SAARC Afghanistan Bangladesh Bhutan India Maldives Nepal Pakistan Sri Lanka

Participatory Research on Climate Smart Agriculture Technologies in Bhutan

Consortium for Scaling up Climate Smart Agriculture in South Asia (C-SUCSeS) Project

SAARC

SAARC Agriculture Centre

BARC Complex, Farmgate, Dhaka, Bangladesh

IFAD Investing in rural people

SAARC Developmnet Fund

SAARC Agriculture Centre

IFPRI INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

Afghanistan Bangladesh Bhutan India Maldives Nepal Pakistan Sri Lanka

Participatory Research on Climate Smart Agriculture Technologies in Bhutan

under

Consortium for Scaling up Climate Smart Agriculture in South Asia (C-SUCSeS) Project

Executed by

DoA

Department of Agriculture
Ministry of Agriculture and Livestock Royal Government of Bhutan

SAARC Agriculture Centre
BARC Complex, Farmgate, Dhaka, Bangladesh

IFAD Investing in rural people

SAARC Developmnet Fund

SAARC Agriculture Centre

IFPRI INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

Participatory Research on Scaling up Climate Smart Agriculture Technologies & Practices in Bhutan

Participatory research was conducted during 2022-2024 under the Consortium for Scaling-up Climate Smart Agriculture in South Asia (C-SUCSeS) Project of SAARC Agriculture Centre.

August 2025

Published by the SAARC Agriculture Centre (SAC), South Asian Association for Regional Cooperation, BARC Complex, Farmgate, New Airport Road, Dhaka – 1215, Bangladesh (www.sac.org.bd).

ISBN Number: 978-984-35-4868-9

Citation

Choney Zangmo, Kezang Euden, Yeshi Lhaden, Kinley Tshering, Yeshey Zangpo, Rinchen Wangmo, Harunur Rashid, Raza Khan, Rumana Azad, Jairuddin M. 2025. Climate-Smart Agriculture Technologies and Practices in Bhutan. SAARC Agriculture Centre, SAARC, Dhaka, Bangladesh, p53

Disclaimer

This book 'Participatory Research on Climate Smart Agriculture (CSA) Technologies in Bangladesh' contains country's promising CSA technologies and practices as an output of validation and viability assessment of CSA technologies through field trials at farmers' plots. Such validation and viability assessment were directed by the National Focal Point of C-SUCSeS project of Bhutan and the crop scientists of the Department of Agriculture, Bhutan. The CSA technologies and practices in this publication are those of the authors and do not imply any opinion whatsoever on the part of SAC.

Cover Design and Printed by:

Generation PPA, Dhaka, Bangladesh
Cell: +8801819230291

Foreword

It is with great pleasure that I present this report on Climate-Smart Agriculture (CSA) for the C-SUCSeS project, an initiative aimed at fostering sustainable agricultural practices to address the pressing challenges of climate change. Though Bhutan is a carbon negative country, our farmers had been bearing the brunt of climate change in form of erratic rainfall, floods, fluctuations in temperature, outbreak of pests and diseases and droughts. Consequently, it has become imperative to enhance and strengthen the resilience of the farms to enable them to secure household food and nutrition security through adaptive practices. This project has thus been augmenting the efforts of the Royal Government of Bhutan in supporting the livelihood of the farmers through increased awareness and knowledge changing climate and promotion of climate smart technologies.

The project's success is a testament to the collaborative efforts and unwavering support from various partners and stakeholders. We are immensely grateful to the SAARC Development Fund (SDF) for their support and for believing in the potential of CSA to improve the livelihoods of our farming communities. We also extend our heartfelt thanks to the International Food Policy Research Institute (IPFRI) for their invaluable technical expertise and guidance. The contribution of the SAARC Agriculture Center (SAC) in facilitating knowledge exchange and providing critical insights has enriched the project’s outcomes and strengthened our capacity for innovation.

Our deepest gratitude goes to the Royal Government of Bhutan for its commitment to sustainable agriculture and climate resilience. The dedication and leadership have created a supportive environment for the successful implementation of this project, inspiring an adaptive and more sustainable future for our agricultural sector.

This report not only reflects the achievements of the C-SUCSeS project, it also serves as a foundation for ongoing efforts to make agriculture more resilient, productive, and sustainable. We hope it will be a valuable resource for practitioners, policymakers, and researchers alike as we continue to navigate the complexities of climate change and food security.

