladesh Meteorological Department. Over 9500 small farmers have been insured through the Sadharan Bima Corporation with Bkash facilitating the collection of premiums and payment of claims. The premium contributions are shared among farmers, the government and project financiers in a ratio of 50:25:25 (Quayyum, S., & Clarke, 2018).

Furthermore, Green Delta Insurance covers 10 thousand farmers, settling claims for 2200 farmers for unseasonal excess rainfall, cyclone signals, and cold spells as of December 31, 2018 (Best Agriculture Insurance in Bangladesh - Green Delta Insurance, 2023). Despite these initiatives, agricultural credit remains limited, accounting for only 3% of total lending. The Global Findex Database 2021 by the World Bank shows that about 47% of the adult population in Bangladesh does not have a bank account, with many being served by MFIs that offer member welfare fund in the form of pseudo micro insurance products linked to credit (Global Findex Database 2021).

While the government and financial institutions in Bangladesh are making strides in climate finance and agriculture insurance, there remains a significant need for expanded coverage and more robust policies to ensure the agricultural sector's resilience against climate variability.

4. Case study on BRAC

4.1 Background

BRAC's case study on promoting sustainable agriculture, food security, and climate resilience in Bangladesh is one example. Different programs and activities have enabled the organization to achieve the indicated objectives on SDG 2 while implementing projects to improve farming practices and modernize them with climate-intelligent technologies, microfinance support, and climate cognizance interventions. Despite the

challenges of traditional farmings and storage limitations, the food organization has made great strides and empowered farmers and the fraternity to beat the climate risks and realize sustainable food production.

BRAC, one of the largest non-governmental organizations in the world, has played a critical role in promoting sustainable development in Bangladesh. The organization was founded with a primary interest in SDG 1 – No Poverty; however, its scope of activity has significantly broadened with the efforts to promote other SDGs. One of BRAC's essential areas of activity has been SDG 2 – Zero Hunger, implementing various programs to tackle food security issues and improve agriculture. The current case study explores BRAC's work on agricultural development across multiple dimensions, from agricultural inputs training to market development and insurance.

Information of the case study is taken from BRAC SDG contribution voluntary Review 2023.

4.2 Program Overview

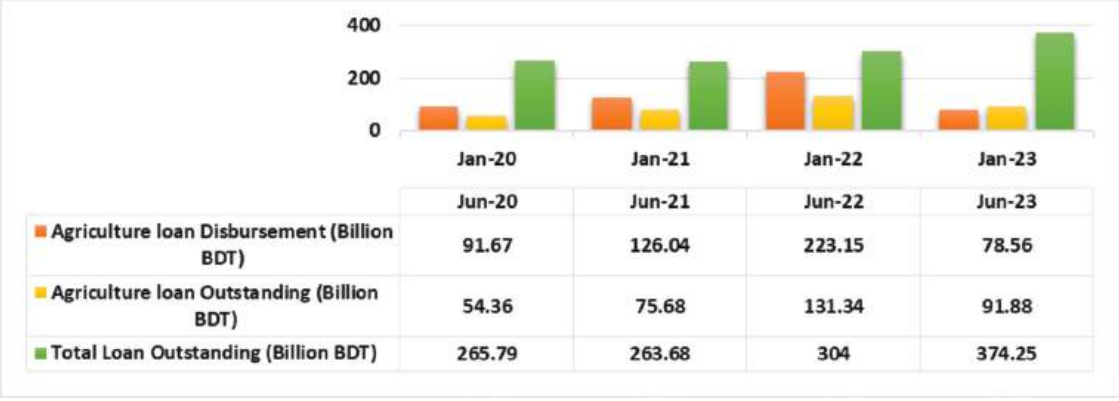
BRAC's multifaceted approach aligns with various targets and indicators under SDG 2, emphasizing its commitment to addressing global hunger and promoting sustainable agriculture. BRAC focuses on enhancing nutrition, ensuring food security, and promoting climate-resilient agricultural practices within its communities through six core programs and two social enterprises. The organization leverages a comprehensive strategy to foster agricultural productivity and combat malnutrition, from the BRAC Health Program to initiatives like the Ultra-Poor Graduation Program and strategic ventures such as BRAC Seed and Agro.

BRAC's Agriculture and Food Security Program (AFSP) has been a catalyst in empowering rural communities. Through initiatives like the BRAC Seed and Agro Enterprise program, the organization has not only imparted knowledge on climate-adaptive agricultural techniques but also supported thousands of farmers in adopting climate-resilient production technologies, thereby increasing crop productivity. Moreover, BRAC's microfinance program has played a pivotal role in facilitating access to agricultural loans, enabling farmers to invest in sustainable cultivation practices, and taking control of their agricultural future (BRAC SDG contribution voluntary Review 2023).

To enhance agricultural productivity and uplift farmers' incomes, as outlined in SDG 2.1 and 2.3, the Agriculture and Food Security Programme (AFSP) under BRAC extended assistance to 1,120,842 individuals between 2016 and 2018. Notably, 64% of beneficiaries were women. This initiative aimed to equip them with knowledge of optimal crop cultivation techniques and resilient agricultural technologies. Subsequently, in 2018, BRAC phased out AFSP and inaugurated the BRAC Seed and Agro enterprise.

Since its inception, BRAC Seed and Agro has aided 30 thousand farmers through 1,200 scheduled meetings, concentrating on enhancing vegetable, rice, and maize production yields (BRAC SDG contribution voluntary Review 2023).

BRAC's poverty alleviation efforts, spearheaded by the Ultra-Poor Graduation Program (UPGP) and Integrated Development Program (IDP), aided 338,780 ultra-poor households from 2016 to 2019. The focus was on bolstering food security and nutrition through resilient livelihoods and entrepreneurship, encouraging the cultivation of at least five nutrient-rich crops (SDG 2.1). Furthermore, between 2017 and 2022, the Microfinance program extended 186,919 agricultural loans, empowering farmers to invest in essential resources, technologies, and practices for sustainable land use, contributing to increase farm productivity and improved food security (SDG 2.1). Recognizing Bangladesh's vulnerability to climate change, BRAC actively promotes adaptation and mitigation measures through nature-based solutions and community-driven approaches to address the resultant adversities and safeguard food security (SDG 2.1). (BRAC SDG contribution voluntary Review 2023). BRAC's concentration of agricultural loans in Bangladesh's financial sector is commendable and can be seen in the graph 5.



	Jun-20	Jun-21	Jun-22	Jun-23
Agriculture loan Disbursement (Billion BDT)	91.67	126.04	223.15	78.56
Agriculture loan Outstanding (Billion BDT)	54.36	75.68	131.34	91.88
Total Loan Outstanding (Billion BDT)	265.79	263.68	304	374.25

Graph 5: BRAC agriculture Loan portfolio

Source: Microfinance in Bangladesh, Annual Statistics, June 2020, June 2021, June 2022 & June 2023

This graph presents data from June 2020 to June 2023, showing, agricultural loan disbursements, and agricultural loan outstanding, and total loan outstanding in billion BDT. Agricultural loan disbursements rose from 91.67 billion BDT in June 2020 to 223.15 billion BDT in June 2022 but fell to 78.56 billion BDT in June 2023. Similarly, the outstanding agricultural loan grew from 54.36 billion BDT in June 2020 to 131.34 billion BDT in June 2022, then dropped to 91.88 billion BDT in June 2023. Despite these fluctuations, the total loan outstanding increased from 265.79 billion BDT in June 2020 to 374.25 billion BDT in June 2023. During this period the number of borrowers

increased significantly from 2.06 million in June 2020 to 3.22 million in June 2022, then decreased to 2.05 million in June 2023. (Microfinance in Bangladesh, Annual Statistics, June 2020, June 2021, June 2022 & June 2023)

The Climate Change Programme (CCP), in its operations spanning 2021-2022, extended support to 16,323 farmers, facilitating access to saline-tolerant, high-yield crop varieties and imparting guidance on adaptive cropping techniques. Notably, this initiative encompassed the provision of weather forecasts, capacity-building exercises, and counsel on eco-friendly utilization of fertilizers and pesticides, aligning with SDG 2.3. Concurrently, the Urban Development Programme (UDP) underscored urban agriculture's significance, advocating tree plantation, seed distribution, and block gardening, benefiting 240,574 households during 2018-2022. Moreover, BRAC's Integrated Development Programme (IDP) implemented climate-resilient homestead gardening, introduced short-grain rice strains, and facilitated climate-adaptive agricultural services, thus bolstering value chain development for 182,064 households from 2016 to 2022. Emphasizing SDG target 2.5, the BRAC Artificial Insemination (AI) enterprise focused on conserving native breeds like Red Chattagram Cattle and Black Bengal Goats, alongside distributing semen from Holstein-Friesian and Sahiwal cattle, as well as Murrah buffalo (BRAC SDG contribution voluntary Review 2023).

Furthermore, it emphasized breed enhancement and augmented milk and meat output in farmer households, integrating progeny shows to identify superior animals for breeding. BRAC AI's operational reach extends across 64 districts and 475 upazilas, employing 2,200 trained insemination workers to enhance farmers' knowledge, capabilities, and socio-economic standing through training, workshops, and mobile veterinary clinics (BRAC SDG contribution voluntary Review 2023).

4.3 Challenges Faced

Despite its commendable efforts, BRAC encountered several challenges in promoting sustainable agriculture and climate resilience. Traditional farming practices, inadequate storage facilities, and context-specific needs posed obstacles to adopting climate-smart agriculture CSA techniques. Moreover, limited awareness of climate change and its impacts highlighted the need for targeted education and outreach efforts.

In conclusion, BRAC's initiatives promoting sustainable agriculture, enhancing food security, and fostering climate resilience exemplify its commitment to achieving SDG targets in Bangladesh. Through innovative programs and community-driven approaches, BRAC has empowered farmers and vulnerable communities to adapt to climate change and build more resilient livelihoods. Addressing the challenges identified and scaling up successful interventions will ensure continued progress towards sustainable development goals in the agriculture sector (BRAC SDG contribution voluntary Review 2023).

Conclusion

Based on the data and findings presented, several strategic recommendations can be made to enhance the resilience and sustainability of the agricultural sector in Bangladesh. These recommendations aim to address the challenges identified and leverage the opportunities provided by current practices:

1. Crop Diversification: Prioritizing crop diversification is essential for reducing dependency on single-crop yields and increasing resilience against climate variability. Diverse cropping systems can help mitigate the risks associated with climate extremes and market fluctuations.
2. Group Lending Models: Encouraging group lending should be considered to enhance access to credit for smallholder farmers. Group lending models can foster community support mechanisms, enhance loan repayment rates, and provide a platform for sharing best practices among farmers.
3. Revaluation of Loan Repayment Terms: The time limit for loan repayment and the grace period for agricultural loans need to be reassessed to better align with the agricultural cycles and the specific challenges that farmers face. This adjustment would help farmers manage their financial obligations without compromising their operational capabilities.
4. Capacity Building in Climate-Smart Agriculture (CSA): Addressing the lack of training and information is crucial, as it is the most significant barrier to adopting CSA practices. Enhanced educational programs and extension services can empower farmers with the knowledge and skills to implement sustainable agricultural practices effectively.
5. Role of Microfinance Institutions (MFIs) in Social Protection: MFIs should continue to play a pivotal role in promoting social protection and raising awareness about crop insurance. These institutions are uniquely positioned to deliver bundled products directly to farmers, increasing their access to financial and insurance services.
6. Technology Adoption among Farmers: Leveraging farmers' openness to embrace technology can facilitate the efficient administration of financial services. Using platforms like Bkash to pay loan instalments is a testament to the potential of technology to streamline agricultural finance processes.
7. Expansion of Crop Insurance: Although crop insurance is not widely offered, its potential benefits suggest that expansion could be highly beneficial. Experimental projects by organizations such as BRAC, Green Delta, and Sadharan Bima Corporation should be scaled up to provide broader coverage, reducing farmers' financial vulnerability to climatic shocks.

8. Introduction of Reinsurance Policies: Implementing reinsurance policies for agricultural insurance can provide an additional layer of security, ensuring that insurance schemes are sustainable and can cover large-scale disasters without facing solvency issues.

9. Locally led adaptations: Floating Cultivation, like locally led adaptation measures, needs to be focused on gaining effective results in CSA.

10. Green microfinance: MRA could make a policy to implement a green microfinance policy to foster the initiation of CSA finance by MFI.

11. International sources: Bangladesh, a climate-vulnerable country, could negotiate diplomatically to obtain financing from climate-related funds like the Green Climate Fund and the Global Environmental Fund.

12. CSA needs to be geography-specific: Haor, Hilly region, and geographical diversification of land need to be considered to implement a particular method of CSA Haor, Hilly region, plain land, and coastal areas have different adaptation capabilities.

These strategic recommendations are designed to strengthen the agricultural sector's ability to withstand and adapt to the challenges posed by climate change. Thus, they will secure the livelihoods of millions of farmers and contribute to Bangladesh's broader economic stability.

Disclaimer: The views expressed in this paper are the views of the author and do not necessarily reflect the views or policies of MRA, Its Board of Directors or the government they represent.