Yonten Gyamtsho
Director
Department of Agriculture
Ministry of Agriculture and Livestock

Preface

The Consortium for Upscaling of Climate Smart Agriculture in South Asia (C-SUCSeS) project represents a small but meaningful step toward supporting local farmers as they face the challenges of a changing climate. By focusing on practical, sustainable farming practices, this initiative seeks to help communities adapt in ways that are both economically viable and environmentally sound.

The project was conceived with the belief that even modest efforts can create ripple effects within our agricultural landscapes. Through collaborative workshops, knowledge sharing sessions, and hands-on demonstrations, training and exposure visits, the project equipped the farmers, extension officials, researchers and policy makers with tools and techniques, knowledge and skills that can enhance productivity while adapting to ever changing climate.

This project is the result of a collaborative effort between the Royal Government of Bhutan, SAARC Development Fund (SDF), International Food Policy Research Institute (IFPRI) and SAARC Agriculture Center (SAC). We extend our heartfelt thanks to these organizations for their contributions and shared commitment to sustainable agriculture.

We hope that this project will inspire further efforts and encourage ongoing innovation in the field of climate-smart agriculture, at a much larger scale as our farmers in this region are small holders and resource poor. Thus, continued support through collaborative approaches like this one is going to make differences in the lives of those farmers in improving household food security and income generation. We are committed to work alongside local farmers and partners in this endeavor, and we are optimistic about the positive changes it will bring to our agricultural communities.

Authors

Acknowledgements

The success of the C-SUCSeS project is a result of the dedication and collaboration of numerous partners and communities. We extend our heartfelt thanks to the SAARC Agriculture Centre (SAC) and the International Food Policy Research Institute (IFPRI) for their support, which have been instrumental in guiding this initiative. Our gratitude also goes to the SAARC Development Fund (SDF) for their generous financial support and unwavering belief in the project's mission to build resilience in agriculture.

We extend our gratitude to the Ministry of Agriculture and Livestock, the Royal Government of Bhutan, and the Agriculture Research and Development Centers for their commitment in further fostering sustainable agricultural practices. Their expertise and support have provided a strong foundation for this project's implementation and success.

We also would like to extend our gratitude to the project district officers and, most importantly, to the farmers whose dedication, hard work, and willingness to adopt climate smart practices have been at the heart of this endeavor. Their resilience and participation inspire our efforts and drive the project's ongoing impact.

To all our partners, stakeholders, and communities, we extend our sincere appreciation for their dedication to a more climate resilient and sustainable agricultural future.

Authors

Contents

Annexures

Tables

List of Figures

Executive Summary

The "Consortium for Scaling-up Climate Smart Agriculture in South Asia (C-SUCSeS)" is a collaborative initiative launched in 2021 by the South Asian Association for Regional Cooperation (SAARC) Agriculture Centre (SAC), the International Food Policy Research Institute (IFPRI), and the International Fund for Agricultural Development (IFAD). This project focuses on promoting Climate Smart Agriculture (CSA) technologies that enhance climate resilience and agricultural productivity across SAARC countries.

In Bhutan, C-SUCSeS project has introduced several CSA technologies through participatory research efforts. These include protected cultivation for vegetables like chili, cabbage, and tomato in Sarpang District, which shields crops from extreme weather and pests, leading to improved crop quality and higher yield of crops. The initiative also promoted drip irrigation systems to optimize water use, reduce water wastage while enhancing crop productivity, and Sustainable Land Management (SLM) practices to prevent soil erosion, improve soil fertility, and support long-term crop productivity.

Farmers adopted the technologies reported increased yields, reduced input costs, and greater income stability, demonstrating the practical benefits of climate-smart interventions. Protected cultivation, for example, enabled farmers to produce high-quality crops year-round despite seasonal climate variability. Drip irrigation and SLM practices contributed to water savings and improved soil health, respectively.

The initiative aims to scale up these efforts by strengthening institutional capacities, fostering local partnerships, and advocating for supportive policy frameworks across the SAARC region. This approach not only enhances the resilience of farming communities; it also contributes to long-term food security and sustainable rural development in South Asia.