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Climate Change Impact on Paddy Cultivation in Sri Lanka: Mitigation Strategies and Bank Involvement

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Abstract

Sri Lanka, an island nation in the Indian Ocean, is highly vulnerable to climate change, which poses significant threats to its economy, food security, and human livelihoods. The paddy cultivation sector, which is a vital component of Sri Lanka's economy, is particularly susceptible to climate-related shocks. This study examines the impact of climate change on paddy cultivation in Sri Lanka, highlighting the effects of climate variability on paddy yields, farmers' livelihoods, and the banking sector. Climate change has led to inconsistent rainfall patterns, increased temperatures, and rising sea levels, resulting in droughts, floods, and soil salinization, thereby affecting paddy yields and farmers' incomes. The study reveals that climate-related events have caused significant losses to paddy farmers, leading to loan repayment difficulties and impacting the banking sector's loan portfolios. To mitigate the effects of climate change, the study proposes various adaptation strategies, including diversification of crops, water management, climate-resilient farming practices, capacity building, and financial risk management. The banking sector plays a crucial role in supporting paddy farmers by providing financial assistance, insurance products, and technical support. The Regional Development Bank (RDB) of Sri Lanka, the premier state owned development bank, has initiated measures to address climate change risks in the agriculture sector. The bank has launched a scheme to promote affordable and clean energy, providing low-interest loans for the agriculture sector and fulfilling electricity requirements through solar-powered systems. The study emphasizes the need for a collaborative approach involving the government, banking sector, farmers, and other stakeholders to develop and implement climate-resilient agriculture practices, ensuring the long-term viability of paddy cultivation in Sri Lanka.

Keywords: Regional Development Bank, Sri Lanka, climate change, vulnerability, agriculture, paddy cultivation, mitigation measures, adaptation measures, financial support, sustainable practices.

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Introduction

Sri Lanka, originally Ceylon, is an island in the Indian Ocean, south of the Indian subcontinent, separated from peninsular India by the Palk Strait. This little island is located between latitudes 5°55′ and 9°51′ N and longitudes 79°41′ and 81°53′ E and has a land area of about 65,610 km². Its strategic location near key sea lanes gave it titles such as "Pearl of the Indian Ocean" and played an important part in past trade routes.

Sri Lanka's topography is diverse, resulting in three main zones based on elevation: the Central Highlands, the Plains, and the Coastal Belt. Central Highlands: These mountainous regions form the interior of the island. The highest point is Pidurutalagala, at 2,524 meters (8,281 feet). Plains: The low-lying plains cover much of the island's surface. Coastal Belt: The coastal areas extend around the island, featuring sandy beaches, lagoons, and mangroves.These mountains play a crucial role in Sri Lanka's climate. They capture moisture from the southwest monsoon, providing water for agriculture downstream. The highlands are home to tea plantations, contributing significantly to the country's economy. The plains support rice cultivation, especially in the dry zone. Despite water scarcity during the long dry season, ancient Sinhalese civilization thrived here. These areas are essential for agriculture and settlements. The coastline, stretching over 1,340 kilometers (830 miles), offers access to the sea for trade, fishing, and tourism. Coastal ecosystems, including coral reefs and mangroves, are vital for biodiversity and coastal protection.Sri Lanka's geographical features shape its landscape, climate, and cultural heritage.

In Sri Lanka, there are three main climatic zones based on the amount of rainfall they receive:

Dry Zone: The Dry Zone in Sri Lanka experiences low annual rainfall and high temperatures. This zone is mainly located in the northern and eastern parts of the country, including areas like Jaffna, Mannar, and Hambantota. The Dry Zone is characterized by arid and semi-arid conditions, with distinct dry and wet seasons.

Intermediate Zone: The Intermediate Zone in Sri Lanka receives moderate rainfall throughout the year. This zone is located in the central part of the country, including areas like Kandy and Nuwara Eliya. The Intermediate Zone generally experiences a more balanced climate compared to the extreme dry and wet zones.

Wet Zone: The Wet Zone in Sri Lanka receives high annual rainfall and has a more humid climate. This zone covers the country's southwestern region, including areas like Colombo and Galle. The Wet Zone experiences heavy rainfall, especially during the southwest monsoon from May to September.

These climatic zones play a significant role in shaping the geographical, ecological, and agricultural aspects of Sri Lanka's geographical distribution of cultivation types and their impact on the country's Gross Domestic Production (GDP). The agriculture industry (primary output) contributes approximately 8.0% of Sri Lanka's GDP at constant market prices. The nation's economy heavily depends on agriculture, which generates exports and supports livelihoods. In 2022, agriculture contributed for 8.75% of GDP *(International Trade Administration, 2021)*.

Sri Lanka's varied topography has an impact on its farming methods. According to various locations, these are some important farming types practiced in Sri Lanka.

Rice Production: In Sri Lanka, rice cultivation is the main type of agriculture. There are two primary seasons for rice cultivation: Yala (April to September) and Maha (October to January).

Tea Plantations: Growing tea is a well-known industry in the central Highlands. For the nation, tea is a significant source of foreign exchange.

Other Crops: Oil seed, fruit, and vegetable crops are also grown in Sri Lanka. About 40% of the land that is farmed is used for coconut cultivation, mostly in the provinces in the south and northwest. Agriculture involves nearly 45% of Sri Lanka's total land area. Approximately 23.73% of the national labor force engages in agricultural activities. Sri Lanka's geographical diversity allows for a variety of agricultural kinds, with rice and tea being particularly prevalent. The nation's economy still heavily depends on the agriculture sector *(Department of Census and Statistics, 2024)*.

Climate Change Impact in Sri Lanka

Sri Lanka, being a tropical island in the Indian Ocean, faces significant impacts from climate change. Here are some key points regarding the geographical scenario and its impact;

1. **Vulnerability to Extreme Weather Events:** Sri Lanka consistently ranks among the top ten countries at risk of extreme weather events according to the Global Climate Risk Index. The country's tropical climate makes it susceptible to cyclones, heavy rainfall, and flooding.
2. **Coastal Vulnerability:** Roughly 50% of Sri Lanka's population lives in low-lying coastal areas in the west, south, and southwest of the island. These coastal regions are at risk of future sea level rise due to climate change.
3. **Biodiversity Threats:** Climate change poses a threat to Sri Lanka's rich biodiversity, including its marine ecosystems and coastal coral reefs, rising sea temperatures and ocean acidification impact marine life and coral health.

4. **Changes in Precipitation and Temperature:** Sri Lanka experiences changes in precipitation patterns and rising temperatures.These changes affect agriculture, water availability, and overall ecosystem health.
5. **Coastal Erosion and Land Degradation:** Sea level rise and extreme weather events contribute to coastal erosion and land degradation.Vulnerable coastal communities face displacement and loss of livelihoods.
6. **Adaptation Measures:** Sri Lanka must focus on building climate resilience, sustainable water management, and disaster risk reduction. Efforts include transitioning to clean energy sources and strengthening sustainable development practices.

Sri Lanka's geographical vulnerability, combined with climate change impacts, necessitates urgent action to protect its people, ecosystems, and economy *(Fact Sheet: Climate Impact in Sri Lanka | United Nations in Sri Lanka, 2024)*.

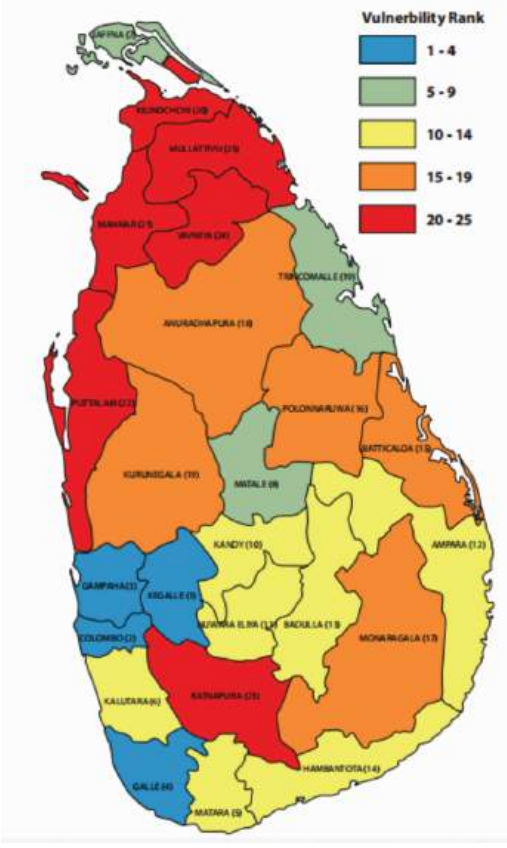


Figure 1: Climate Change Induced Vulnerability at District Level

(Punyawardena, B.V.R.et al.,2013)

Sri Lanka has seen several effects of climate change during the last ten years, which have had a major influence on the country's environment, economy, and society. Let's examine a few of these significant effects: Blue Carbon Ecosystems Under Threat, Increased Vulnerability, Shifts in Rainfall Patterns, Global North's Role in Climate Financing etcetera.

These disparities underscores the urgency of addressing climate impacts in vulnerable countries like Sri Lanka. Sri Lanka has witnessed shifts in seasonal rainfall patterns over the last decade. Increased floods and droughts directly impact rural food security and livelihoods. These changes pose considerable threats to the economy and human health *(Malkanthi, Pushpa. et al., 2019)*.

Climate Change Vs Paddy Cultivation during past decade

Sri Lanka has seen the effects of climate change on paddy agriculture during the last ten years. Here are a few instances:

Inconsistent Rainfall: Sri Lanka has seen unpredictable rainfall patterns, with some areas seeing tremendous downpours and others enduring drought-like conditions. In 2017, the country had a severe drought, notably in the northern and eastern areas, resulting in a considerable decrease in rice output. Many farmers battled to keep their fields in good condition owing to water constraints.

Droughts: Droughts have grown more common and severe in Sri Lanka. In 2016, the country faced one of its most severe droughts in decades, causing damage to rice production throughout the country. Farmers experienced financial losses because of low yields and crop failures caused by a shortage of water.

Sea-level increase: Sri Lanka's coastline areas, which contain paddy fields, are vulnerable to sea-level increase. Seawater intrusion has grown to be a major concern for paddy farming in recent years. For instance, in the Ampara District, the salinity of the paddy fields has increased due to increasing sea levels, making rice cultivation difficult.

Temperature Increase: Over the previous ten years, Sri Lanka has experienced an increase in average temperatures. Elevated temperatures during crucial phases of paddy development might have an adverse effect on yields. For example, in 2019 there was a notable decrease in rice yield in some areas due to high temperatures and water constraints.

Extreme Weather occurrences: Climate change has led to an increase in extreme weather occurrences in Sri Lanka. Numerous areas that cultivate paddy have experienced floods due to cyclones and intense rains. Heavy rainfall and floods in the Kurunegala and Anuradhapura districts destroyed paddy fields in 2018, delaying planting and harvesting seasons.

To address these issues, Sri Lanka has put in place several adaption strategies, such as:

The usage of rice cultivars that are more adapted to the climate, including Bg 359 and Bg 352, has been encouraged by the government. These types are more robust to salt and drought.

Farmers have been urged to implement water-saving techniques, such as the System of Rice Intensification (SRI), which may increase yields even in times of water shortage while using less water.

Agro-meteorological advisory services were created to provide farmers with timely weather information and guidance, enabling them to make well-informed decisions about irrigation and crop management.

These instances highlight Sri Lanka's continuous battle against climate change in rice production. To maintain food security and safeguard farmers' livelihoods, the nation is still working to establish resilient agricultural systems and use sustainable techniques.

Agriculture vs Bank engagement in Sri Lanka

Sri Lanka's economy is heavily dependent on paddy agriculture, and the banking industry is essential to the growth and financing of this industry. The banking industry supports Sri Lankan rice cultivation in the following ways:

Banks offer agricultural loans: Specially designed for paddy farming. Farmers utilize these loans to purchase equipment, seeds, fertilizer, and other inputs needed for paddy farming. The loans assist farmers in meeting their financial obligations while also ensuring that operations run smoothly during the crop phase. Banks provide working capital lending to paddy farmers in order to help them pay for labor, maintenance, and other operating expenditures of their business. The management of cash flow and continuation of paddy growing operations are aided by this kind of funding for farmers.

Financial Advisory Services: Banks often provide financial advisory services to paddy farmers, assisting them in financial planning, budgeting, and risk management. These services help farmers make informed decisions regarding their paddy cultivation activities and optimize their financial resources.

Mobile Banking and Digital Solutions: With the advancement of technology, banks in Sri Lanka have introduced mobile banking and digital solutions that benefit paddy farmers. Farmers can access their accounts, make transactions, and receive updates on loan repayments and interest rates through mobile banking applications. These digital solutions provide convenience and accessibility to farmers, especially those in remote areas.

The support and services provided by the banking sector contribute to the growth and development of paddy cultivation in Sri Lanka. Access to finance and financial services

enables farmers to invest in their cultivation activities, adopt modern practices, and improve their livelihoods. It also helps in ensuring the stability and sustainability of the paddy sector, which is essential for the overall agricultural and economic development of the country.

Climate Change impact on Banks

Table 01: Relationship between the influence of climate change and the cultivation of rice, the distribution of loan facilities, and repayment patterns.

Year	Production (mt.)	Granted All Loans (LKR. Mn.)	Refinance			Climate Change Impact
	Total		Granted Amount (LKR. Mn.)	Recovery Amount (LKR. Mn.)	Recovery %	
2012	3,846	5,527	5,302	4,146	78.20%	By the end of October 2012, drought had affected an estimated 1.8 million people in Sri Lanka. Since December 2011, for the second consecutive season, rainfall had been scanty. As a result, many of the water reservoirs dried up, and people living in the worst-hit remote rural areas didn't have access to safe drinking water. The arrival of rains in December 2012 relieved drought conditions in many areas, but the subsequent flooding intensified the vulnerability of many poor living in the country's hardest hit regions *(Sri Lanka: Drought Revised Emergency Appeal n° MDRLK004 - Sri Lanka, 2013).*
2013	4,621	5,427	5,074	4,528	89.24%	The USDA estimates 2012/13 Sri Lanka rice area planted to reach 1.13 million hectares (mHa), down by nearly 6 percent from the previous forecast and down 10 percent from the previous year. This 10 percent decline can be attributed to flooding that impeded planting and destroyed plantings *(Sri Lanka rice Production, 2013).*

2014	3,381	4,761	4,856	4,314	88.84%	The 2013/2014 drought has seriously damaged the agricultural production (specially the paddy production) in both Yala and Maha cultivation seasons. Over one million people in Sri Lanka have been severely affected by the drought in 2013/2014 for many districts in the Island *(Nianthi.R., 2018)*.
2015	4,819	5,582	5,642	4,744	84.08%	
2016	4,420	6,384	5,835	4,808	82.40%	
2017	2,383	6,039	6,175	5,130	83.08%	As of 20 August, more than 1.2 million people across 19 out of 25 districts remain affected by drought. Northern, North-Central and Eastern Provinces are reporting low levels of water for agricultural, drinking and household use. The failure of two harvests in 2017 has raised concerns for the food security and livelihoods of affected communities. The Government of Sri Lanka is distributing drinking water and planning to provide relief packs *(World Bank Climate Change Knowledge Portal, 2024)*.
2018	3,930	6,510	7,126	6,144	86.22%	In December 2018, heavy rains flooded parts of Vavuniya district, destroying thousands of acres of paddy crops. With the new planting season approaching, paddy farmers find themselves in a financial bind as they rush to purchase seeds and prepare the land in time *(Floods in Northern Sri Lanka Endanger Paddy Farmers' Harvest, 2019)*.
2019	4,592	9,760	7,298	5,306	72.70%	Sri Lanka is in the midst of a long spell of dry weather again following below-average rains in the first half of 2019 *(ECHO, 20 Aug 2019).*
2020	5,121	9,701	5,268	2,587	49.11%	Unexpectedly high-intensive rain and prolonged drought seasons made it hard to succeed in both seasons.
2021	5,150	13,052	3,508	1,222	34.83%	Heavy rain has lashed Sri Lanka triggering floods and landslides that have killed at least 17 people and forced tens of thousands from their homes in June 2021.

2022	3,393	12,454	3,705	417	11.26%	Slices through yellowed paddy stems dried out by a drought that has destroyed over 95% of his crop and is threatening crisis-hit Sri Lanka's summer rice harvest.Drought dents Sri Lanka's economic hopes, farmers' livelihood

Source: (Central Bank of SL, 2023)

Paddy farmers' ability to repay their loans was probably significantly impacted by the way climate change affected paddy planting in Sri Lanka between 2012 and 2022.The proportion of recovery and the volume of production are positively correlated. There are a few exceptions to the general rule regarding the impact of climate change, such as the COVID-19 post-impact and government initiatives. However, unanticipated climate change poses the greatest risk to output decline. There is no simple fix for the effects on crop cultivation or the soil bed. Consequently, after an extreme weather event (such as a drought or flood), the farmers will not be satisfied with the next crop. Paddy farmers may experience financial strain as a result of lower yields or crop failures brought on by unpredictable weather patterns, which makes it difficult for them to repay debts taken out for equipment, agricultural inputs, or other associated expenses. Flooding and drought seasons have happened continuously since 2012, at least once a year. In light of their revenue level, the paddy farmers are still not in a recovered state.

Regional Development Bank

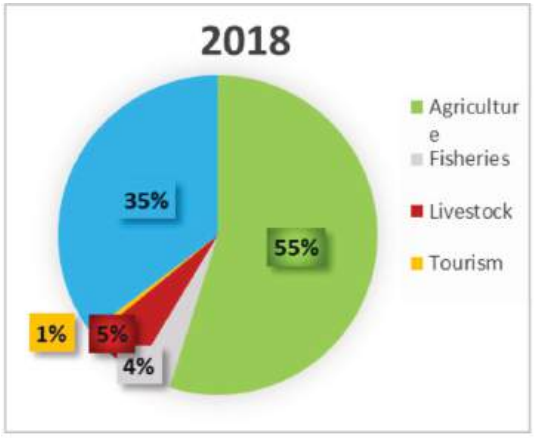
The Regional Development Bank, which is the premier development bank in Sri Lanka, focuses particularly on the development of the fishery, agricultural, industrial, and tourist industries.

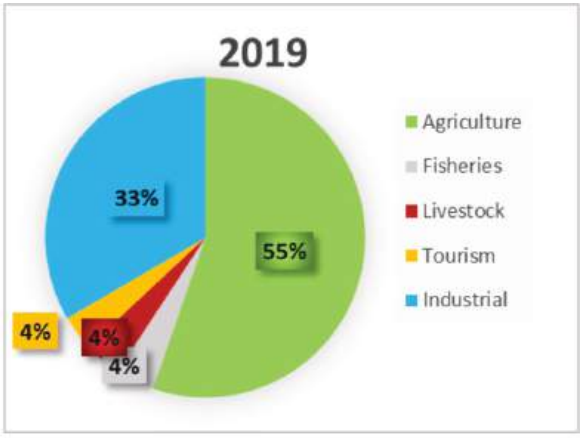
The vision: “To Be the Trusted Development Financing Partner to the Nation”

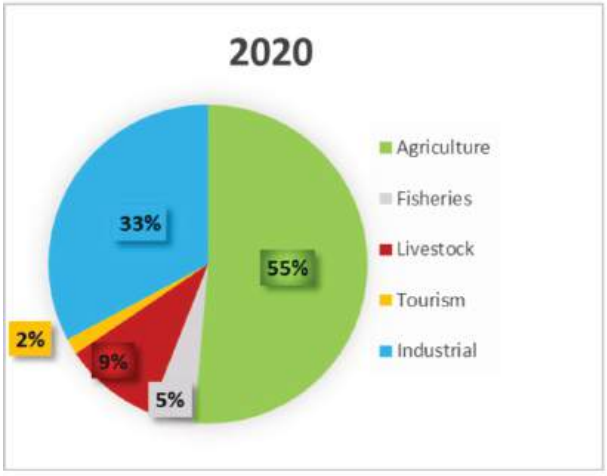
The Mission: “To provide financial and affiliated services to enterprises and entrepreneurs whilst promoting inclusive development”

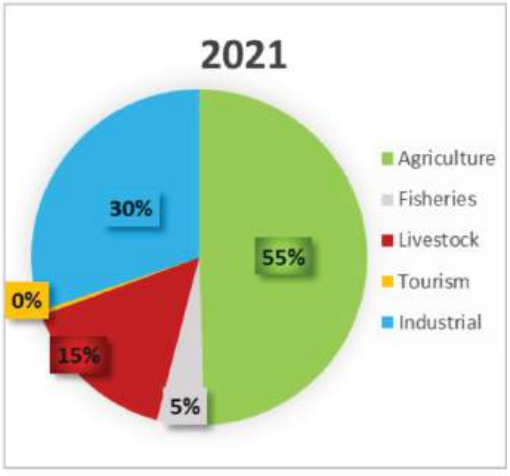
The bank always takes into account raising living standards through lending while advancing the growth of the nation along its three pillars (people, planet, and profit). Additionally, the bank must retain a viable loan portfolio and set aside 15% of the total for the agriculture portfolio to comply with the RDB's statutory requirements. Consequently, the bank is complying with this mandate by enabling a significant number of farmers on the island.

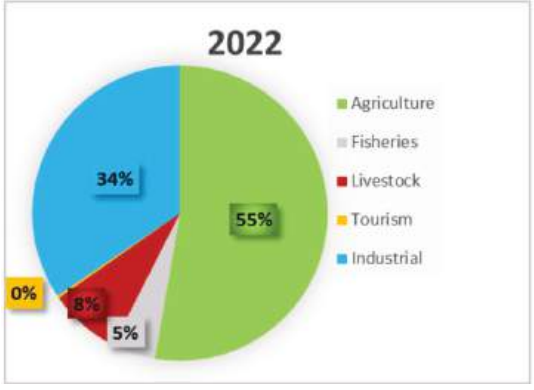
The credit facility disbursements for the previous five years is displayed in the following charts.


2018
35%
55%
1%
5%
4%
Agricultur
e
Fisheries
Livestock
Tourism


2019
33%
55%
4%
4%
4%
Agriculture
Fisheries
Livestock
Tourism
Industrial


2020
33%
55%
2%
9%
5%
Agriculture
Fisheries
Livestock
Tourism
Industrial


2021
30%
55%
0%
15%
5%
Agriculture
Fisheries
Livestock
Tourism
Industrial


2022
34%
55%
0%
8%
5%
Agriculture
Fisheries
Livestock
Tourism
Industrial

The development lending portfolio is specially made up of the above-mentioned sectors, and these sectors are highly vulnerable to climate change as per the National Adaptation Plan for Climate Change Impacts in Sri Lanka: 2016 - 2025.

Agriculture Loan written off incident in RDB

This decision was taken by the Central Bank of Sri Lanka with the collaboration of the SL Government as a solution for the economic crisis impact on grass-roots level MSMEs.

In 2022, there were selected agricultural loans that were written off.

Proposed and practicing Mitigation Measures and Adaptation measures for secure the cultivation

Mitigating the impact of climate change on paddy harvests in Sri Lanka requires a multi-faceted approach that addresses both adaptation strategies and efforts to reduce the drivers of climate change. Here are some mitigation measures:

- **Diversification of crops**: Encouraging paddy cultivators to diversify their crops can help spread the risk associated with climate variability. Introducing drought-resistant or flood-tolerant crop varieties alongside paddy can provide alternative sources of income and ensure food security in case of paddy crop failures.
- **Water management**: Paddy farmers may adapt to shifting precipitation patterns and water scarcity by enhancing water management strategies including rainwater gathering, effective irrigation systems, and water conservation measures. To guarantee consistent access to water for agriculture, this entails making infrastructure investments in the form of reservoirs and water storage facilities.
- **Promoting climate-resilient farming methods**: Paddy crops may be more resilient to climate stressors by using climate-smart agricultural practices including integrated pest control, agroforestry, and conservation agriculture. These methods lessen reliance on pests and illnesses, enhance water efficiency, and enhance soil health.
- **Capacity building and educating farmers**: Farmers can be better equipped to make decisions and adjust to changing conditions if they get training and extension services on climate-smart agriculture techniques, weather forecasting, and risk management.
- **Financial risk linked with climatic unpredictability**: It can be reduced by providing access to affordable loans and insurance plans that meet rice producers' needs. Farmers might have a safety net through loan packages with tailor-made repayment periods and insurance against crop losses from extreme weather occurrences.

- **Research and innovation**: Investing in research and development of climate-resilient crop varieties, sustainable farming technologies, and early warning systems for weather-related disasters can support long-term adaptation efforts and enhance the resilience of paddy cultivation to climate change.
- **Policy support**: Enacting supportive policies and regulatory frameworks that incentive climate-smart agriculture, promote sustainable land use practices, and integrate climate change considerations into agricultural planning and decision-making processes.
- **Community-based adaptation**: Facilitating community participation and collaboration in adaptation planning and implementation can enhance the effectiveness and sustainability of mitigation measures. Engaging local communities, farmers' organizations, and relevant stakeholders in identifying their specific vulnerabilities and co-designing adaptation strategies ensures that interventions are contextually appropriate and socially inclusive.

By implementing a combination of these mitigation measures, Sri Lanka can enhance the resilience of its paddy harvests and safeguard the livelihoods of paddy cultivators against the adverse impacts of climate change.

Banks involvement to sustain the paddy production

Banks provide financial support as well as financial advisory services. In this case, banks can use both of the services to mitigate the experienced negative impacts and protect against the unexpected negative impacts arising from climate change by adhering to adaptation measures. Integrated rice-fish farming: In rice-fish farming systems, paddy fields are stocked with fish species that complement rice cultivation. Fish such as tilapia, carp, or catfish are introduced into the flooded paddy fields, where they feed on insects, weeds, and organic matter, reducing the need for chemical inputs and enhancing nutrient cycling. This symbiotic relationship between rice and fish improves overall farm productivity and provides additional sources of protein and income for farmers.

Banks play a significant role in addressing climate change concerning paddy cultivation through various financial mechanisms, investments, and policy advocacy. Here's how banks can contribute to mitigating climate change impacts on paddy cultivation:

Finance for climate-resilient agriculture: Banks are able to give paddy farmers financial assistance for using climate-resilient agricultural techniques. This includes financing for infrastructure upgrades that help farmers adapt to shifting climatic circumstances and lower the risk of crop failure, such as irrigation systems, water management tools, and drought-resistant crop types.

Promoting sustainable farming practices: Banks can incentivize sustainable farming practices among paddy cultivators by offering loans or credit facilities with favorable terms for projects that reduce greenhouse gas emissions, conserve natural resources, and promote soil health. Investments in practices such as conservation tillage, agroforestry, and organic farming not only mitigate climate change but also improve the resilience and productivity of paddy fields.

Supporting renewable energy: Banks can finance the adoption of renewable energy technologies such as solar-powered irrigation pumps and biogas digesters on paddy farms. By reducing reliance on fossil fuels and lowering greenhouse gas emissions, these investments contribute to mitigating climate change while providing farmers with access to clean energy solutions that enhance agricultural productivity and resilience.

Risk management and insurance: Banks can collaborate with insurance providers to offer weather-indexed insurance products tailored to the needs of paddy cultivators. These insurance schemes provide financial protection against crop losses due to extreme weather events such as droughts, floods, or storms, helping farmers manage climate-related risks and stabilize their income.

Investing in research and innovation: Banks can support research and innovation in climate-smart agriculture by funding projects that develop and disseminate technologies and practices for sustainable paddy cultivation. Investments in crop breeding, remote sensing, precision agriculture, and climate forecasting improve the resilience and adaptive capacity of paddy farmers to climate change impacts.

Engaging in policy advocacy: Banks can advocate for policies and regulations that incentivize climate-smart agriculture and support the transition to a low-carbon economy. This includes lobbying for carbon pricing mechanisms, subsidies for renewable energy and energy-efficient technologies, and incentives for sustainable land use practices that benefit paddy cultivation and contribute to climate change mitigation.

Capacity building and knowledge sharing: Banks can facilitate capacity building and knowledge sharing initiatives to raise awareness among paddy cultivators about the impacts of climate change and the importance of adopting sustainable farming practices. By providing training, workshops, and educational materials, banks empower farmers to make informed decisions and implement climate-resilient strategies on their farms.

Overall, banks play a crucial role in supporting paddy cultivation while addressing the challenges posed by climate change. By aligning their financial activities with climate objectives and promoting sustainable practices among paddy cultivators, banks can contribute to building resilience, reducing emissions, and ensuring the long-term viability of paddy farming in a changing climate.

Paddy cultivation can be integrated into poly-culture farming systems, where it is grown alongside other crops to enhance biodiversity, improve soil health, and increase overall farm productivity. Here are some examples of how paddy can be incorporated into poly-culture systems:

- **Mixed cropping:** Paddy can be grown in mixed cropping systems with other complementary crops such as legumes, vegetables, or tubers. For example, paddy fields can be intercropped with leguminous crops like mung beans, cowpeas, or pigeon peas, which fix nitrogen in the soil, improve soil fertility, and suppress weeds. Similarly, vegetables like okra, pumpkin, or sweet potato can be grown alongside paddy, utilizing the space between rice plants and maximizing land productivity.
- **Livestock integration:** Paddy cultivation can be integrated with livestock rearing to create crop and animal production synergies. For instance, paddy straw can be used as fodder for livestock such as cattle, goats, or ducks, while animal manure can be applied to paddy fields as organic fertilizer, enhancing soil fertility and crop yields. This integrated approach to farming improves nutrient cycling, reduces waste, and enhances farm resilience.

As well as a richness and mechanical viability of our rainfed tank cascade system, Banks can can play a crucial role in supporting the rehabilitation of rainfed cascade systems for paddy cultivators through various financial mechanisms and initiatives. Here's how they can provide support.

Loans for infrastructure development: Banks can offer loans or credit facilities to paddy cultivators, farmers' cooperatives, or community organizations for the rehabilitation and construction of rainfed cascade systems. This includes funding for the repair, maintenance, and expansion of irrigation channels, reservoirs, check dams, and other water management infrastructure essential for capturing and storing rainwater.

Subsidized interest rates: Banks can provide loans with subsidized interest rates or concessional terms for projects aimed at rehabilitating rainfed cascade systems. Lower interest rates reduce the financial burden on paddy cultivators and incentivize investment in water conservation and management infrastructure.

Flexible repayment options: Offering flexible repayment options, such as grace periods or seasonal repayment schedules aligned with the agricultural cycle, can accommodate the cash flow constraints of paddy cultivators and ensure that loan repayments are manageable, particularly during lean periods or crop failures.

Technical assistance and capacity building: Banks can collaborate with agricultural extension services, research institutions, and development agencies to provide technical assistance, training, and capacity-building programs to paddy

cultivators on sustainable water management practices, watershed management, and efficient use of rainfed cascade systems. **Insurance products:** Banks can facilitate access to weather-indexed insurance products tailored to the needs of paddy cultivators to mitigate the financial risks associated with climate variability and extreme weather events. Insurance coverage for crop losses due to droughts, floods, or other weather-related disasters provides a safety net for farmers and encourages investment in rainfed agriculture.

Partnerships and co-financing: Banks can partner with government agencies, non-governmental organizations (NGOs), international development partners, and private sector stakeholders to co-finance rehabilitation projects for rainfed cascade systems. Collaborative efforts leverage resources, expertise, and networks to scale up investment and maximize the impact of interventions.

Green financing initiatives: Embracing green financing principles, banks can prioritize investments in sustainable agriculture and environmental conservation, including projects that rehabilitate rainfed cascade systems and promote climate-resilient farming practices. Green loans, bonds, or investment funds dedicated to such initiatives attract socially responsible investors and contribute to sustainable development goals.

Monitoring and evaluation: Banks should establish robust monitoring and evaluation mechanisms to assess the effectiveness and impact of financing support for rain-fed cascade rehabilitation projects. Regular assessments help identify challenges, measure outcomes, and refine strategies to optimize the contribution of financial services to agricultural resilience and rural development.

By leveraging their financial resources, expertise, and networks, Sri Lankan banks can support the rehabilitation of rain-fed cascade systems for paddy cultivators, enhance water security, and build climate resilience in agricultural communities.

RDB involvement

The Bank faces significant risks due to climate change impacting its loan portfolios, particularly in the agriculture sector, since RDB is prioritizing it. The proposed strategy involves a consultancy assignment to assess the risk, identify targets in the agricultural sector MSMEs, understand their needs, and develop insurance product(s) to protect and grow the MSMEs. The goal is to recommend remedial actions, including the implementation of an insurance scheme. The comprehensive study and collaborative assessments are crucial for effective implementation, ensuring the Bank's resilience in the face of climate-related challenges while also supporting the interests of farmers. To ensure its continuity and integration into the bank's profile, it is in line with the Environmental and Social Management Unit (ESMU) and the Bancassurance Unit of the Credit Department's collaboration to implement and monitor this task.

Bank has launched a scheme to address the 7th goal (affordable and clean energy) in the Sustainable Development Goals (SDGs). It facilitates low-interest loans for the agriculture sector as well as fulfills their agribusiness electricity requirements through solar-powered systems such as solar-powered water pumping systems.

Conclusion

There is a critical need for climate risk management solutions for MSMEs due to the imminent threat of climate change to the country development. Initial data analysis confirms significant vulnerability particularly in agriculture-related loans, and secondary impacts on other portfolios. Specially paddy cultivation is in a critical situation due to the unexpected consequences of climate change, which will lead to a chain of negative impacts for Sri Lanka. Anticipating future challenges, including potential government reluctance to compensate for future crop damage loan repayments, is essential.

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Financing for Climate-Resilient Agriculture in the Asia-Pacific

Anil Kumar S. G.

Abstract

Climate change presents a growing challenge to agricultural communities across the Asia-Pacific region, where 40% of the population relies on agriculture and smallholder farmers account for 85% of all farms. The adverse impacts of shifting weather patterns and extreme events on productivity and livelihoods are profound. This article delves into the impacts of climate change on agriculture, highlighting disruptive shifts in weather patterns, emergence of new pests, and declining soil health due to practices like crop residue burning. These challenges necessitate innovative solutions and robust support systems for farmers to adapt and thrive. Financial institutions and organizations play a pivotal role in enabling the transition to climate-smart agriculture by offering tailored financial products, fostering strategic partnerships, and providing capacity-building programs. Samunnati, an advocate for climate-smart agriculture, has initiated numerous projects to support smallholder farmers. Field narratives from FPOs illustrate the real-world application of climate-smart practices, including weather alert systems and soil testing technology, which enhance productivity and sustainability. This article underscores the importance of innovative solutions like biochar, precision agriculture, and financial mechanisms in building resilience among smallholder farmers. Samunnati's efforts highlight the need for continuous monitoring, evaluation, and scalability to ensure the effectiveness and broad impact of climate-smart agricultural practices. Through collaboration and investment, a sustainable agricultural future that benefits both farmers and the environment can be achieved.

Introduction

Climate change presents an increasingly urgent challenge to the agricultural communities across the Asia-Pacific region. In this region, approximately 40% of the population relies on agriculture, and smallholder farmers make up 85% of all farms. The impact of climate change on farmers, in relation to both productivity and livelihoods, cannot be emphasized enough. Shifting weather patterns, and the increasing frequency of extreme events pose severe threats to agrarian landscapes.

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This article explores the various impacts of climate change on agriculture, highlights innovative solutions like biochar and precision agriculture, and discusses the role of policy and financial mechanisms in supporting smallholder farmers.

Climate Change: Disadvantages and Hurdles

Climate change is already manifesting in the form of untimely floods, erratic monsoons, and the emergence of new pests and diseases. One of the most evident impacts is the disruption of traditional farming practices. Sowing patterns, once synchronized with the arrival of monsoons and cultural festivals, are now in a state of flux. Monsoons have become increasingly erratic, making it challenging to predict when and how much rain will fall. Temperature fluctuations are also a cause for concern, exemplified by the threat to mustard crops during freezing conditions.

Agricultural productivity in the Asia-Pacific region lags the global average, and the sector is highly vulnerable to climate change. A worst-case scenario predicts a temperature rise of up to 4.4°C, potentially leading to significant yield reductions. Furthermore, the common practice of burning crop residues after harvest contributes to air pollution, greenhouse gas emissions, and declining soil health. Additionally, farmers are grappling with the emergence of new, pesticide-resistant pests, such as the pink bollworm in cotton farming. The unpredictability of weather and the effects of climate change have left farmers ill-prepared to adapt to these challenges, and there is currently no comprehensive mitigation strategy at the farmer level.

Role of Financial Institutions and Organizations

Financial institutions and organizations play a critical role in enabling the transition to climate-smart agriculture for smallholder farmers. Their support can take various forms, including providing financial resources, facilitating access to technology, and offering capacity-building programs. Here's an expanded look at their roles:

Access to Finance

Financial institutions must develop and offer tailored financial products such as low-interest loans, microfinance, and crop insurance that cater to the unique needs of smallholder farmers. Investment in agricultural infrastructure, such as irrigation systems and storage facilities, is essential for enhancing resilience to climate change. Financial Institutions have established dedicated verticals for Climate Smart Agriculture (CSA) Finance, which aim to build compliant portfolios and support CSA entities through financial engagement.

Strategic Partnerships

Collaborations between financial institutions, non-governmental organizations, and

corporate entities are crucial for pooling resources and expertise. These partnerships enhance the availability of financial resources and reduce the risks associated with agricultural investments.

Capacity Building and Training

Programs that equip Farmer Producer Organizations (FPOs) and their member farmers with the necessary skills and knowledge to adopt climate-smart practices and the benefits of adopting such practices. Training initiatives focus on modern agricultural techniques, financial literacy, and the use of digital tools, thereby empowering farmers to make informed decisions and improve productivity.

Technology Access

Providing farmers with access to advanced agricultural technologies is vital for improving resilience. This includes climate-resilient crop varieties, precision farming equipment, and digital tools that optimize resource use. Financial institutions can facilitates access to such technologies and encourages their adoption through various initiatives, ensuring that farmers can effectively respond to climate-related challenges.

Community Engagement and Knowledge Dissemination

Effective community engagement efforts, including mobilization meetings and sensitization sessions, help build trust and encourage active participation from local communities through collaboration among stakeholders involved in CSR activities.

Addressing climate change and challenges

In the face of these challenges, Samunnati has taken proactive measures to address the pressing issues faced by farmers and support them in adapting to the changing climate. When assessing the readiness of farmers to confront climate change, two dimensions must be considered: the farmers themselves and the policy level. Farmers need to be made aware of the changes and challenges posed by climate change. Thanks to policy efforts and increasing exposure to the consequences of climate change, many farmers are now more aware of the need to adapt.

However, the transition to climate-smart agriculture practices requires accessible and affordable solutions. While technology interventions are emerging, they must reach the farmers effectively. For instance, drip irrigation has shown promise in conserving water resources and adapting to climate change. To facilitate this transition, policymakers can play a significant role by providing a safety net to farmers during the adoption phase.

Samunnati's Role in advocating for Climate Smart Agriculture

Samunnati recently hosted The Lighthouse Conclave, which delved into some of the

climate-smart agricultural practices and regenerative agriculture that offer a promising pathway to not only mitigate the impact of climate change but also ensure the resilience and sustainability of our agricultural systems. With the agricultural industry contributing around one-third of the world's greenhouse gas emissions, there is an unexpected window of opportunity in the battle against climate change. Imagine farms that actively contribute to limiting global warming in addition to producing food.

At Samunnati, we recognize the immense potential for agriculture to contribute to the carbon market and are actively exploring ways to unlock this potential. We see Farmer Producer Organizations (FPOs) and Agri-enterprises playing a pivotal role in this journey. Our initial focus is on providing financial and technical support to FPOs and Agri-enterprises, with the goal of enhancing their ability to participate effectively in adopting climate smart practices. This includes providing loans to farmers and advance payment options to address upfront costs, coupled with capacity-building programs delivered in collaboration with ecosystem partners. By equipping FPOs and Farmers with the knowledge, tools, and financial resources they need, we believe we can make a significant contribution to the future of the carbon market.

Samunnati's Biochar Initiative

At Samunnati, we're driven by a singular purpose: revolutionizing agriculture for a more sustainable future. Our biochar initiative is at the forefront, making significant strides in this arena.

Farmer Trials: We firmly believe in the power of science-backed solutions. That's why we've forged strategic partnerships with industry leaders like Arvind Mills and Pratibha Syntex, reaching thousands of cotton farmers across India. Through large-scale field trials, we're putting biochar to the test in real-world conditions, assessing its impact on cotton yields. This data will be instrumental in demonstrating the tangible benefits of biochar for farmers and the agricultural sector. These trials bridge the gap between scientific research and on-farm application, paving the way for widespread biochar adoption.

Carbon Credit Generation: We recognize the importance of creating a financially sustainable model for biochar adoption. To address this, we've partnered with the Carbon Standards International (CSI) Registry, the pioneers in generating carbon credits specifically for artisanal biochar production. By diverting crop residue from burning to biochar production, we significantly reduce harmful greenhouse gas emissions. The CSI Registry validates these carbon sequestration benefits, allowing biochar producers to earn tradable carbon credits. The revenue generated from these credits is then strategically reinvested to subsidize the cost of biochar for farmers, making this transformative technology even more accessible.

The results are promising. Through our partnership with The Heartfulness Institute, we have witnessed transformation of a barren landscape into a thriving green oasis, demonstrating biochar's potential for soil rejuvenation. The biochar initiative is more than just a technology; it's a comprehensive approach to building a more sustainable future for agriculture. Through farmer trials, carbon credit generation, and a deep understanding of the agricultural landscape, we're empowering rural communities, fostering a circular economy, and building resilience for generations to come.

As research and implementation efforts continue, biochar has the potential to be a game-changer, not just for India, but across the globe. By harnessing the power of this innovative technology, we can create a future where a thriving agricultural sector coexists with a healthy planet. Samunnati's biochar initiative stands as a testament to this vision. By harnessing the power of biochar, we can unlock a future where agricultural productivity soars, rural communities prosper, and the environment flourishes.

Field Narrative: Sustainability in Action

Samradha Kisan Producer Company Ltd. (Ujjain, Madhya Pradesh)

Climate-Smart Agriculture: Samunnati, in partnership with Secufarm-WRMS, equipped the member farmers of this FPO with a weather alert system. Subsequently, a weather alert system was implemented, encompassing a 25-kilometre radius around the FPC. The WRMS facility was utilized for the POP implementation of garlic and onion crops. This initiative facilitated risk mitigation for farmers and provided timely weather updates, resulting in enhanced productivity. The system empowered farmers to engage in precision farming, allowing them to tailor their agricultural practices based on weather data and optimize resource utilization.

Krushik Mitra Farmer Producer Company Limited (Belagavi, Karnataka)

Soil Testing Technology: The Krushik Mitra Farmers' Producer Company (FPC) has availed loan facility from Samunnati for supporting its member farmers in Agri and allied activities. The FPO has embraced innovation by incorporating a soil testing device. The FPC gathered soil samples from farmers and performed comprehensive soil analyses using this state-of-the-art technology. This cutting-edge tool offers farmers immediate access to crucial information about soil composition, nutrient concentrations, and pH levels. Empowered with these insights, members of the FPC can fine-tune their crop management approaches, boost yields, and advocate for environmentally sustainable farming practices.

Conclusion

The future of agriculture in the Asia-Pacific region hinges on the ability to embrace innovative, climate-smart practices that not only mitigate the adverse effects of climate

change but also enhance productivity and sustainability. By leveraging technologies such as biochar, precision agriculture, and participating in carbon markets, smallholder farmers can build resilience and secure their livelihoods. Institutions like Samunnati play a crucial role in facilitating this transition by providing the necessary support, training, and financial mechanisms. It's imperative that we continuously monitor and evaluate the impact of these initiatives, ensuring they remain effective and aligned with our goals. Robust monitoring and evaluation mechanisms enable us to adapt strategies based on real-world outcomes, ensuring ongoing effectiveness and relevance. Moreover, scalability is paramount for the success of these initiatives, allowing us to extend benefits to other communities. By designing models that are inherently scalable, we can replicate successful practices across different regions, amplifying their impact and providing support to a greater number of smallholder farmers. Together, through collaboration, investment, and a commitment to sustainable practices, that benefit both farmers and the environment.

Empowering Smallholder Farmers through Climate Smart Agriculture in Bundelkhand

Nandini Ghose[1] and Bhupesh Pal[2]

Abstract

Jhansi district of UP, which is a part of Bundelkhand region, is witnessing climatic challenges like increasing temperature, reduction of winter days, erratic rainfall patterns, and prolonged droughts over a long period. The region suffers from water scarcity, natural resource degradation, low crop productivity, low rainwater use efficiency, high erosion, poor soil fertility, inadequate irrigation facilities, decreasing vegetation cover and frequent crop failure resulting in scarcity of food, fodder and fuel to the small and marginal farmers. To mitigate these challenges NABARD and IFFCO Kisan started a three year climate smart farming project in Jhansi with the aim of revolutionizing agricultural practices and empowering farmers through technology. The project introduced IoT-based irrigation systems coupled with voice advisory services related to agriculture, fertilizer, pesticide, and cost-effective cultivation techniques. The project, though still under implementation, has created a positive result on farmers' livelihood, agricultural productivity, and environmental sustainability by reducing wastage of water, restricting over use of pesticides and fertilisers, reducing cost of farming, getting larger market for better quality crop thereby increasing farmers income and above all making farmers aware of a sustainable and more environment friendly farming practices which, if practised in a large scale, will change the life of people of Bundelkhand (*Dy General Manager and* Shri Bhupesh Pal).

Introduction

Small and marginal farmers, comprising of 93% of farmers in Uttar Pradesh, are the backbone of agriculture, yet they face numerous challenges such as limited resources, climate variability, market access constraints, and limited knowledge. In specific regions characterized by unique climate conditions and socioeconomic contexts, the situation aggravates due to climate variability, which threatens the productivity and resilience of farming communities.

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Nestled in the heart of Uttar Pradesh, the historic district of Jhansi is a part of Bundelkhand region which is witnessing climatic challenges like increasing temperatures (annual maximum temperature increased to 47.8 degree Celsius in 2019), erratic rainfall patterns, and prolonged droughts over a long period. According to National Institute for Disaster Management (NIDM, 2014), Bundelkhand region of U.P. and M.P. had a drought every 16 years in 18th and 19th centuries, which increased by three times during the period 1968 to 1992 and is now becoming an annual feature.

Lack of sufficient interventions from Government, Banks and other stakeholders lead to deterioration of situation and overall decline of the agricultural economy. Climate smart agricultural practices tailored to the specific needs of small and marginal farmers is the need of hour in Uttar Pradesh, as demonstrated in the paper.

This paper explores the impact of innovative pilot project of NABARD on the small farmers in Jhansi, a part of Bundelkhand region, highlighting technologies and strategies to improve their livelihoods.

Bundelkhand's Agricultural and climatic Landscape

Bundelkhand comprising of 7 districts (Jalaun, Banda, Lalitpur, Hamirpur, Jhansi, Mahoba and Chitrakut) is comparatively the least developed region in terms of agriculture and related activities.

- Though average holding size in Bundelkhand is highest (1.43 ha.) in entire UP's average (0.73 ha.), Ground Level Credit (GLC) per hectare is lowest (₹ 0.36 lakh/ha) in comparison to that of the State (₹ 0.97 lakh/ha).
- Among all the nine agro-climatic zones of UP, Bundelkhand region of Uttar Pradesh has the lowest average annual household income and lowest livelihood security. The region suffers from water scarcity, natural resource degradation, low crop productivity (average 1 q/ha to 1.5 q/ha), low rainwater use efficiency (35% to 45%), high erosion, poor soil fertility, frequent droughts, poor irrigation facilities, inadequate vegetation cover and frequent crop failure resulting in scarcity of food, fodder and fuel.[1]
- Wheat (27.46%) followed by gram (12.31%), soybean (8.45%), rice (4.09%) and sesame (2.66%) were found to be major crops grown in Bundelkhand region of India. The region is well suited for pulses especially chickpea production due to its unique agro-climatic condition and known as bowl of pulses (8.41% of total production in the country). This region contributes about 53% of total pulse area and 43% of the total pulse production of Uttar Pradesh[2].

[1] & [2] Sources: Economics of Pulse Production in Bundelkhand Region of Uttar Pradesh, India: An Empirical Analysis; (Research on World Agricultural Economy; Volume 03 ; Issue 03; September 2022)
Other sources: The Pharma Journal and Newsletter, Bundelkhand Development Society

- Unbalanced use of fertilizers, as illustrated below has degraded the soil to a large extent.

Table 1: Fertilizer Consumption in Bundelkhand (000' tones)[3]

Year	Total	Ratio (N:P:K)
1970-71	7.45	6.5:2.5:1
1980-81	27.76	17:9:1
1990-91	58.99	71:42:1
2000-2001	79.11	215:160:1
2001-2002	92.51	431:280:1

- **Geography and Soil Type: -** Geographically, Bundelkhand has a distinct identity of its own. The soil quality changes from east to west Bundelkhand as most of the western part of the Jalaun district is sandy. Some parts of the plains are irrigated by canals. In spite of being arid, The Banda plain is one of the most fertile regions of Bundelkhand. The soil is generally less fertile as it moves towards the Chitrakoot district. Towards the south, there are the high land called intermediate regions of Bundelkhand. To the south of the central region of Bundelkhand has the plateau or uplands of Bundelkhand. Which covers the southern parts of Lalitpur, Tikamgarh, Chitrakoot, and Panna districts.[2]
- **Climate Type:** - Bundelkhand is a hot and semi-humid region. Generally hottest days are in May and coldest days are in December or January.

Actual local temperatures are much higher, due to local conditions such as lack of haze and radiation from rocky soils or outcrops. Banda is one of the hottest places in India.

2. Climate Change in Jhansi and Its Impact

Climatic modelling experiments was done by United Nations Institute of Training and Research (UNITAR) for a baseline period of 1961-90 with observed GHG and for one future time slice of 2071-2100. This research predicted that temperature is likely to be higher by about 2 to 3.5 degree in Bundelkhand by the end of this century.

The impact of climate change on wheat (staple food) and soybean (cash crop) have been assessed using the Infocrop agricultural model by UNITAR. The outputs from model generated climate change scenarios were used as inputs for the crop model. The key findings from this exercise were that since winter temperatures will be erratic, the yields of wheat may be affected negatively (-25% to -50%); days required for anthesis, and maturity may be reduced by 3 to 12; additional weeds and pests may crop up. All this will put a severe stress on the food security in the Bundelkhand region.

[3] **Source:** Land Degradation in Uttar Pradesh: Causes, Extent and Intensity; ResearchGate article)

2.1. Changes in Temperature and rainfall in Jhansi

A team of Researchers of Bundelkhand University led by Prof. Rambir Singh analysed variation in temperature and rainfall data of 41 years (1979-2019) in 2020 and using different statistical tool, observed following results:

a) The annual maximum temperature has been analysed from 1979 to 2019. The maximum temperature in the summer month of May and June may go beyond 450C. The data shows that in past 10 years the maximum temperature is largely increasing.

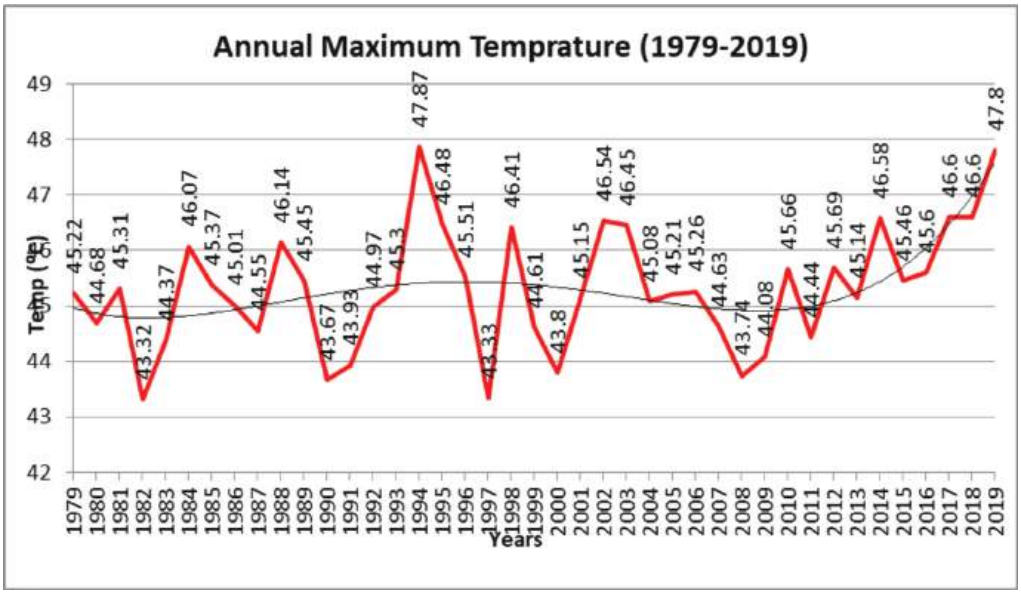


Figure 1: Annual maximum temperature from 1979-2019

(Data Source: Open Weather Limited)

The analysis further reveals that maximum temperature in high summer month of June tends to decrease whereas in winter months tends to increase. This can be due to the erratic and unseasonal rainfall events influencing temperature, thereby causing warmer winters.

b) Number of Hot Days: -

To assess comparative variation in maximum temperature, the analysis duration of 41 years has been divided in 02 slots, i.e., 1979-1998 and 1999-2019.

The number of annual hot days with temperature above 40 ºC tends to increase in the two time slots. During 1979-1998 the average annual days were 40.45 ºC which increased to 45.28 ºC during 1999-2019 (Figure 2).

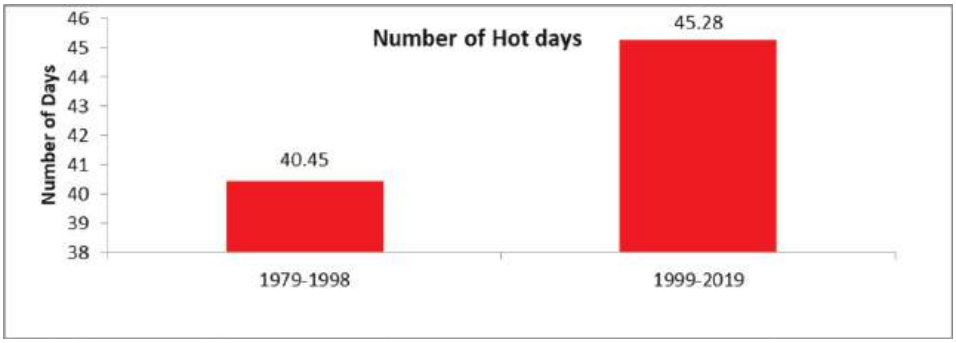


Figure 2: Change in number of Hot days (between blocks of 1979-1998 and 1999-2019).

(Data Source: Open Weather Limited)

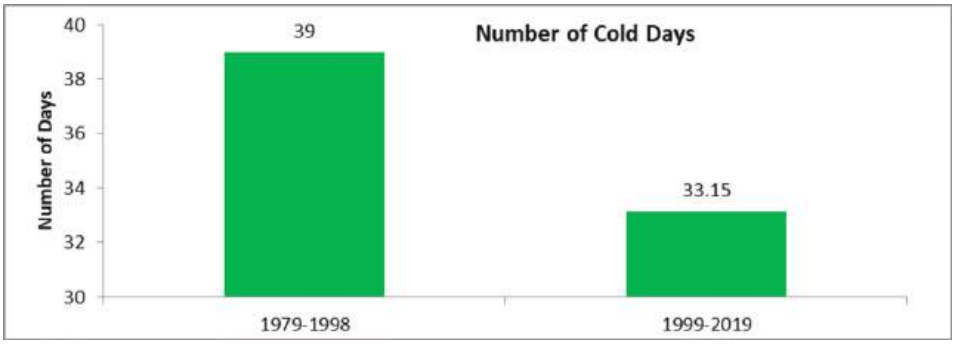


Figure 3: Change in number of cold days (between blocks of 1979-1998 and 1999-2019).

(Data Source: Open Weather Limited)

2.2 Changes in rainfall in Bundelkhand

The annual rainfall in Bundelkhand region in the present century has been about 95 cm, albeit with wide temporal variations. Nearly 85 cm falls over just four months from June to September, that too, in about 40 effective rainy days. The remaining 10 cm of rainfall occurs in another 6 days distributed within the remaining eight months. Consequently, some months remain completely dry, and some rainy days get heavy downpour. Further, out of 85 cm of monsoonal rainfall in Bundelkhand, about 40 cm may fall in just 20 hours, which means an average of 2 cm per hour. On some occasions, the intensity goes up to 3 to 5 cm per hour, each spell lasting for 15 minutes to half an hour. Thus, the rainwater in Bundelkhand, like the rainfall in the humid tropics elsewhere, has little time to penetrate into the soil for recharging the ground water (Source: UNITAR report).

a) **Annual rainfall pattern:** For the last thirty years average rainfall received was around 779.84 mm. The bars below the trend line showed deficit rainfall and above it showed excess rainfall. The trend line showed that there is gradual decrease in average annual rainfall during the last thirty years' time.

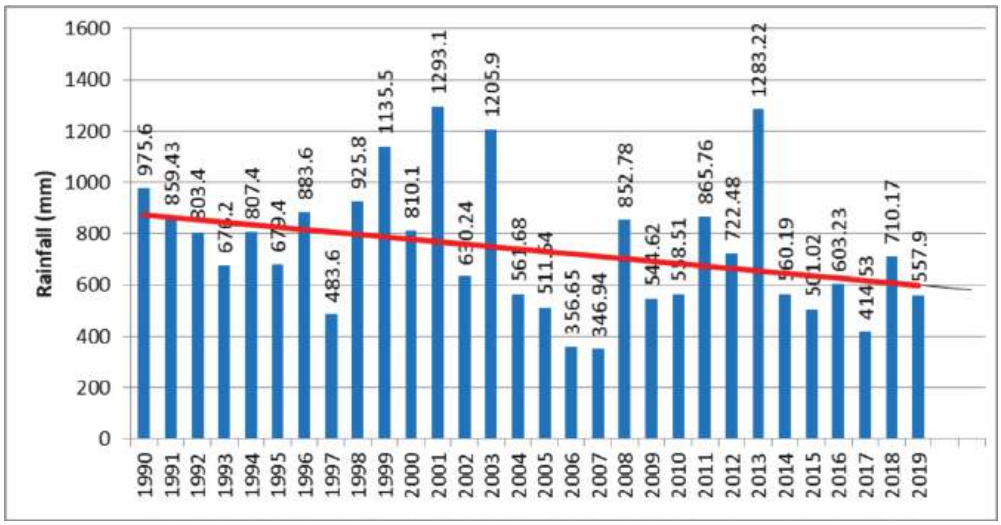
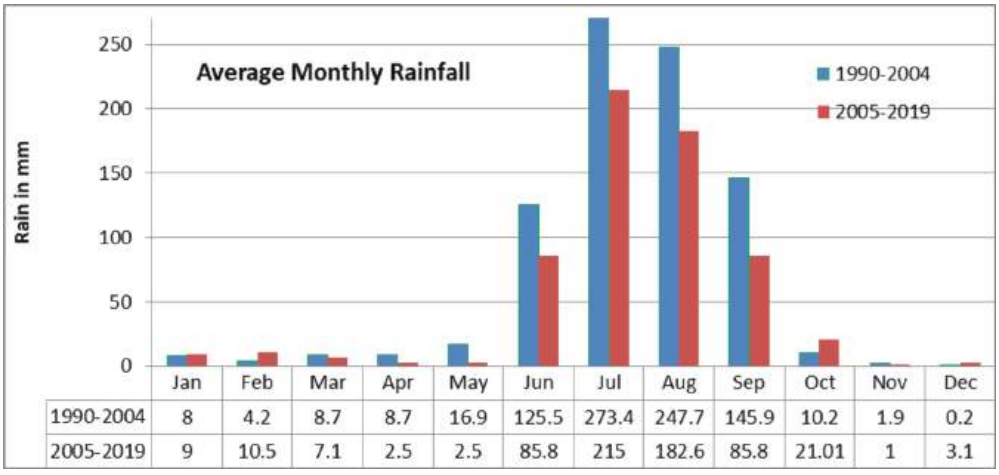


Figure 4: Average annual rainfall from 1990-2019.

(Data Source: Open Weather Limited)

b) **Average monthly rainfall (mm):** The average monthly rainfall is assessed for 1990-2004 and 2005-2019 to understand the rainfall variations and its impacts on agriculture.

There is a shift in the rainfall occurrence during monsoon seasons of last 15 years (1990-2004) compared to the past 15 years (2005-2019). The months of Kharif season receive low rainfall on an average compared to the previous year and but the rainfall during the months Rabi season is increasing thereby indicating the events of unseasonal rainfall.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1990-2004	8	4.2	8.7	8.7	16.9	125.5	273.4	247.7	145.9	10.2	1.9	0.2
2005-2019	9	10.5	7.1	2.5	2.5	85.8	215	182.6	85.8	21.01	1	3.1

Figure 5: Average monthly rainfall (between blocks of 1990-2004 and 2005-2019).

(Data Source: Open Weather Limited)

2.3 Impact of this change

These climate-induced challenges are making agriculture highly unsustainable and unprofitable. Farmers become defaulter to the Banks and get entrapped in debt cycle leading to migration of farmers/landless labourers to other States. This highlights the urgent need for adaptive measures and sustainable farming practices to mitigate the adverse effects of climate change on this vulnerable region.

The stress factors and their impacts are given below:

a) **Intensified Temperatures:**

- **Heat Stress:** Heat stress can cause premature wilting, reduced grain size, and lower overall productivity.
- **Pest and Disease Proliferation:** Warmer temperatures is leading to the proliferation of pests and diseases, which can devastate crops. Pests such as locusts and diseases like rust and blight have become more prevalent, causing significant damage to crops.

b) **Erratic Rainfall Patterns:**

- **Unpredictable Monsoons:** The unpredictability in monsoons makes it challenging for farmers to plan sowing and harvesting, leading to crop losses.
- **Waterlogging and Soil Erosion:** Sudden and intense rainfall can cause waterlogging, which damages crops like wheat, gram, and pulses. It can also lead to soil erosion, depleting the fertile topsoil necessary for crop growth.

c) **Prolonged Droughts:**

- **Water Scarcity:** Prolonged periods of drought, lead to severe water scarcity. With insufficient water for irrigation, crops suffer from moisture stress, leading to stunted growth and lower yields.
- **Decline in Groundwater Levels:** Over-reliance on groundwater for irrigation, coupled with insufficient recharge due to drought, has led to a significant decline in groundwater levels. This makes it increasingly difficult to sustain agricultural activities.

d) **Impact on Specific Crops:**

- **Wheat and Pulses:** Increased temperatures can lead to reduced grain filling and lower yields. Erratic rainfall can disrupt the planting and growing cycles, further impacting productivity.
- **Oilseeds:** Heat stress during flowering and seed formation stages can significantly reduce oil content and yield.

- **Vegetables and Fruits:** High temperatures and water scarcity affect the quality and quantity of vegetables and fruits. Heat can lead to sunburn, reduced size, and poor taste, while irregular water supply can cause issues like cracking and reduced shelf life.

3. Addressing challenges: Solutions

Adaptive agricultural practices such as drought-resistant crop varieties, improved irrigation techniques, and sustainable water management are critical to mitigate the adverse impacts of climate change on agriculture. Additionally, educating farmers about climate-smart practices and providing them with the necessary resources and support is crucial in ensuring the resilience of Bundelkhand's agriculture against the ongoing and future challenges posed by climate change.

In this context, continuous study and observation by NABARD over the years indicated that the erratic climate in the region is not the only problem rather just the tip of the iceberg. The lack of awareness among the farmers regarding efficient irrigation system, optimizing pesticide and fertilizer use, inadequate supply of cost-effective inputs and farm machineries and lack of knowledge regarding changing weather conditions have added miseries to their lives. This leads to decreased crop yields, increased input costs, and environmental degradation due to the excessive use of inputs like water, fertilizers, and pesticides. Inefficient irrigation methods caused soil erosion, water wastage, and reduced crop quality, while excessive pesticide and fertilizer use affected soil health and human health adversely. Thus, agriculture interventions which are context-specific are needed.

To mitigate the impacts outlined above, NABARD and IFFCO Kisan have started a precision farming project in DPR mode in Jhansi with the aim of revolutionizing agricultural practices and empowering farmers through technology. The project introduced IoT-based irrigation systems coupled with voice advisory services related to agriculture, fertilizer, pesticide, and cost-effective cultivation techniques. The three-year project entailing a cost of ₹ 42.66 lakh in September 2022.

3.1. NABARD Supported IoT based agriculture in Jhansi

3.1.1 Objectives of the Project:

The entire project is conceptualised on 5 pillars:

1. Precision Agriculture Technologies
   (includes IoT-based Monitoring, Drip Irrigation and Soil Health Management).
2. Water Management Strategies
   (includes Rainwater Harvesting, adoption of sprinkler and drip irrigation techniques).

3. Sustainable Farming Practices
(includes Organic Farming practices and Crop Diversification)

4. Farmer Training and Support
(includes skill development programs and workshops for farmers, women and for strengthening Extension Services

5. Market Linkages and Value Addition
(Formation of Farmer Producer Organizations (FPOs) and supporting value addition activities)

3.1.2 Deliverables of Project:

i. Setting up 5 Model Representative Smart Farms.

ii. Farm activity traceability through Krishi Dev Gyan Platform (KDG) using Artificial Intelligence (AI)/Machine Learning (ML) & Internet of Things (IoT) based solutions.

iii. Pest & Disease prediction- Setting up of IoT hardware on the field to ensures a precise set of data points accumulated through hyperlocal sources

iv. Yield prediction- crop simulation models run on different stages of crop life cycle to have a predictive analysis of the estimated yield that will arise at the end of the cropping cycle.

v. Demonstration of use of Agri-Drone for spraying pesticides in sample area of 20 Acres. two sprays in each crop season.

vi. Demonstration of Controlled cultivation with Automated irrigation (Fully Automated & Semi Automated) facilities and balanced use of chemical inputs.

vii. Contextualized & Actionable advisories for crops - To provide near real time farm-based solutions to the farmers through the collection of various hyperlocal data sources (AWWS, Remote Sensing, Soil Moisture/Temperature Sensors) installed throughout the Model farms.

viii. To bring awareness in the farming community about the benefits of cultivating vegetables etc. and additionally intimating the farmers about the data driven precision agricultural practices & efficiency of technologies (Drone, IOT devices in AWWS, fully/semi-automated Irrigation System, Soil Moisture/Temperature Sensors, Remote Sensing etc.) in regular agricultural practices.

ix. Digital farmer and farm profiling of all farmers covered under the project in district

x. Training of the field executive and orientation of FPO and farmers on the project approach and Methodologies –one in each half year.

xi. 1 voice and 1 text advisories every alternate day on crop cultivation, weather, Mandi, etc. Modification of advisories to other farmers synchronizing the conditions on Model Representative Farms

xii. Facilitation of Input supplies and forward linkage of the quality produce

3.1.3 Interventions in the Project

The project introduces Smart precision agriculture, which is an innovative approach that leverages state-of-the-art technology to sustainably increase agricultural yields. By incorporating smart IoT devices and sensors, farmers can save time on fieldwork and maximize their crop output. These advanced technologies enable more effective use of resources through continuous monitoring of temperature, humidity, and soil moisture levels, which in turn reduces power and water consumption. This facilitates efficient monitoring of field conditions. By integrating smart precision agriculture techniques with artificial intelligence and IoT, along with data-driven weather advisory services, farmers can adopt a comprehensive approach to overcoming agricultural challenges.

Technical Component Details: IoT Irrigation System

- **Sensors:** Install soil moisture sensors, weather stations, and flow meters across the farm to collect real-time data on soil moisture levels, weather conditions, and water usage.
- **Data Analysis**: Utilize IoT platforms to analyse the collected data and generate insights into optimal irrigation schedules and water requirements for different crops. Advisory messages are then sent to farmers' phones, indicating when and how much irrigation is needed.
- **Automated Irrigation:** Implement automated irrigation systems that can adjust water flow based on real-time data inputs, ensuring precise and efficient water delivery to crops.

3.1.4 Implementation Strategy

Any new technology usually takes time to get acceptance by the farmers especially small farmers whose livelihood depends on the success of the new technology. In this project, extensive discussion at various levels with farmers, implementing NGO, line department officials took place and following method was adopted

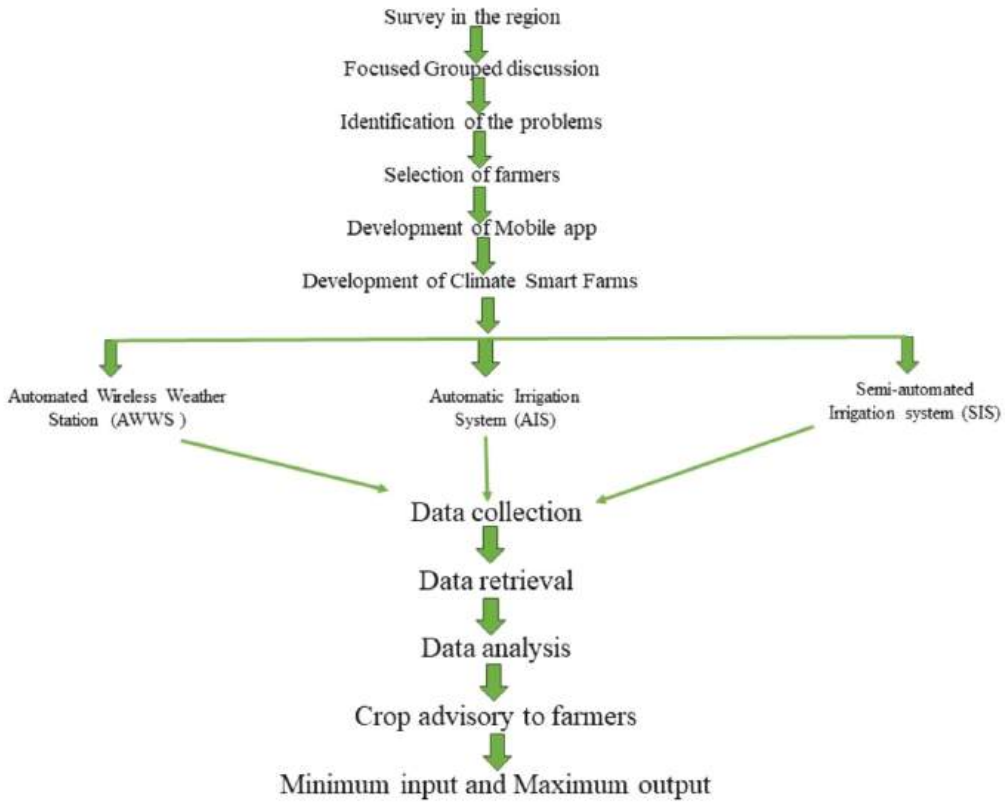


Figure 6: Process Diagram for Intervention

Community based Approach for ground level implementation

Implementing a smart agriculture project required a community-based approach to ensure sustainability, inclusivity, and maximum impact. This approach, as explained below, involves engaging local stakeholders, building capacity, and fostering collaboration to create a supportive environment for smart agriculture initiatives.

a) Stakeholder Engagement

- Local Farmers: Actively involve farmers in the planning and implementation process to ensure the solutions are tailored to their specific needs and challenges.

- Village Leaders and Community Groups: Engaged to build trust and facilitate the adoption of new technologies and practices.
- Government Agencies and NGOs: Collaboration to leverage resources, expertise, and existing networks.

b) Capacity Building

- Training Programs: Regular training sessions for farmers on smart agriculture techniques, IoT technology, and data-driven decision-making.
- Demonstration Plots: in different villages to showcase the benefits and practical application of smart agriculture technologies.
- Extension Services: to provide continuous support, advice, and technical assistance to farmers.

3.1.5 Monitoring and Evaluation

- Progress Tracking: through field visits, surveys, and data collection to assess the impact and identify areas for improvement.
- Feedback Mechanisms: through regular interactions with farmers to ensure continuous improvement of the project.

3.1.6 Financial Outlay

Out of total financial outlay of ₹ 42.66 lakh, NABARD share is 55% and IFFCO is bearing 45%. Apart from sharing cost for remote sensing, AWWS, IoT-based irrigation system, soil sensors, WAN gateway etc., NABARD also provides for Agri-Tech Consultancy services, training of farmers, field staff salary, insurance and project management cost. The farmers will bear the maintenance cost of machineries and Advisory services charges, once the project period is over.

3.1.7 Outcomes

Figure 7: Expected Benefits of Climate Smart Agriculture

A Comparative analysis of traditional and SMART farming systems in the project (Wheat cultivation in 1 acre):

Cost of Traditional Farming (in ₹)		Cost of Climate Smart Farming (in ₹)		Change
Output	24000	Output	33000	38%
Input	13500	Input	9600	-29%
Net Profit	10500	Net Profit	23400	123%

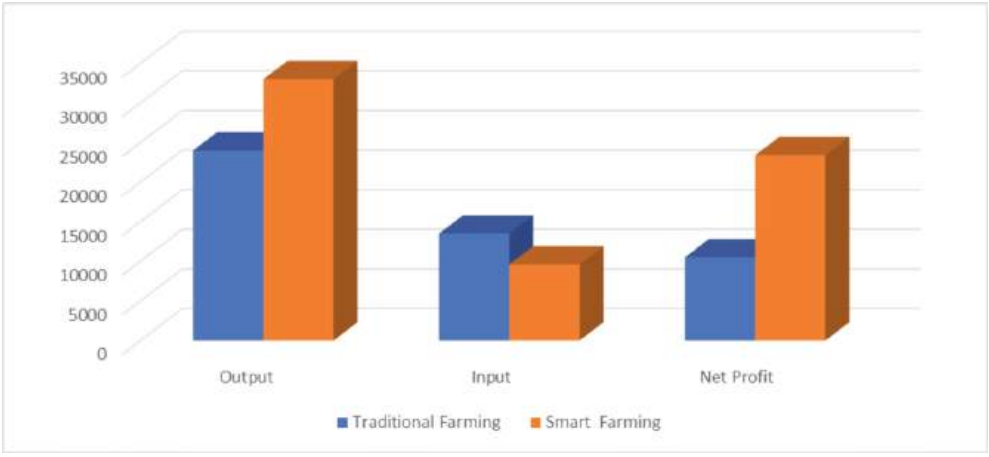


Figure 8: Comparison between traditional and smart farming system

Various Benefits that have accrued to farmers from IOT based systems in the project

Benefits Accrued	Remarks/Elaboration
Irrigation Benefits	1. Accurate rainfall predictions have saved farmers average 2 to 3 irrigations, saving cost of ₹ 800 to ₹ 1500. Additionally, it has helped farmers in managing fertilizers and pests more effectively. 2. Precision irrigation minimizes water wastage and ensures crops receive the right amount of water at the right time. 3. Due to frequent power cuts, most farmers have to stay awake all day and night just to wait for the electricity for irrigation (as most are electric pumps). The installation of IoT-based pumps has resolved this problem as irrigation can be scheduled. The pump automatically turns on and off as per schedule, eliminating the need for farmers to stay awake all night. 4. Reduction in irrigation costs has proven to be more efficient compared to diesel engines. It reduced labour costs also associated with manual irrigation. 5. Improves crop health and yield by maintaining optimal soil moisture levels.

<table>
<tr>
<td>Weather-Based Crop Advisories (So far, two automatic weather stations have been installed, serving 750 farmers in the Nihura and Badora villages of the Babina block in the Jhansi district)</td>
<td>The IoT sensor data from various smart farms are collected and integrated with weather forecast data to provide real-time weather-based advisory services to farmers through user-friendly mobile application, Krishi Dev Gyan (KDG), developed by IFFCO Kisan.
Benefits: -
1. This mobile application delivers weather-based advisory notifications and recommendations directly to the smartphones of registered farmers.
2. It provides crop-specific recommendations based on weather forecasts, including optimal planting times, irrigation scheduling, pest management strategies, and harvesting schedules. This comprehensive approach helps farmers make informed decisions and enhances their ability to manage crops effectively.
3. Further, the IoT-based system is also providing advisory services for plant disease and pest forecasting and has benefitted following farmers:
<table>
<tr><th>Farmer Name</th><th>Crop</th><th>Disease/Pest Identification</th></tr>
<tr><td>Mr. Satvant</td><td>Mustard</td><td>Stem rot, Aphid, Wilt</td></tr>
<tr><td>Mr. Shantilal</td><td>Wheat</td><td>Leaf spot, Caterpillar</td></tr>
<tr><td>Mr. Satvan</td><td>Lemon</td><td>Red Mite</td></tr>
<tr><td>Mr. Shantilal</td><td>Ground Nut</td><td>Leaf Spot</td></tr>
<tr><td>Mr. Jitendra Rajput</td><td></td><td>Smut</td></tr>
<tr><td>Mr. Rachendra Rajput</td><td>Wheat</td><td>Yellow Rust</td></tr>
</table>
4. Pesticide expenditure cost has reduced by average ₹ 1200 per acre.
5. Improves overall farm productivity and profitability by optimizing resource utilization and reducing crop losses due to adverse weather.</td>
</tr>
<tr>
<td>Optimal Agri-Input Usage (Fertilizers and Plant Protection Products)</td>
<td>1. The data collected from smart farms using various advanced techniques is analyzed through IoT to predict pest and disease outbreaks based on weather conditions and crop phenology.
2. Additionally, it predicts other input requirements such as micronutrients and fertilizers. Farmers are encouraged to utilize bioinoculants like Phosphate Solubilizing Bacteria (PSB), which can help reduce the dosage of Diammonium Phosphate (DAP) in the soil.
3. Advisory services on Good Agricultural Practices (GAP) are also provided.
Benefits:
i. Farmers have begun applying optimal doses at the right time to control specific issues in the field. This has significantly reduced the excessive use of fertilizers, micronutrients, and plant protection products, preventing overuse of chemicals, reducing the risk of pesticide resistance and soil degradation.
ii. This has saved on an average cost of fertiliser ₹ 400 to 500 per acre.
iii. Improves crop quality and marketability by minimizing chemical residues.</td>
</tr>
</table>

IOT Based Pump

Automatic Weather Station

Overall, smart climate agriculture cultivation brings about transformative changes at the farmers' level, enhancing agricultural productivity, resilience, and sustainability while improving livelihoods and promoting inclusive rural development.

Sheetal Prasad, Farmer

"I grew beans this year, just like last year, but this time the yield has been much better. Additionally, the expenses on fertilizers and pesticides have reduced. Earlier, we were unsure about which diseases were affecting the crops and which pesticides to use. We would just go to the store and buy any pesticide available. However, since receiving advice on my phone from NABARD and IFFCO Kisan, I've received significant help regarding the proper use of pesticides, fertilizers, seeds, and water." – (Fully Automatic IoT system)

4. Farmer's Testimony

Sheetal Singh Rajput, Farmer

Particulars	Pre-intervention	Post-intervention	% Change	Remarks
Irrigation	1800	1500	17%	Saving in at least 1-2 irrigation due to weather prediction
Fertilizer application	4200	3100	26%	Bioagent and microbes
Intercultural Practices	3200	2400	25%	Due to Balance Irrigation and Nutrient management

Plant protection	3400	1850	46%	Use of biofertilizer like PSB which reduces the cost of fertilizer Input
Total cost	**12600**	**8850**	30%	

S.N.	Previous Practices	Current practices
1	Application of 2 bags of DAP per acre in beans crop	Now reduction to One bag DAP and apply PSB culture, Vermi -compost, Chelated Zinc
2	Application of 2 bag Urea	Applied only 20 kg Urea with Humic acid and NPK consortia, 19:19:19
3	Pesticide cost was approx. 1200 per acre for beans crop	Due to the use of Trichoderma and bioinoculants this year, the cost of pesticides has been reduced significantly, from around 400 to 450 rupees compared to before.

5. Way Foreword

Overall, the project has a positive impact on farmers' livelihoods, agricultural productivity, and environmental sustainability, laying the foundation for replication of an innovative project in agriculture.

To ensure the successful implementation and sustainability of climate smart agriculture in the Bundelkhand region, a comprehensive and strategic approach is essential. Three things are essential in this strategic approach:

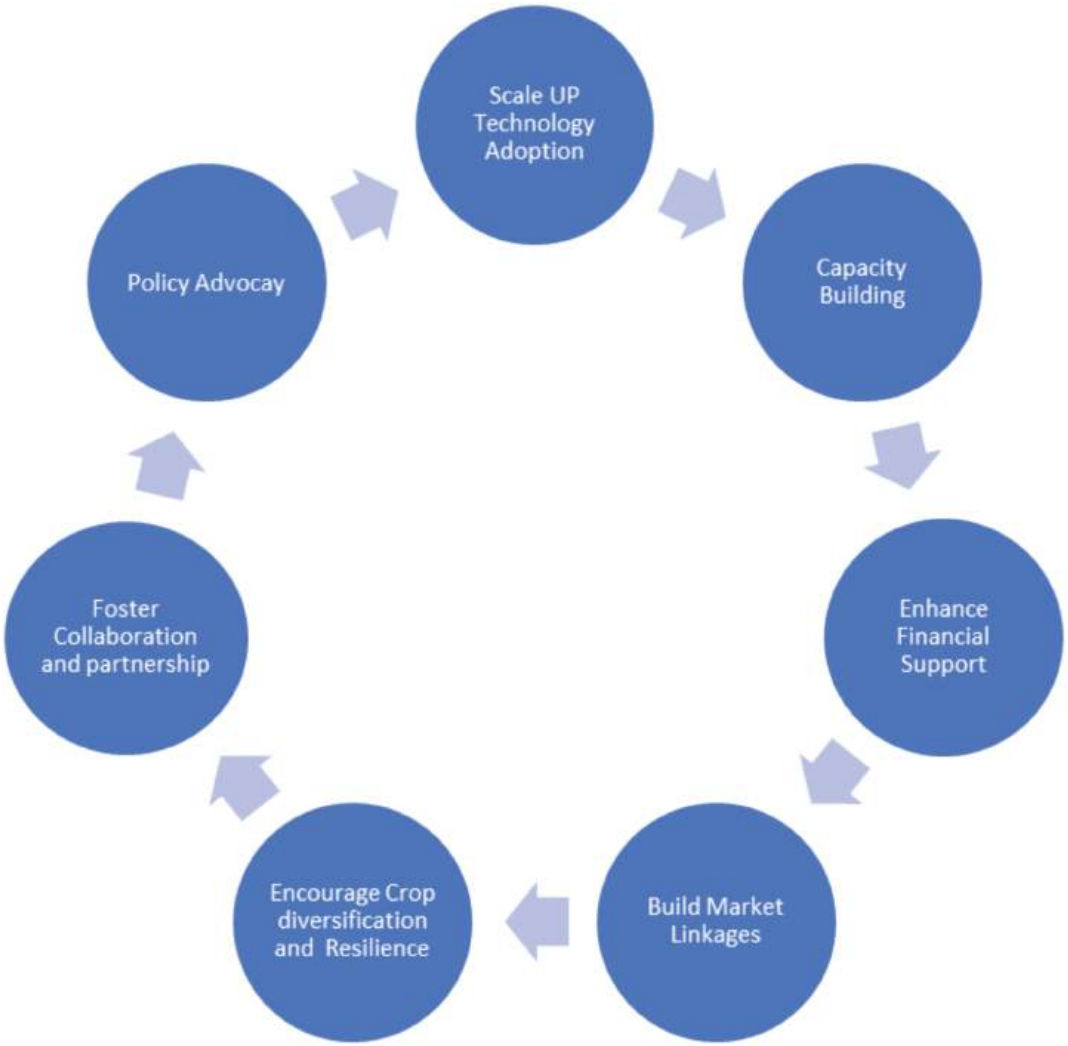
a) **Bankable plan:** for the farmers so that the grant-based pilot project model can be elevated to a loan based agrarian practice acceptable by the farmers as well as bankers and investors. A proper value chain can be formed and strengthened over a period of time with backward and forward linkages.

b) **Policy Support:** Supportive farmer-friendly policies at the local, state, and national levels that promote the adoption of smart agriculture practices. The Policy should be made keeping in mind the initial requirement of investment by the farmers and handholding in terms of knowledge and technology for a longer time period.

c) **Collaborative Platforms:** Create platforms for dialogue and collaboration among stakeholders to align efforts and resources towards common goals.

This narrative outlines the key steps and initiatives that can drive this transformation.

By following this comprehensive and strategic approach, the Bundelkhand region can significantly enhance agricultural productivity, improve livelihoods, and ensure



sustainable and resilient farming practices. This transformation will not only benefit the farmers of Bundelkhand but also contribute to the overall development and prosperity of the region.

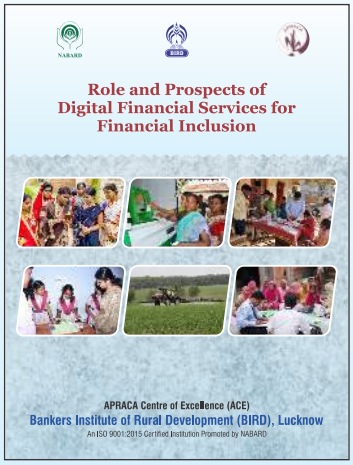
Abbreviations

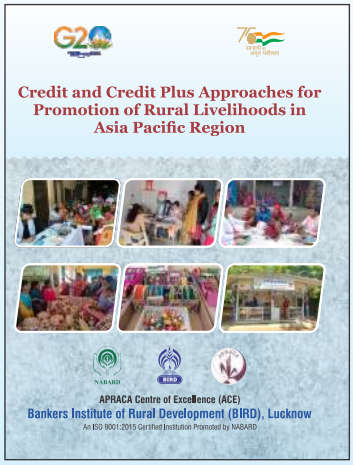
ADB	Asian Development Bank
ADPs	Adivasi Development Programmes
AFSP	Agriculture and Food Security Program
AI	Artificial Intelligence
AI	Artificial Insemination
ATM	Automated Teller Machine
AWD	Alternate Wetting and Drying
AWS	Agro-Weather Stations
AWS	Automatic Weather Stations
BBS	Bangladesh Bureau of Statistics
BDT	Bangladeshi Taka
CCP	Climate Change Programme
CSA	Climate Smart Agriculture
CSI	Carbon Standards International
CSR	Corporate social responsibility
DAP	Diammonium Phosphate
DoE&F	Environment & Forests Department
ESG	Environmental, Social and Governance
ESMU	Environmental and Social Management Unit
FAO	Food and Agriculture Organization
FAW	Fall Armyworm
FPC	Farmers' Producer Company
FPOs	Farmer Producer Organizations
GAP	Good Agricultural Practices

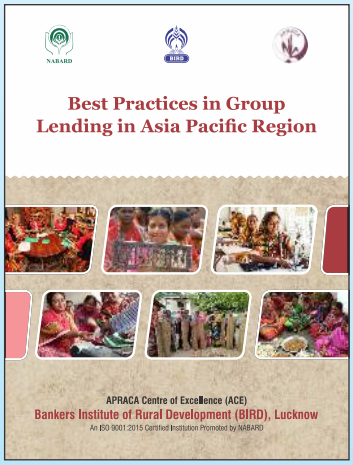
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEF	Global Environment Facility
GLC	Ground Level Credit
IDCOL	Infrastructure Development Company Limited
IDP	Integrated Development Program
IoT	Internet of Things
IPM	Integrated Pest Management
JLG	Joint Liability Group
KDG	Krishi Dev Gyan
KVKs	Krishi Vigyan Kendras
LANDBANK	Land Bank of the Philippines
LDCs	Least Developed Countries
LDDP	Livestock and Dairy Development Project
MFIs	Microfinance Institutions
ML	Machine Learning
MP	Madhya Pradesh
NABARD	National Bank for Agriculture and Rural Development
NAFCC	National Adoption Fund for Climate Change
NER	North Eastern Region
NIDM	National Institute for Disaster Management
PCA	Philippine Coconut Authority
PIAs	Project Implementing Agencies
PKSF	Palli Karma Sahayak Foundation
PVTG	Particularly Vulnerable Tribal Group
PSB	Phosphate Solubilizing Bacteria

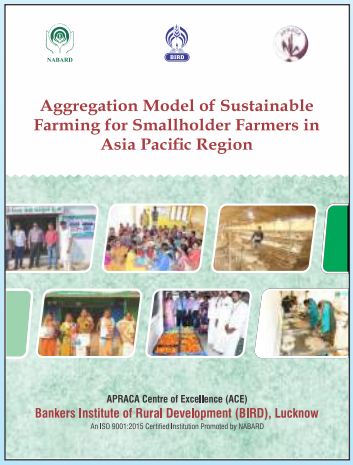
RDB	Regional Development Bank
SDGs	Sustainable Development Goals
SHG	Self Help Group
SRI	System of Rice Intensification
TDF	Tribal Development Fund
TSP	Technology Service Providers
UDP	Urban Development Programme
UNITAR	United Nations Institute of Training and Research
UP	Uttar Pradesh
UPGP	Ultra-Poor Graduation Program
UT	Union Territory
WRC	Wet Rice Cultivation

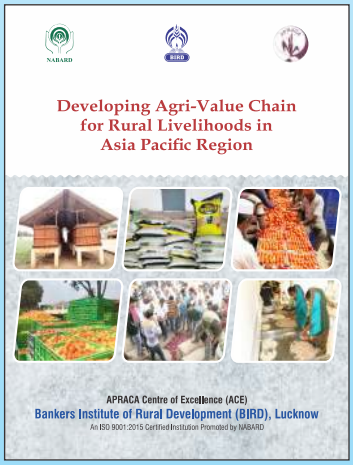
ACE- NABARD Publications

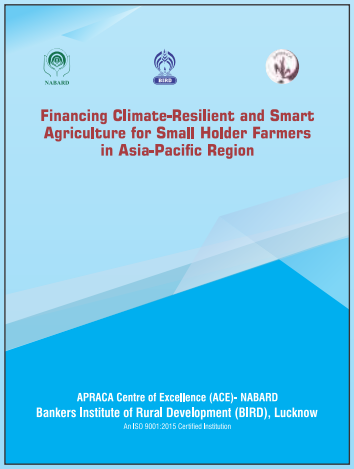












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