Chapter 1

Introduction

The "Consortium for Scaling-up Climate Smart Agriculture in South Asia (C-SUCSeS)" is a collaborative project implemented jointly by the SAARC Agriculture Centre (SAC), and international Food Policy Research Instiute (IFPRI), and cofounded by SAARC Development Fund (SDF), and the International Fund for Agricultural Development (IFAD). This initiative aims to promote sustainable and resilient agricultural practices across SAARC countries by strengthening policies, institutions, and skills to scale up climate-smart strategies and technologies. In Bhutan, the project, launched in 2021, focuses on participatory research on prioritized Climate Smart Agriculture (CSA) technologies through three Agriculture Research and Development Centers (ARDCs). ARDC- Samtenling, for instance, oversees protected cultivation research in Dekiling Gewog, Sarpang District, involving farmers in the cultivation of vegetables like chili, cabbage, and tomato.

The ARDC-Wengkhar led the participatory research on drip irrigation system, which was implemented across three distinct sites in Mongar and Lhuentse Districts, engaging three farmers groups with predominately female membership. These included the Kilikhar women's group and Tsakaling vegetable group in Mongar District and Tongphugang womens group in Lhuentse District. The upscaling of this technology was done in Mongar with installation of an automated drip irrigation system covering 1.5 acres at Resa Passion Fruit Farm in Saling, Mongar.

Earlier, ARDC Bajo, in collaboration with the Dagana District Agriculture sector, implemented Sustainable Land Management (SLM) activities at Salamji village in Tsangkha, Gewog, from 2006 to 2008 with support from the United Nations Development Program (UNDP) projects. This initiative formed the Salamji Phashing Zinchoung Tshokpa group, benefiting 16 households and managing 494 acres of land through SLM technologies such as contour stone bunding, terracing, hedge row plantation, community forest management, and check dams. In December 2022, participatory research was conducted to assess the impact of these SLM technologies by interviewing beneficiaries and evaluating the potential for scaling them up nationwide. Based on the multiple benefits, SLM was upscaled in Punakha and other Tshangkha and Karmaling Gewogs of Dagana. ARDC Wengkhar led the study on drip versus manual irrigation, with the participation of 22 farmers (91% women). This project underscores the commitment to climate-smart interventions that support smallholder farmers, especially women, in building resilience and adapting to changing climate.

Chapter 2

Participatory Research

Participatory research was conducted at different locations on climate smart Agriculture Technologies such as protected agriculture, drip irrigation and sustainable land management.

2.1 Objectives

i. To carry out validation of CSA technologies through participatory research with.

ii. To enhance farmers' adaptive capacity to the changing climate with the adoption of appropriate CSA technologies,

iii. To compare the returns to investment through use of these technologies with conventional farming methods

2.2 Methodology

Description of PR sites and selection of farmers

2.2.1. Protected Cultivation

The selection of sites and participating farmers was based on the household already owning a poly-house and already engaged in winter vegetable cultivation using such facilities. The poly-houses were either bought privately or provided by the Royal Government of Bhutan in subsidy programs. The selection of the farmers was carried out in collaboration with the district and gewog agriculture sector of Singye, Dekiling, and Umling gewogs under Sarpang District.

The participatory research can be classified as a wet-subtropical agro-ecological zone with an altitude ranging from 200 to 3,600 meters above sea level (masl) with an annual rainfall of 2500-5500 mm and a maximum and minimum temperature of 35°C and 12°C, respectively.

2.2.2. Drip irrigation

The participatory research on drip irrigation system was conducted in Mongar and Lhuentse Districts, situated at elevations ranging from 1200 to 1959 meters above sea level. These sites were selected based on prevalent water scarcity, dry spells, and the need for efficient water management solutions. The research engaged local farmers' groups to evaluate the technical performance of drip system under local conditions and to assess the technology's potential for broader adoption in similar agroecological zones. In line with the project's design to focus on benefiting women farmers and complementing other projects for greater effectiveness, three women's groups were identified as already established through Commercial Agriculture and Resilient Livelihoods Enhancement Program (CARLEP). The groups were the Kilikhar Vegetable cultivation group in Mongar, the vegetable cultivation group in Tsakaling, Mongar and the Tongphugang women's group in Lhuentse.

At the kilikhar research, Mongar, the research trial was established in an open field with a plot size of 14 m2 (14 m × 1 m) with a standard plant spacing of 60 cm × 60 cm (plant to plant and row to row). The 9 out of 18 total plots were irrigated by drip irrigation system while remaining 9 plot were irrigated manually (control). Cole crops such as broccoli, cabbage and cauliflower were transplanted, and the data were recorded. Seven participating farmers from the Kilikhar Women's Group were actively involved in plot establishment, crop management, and data collection, ensuring that the local knowledge guided the research process and implementation while building technical capacity among the participants.

The participatory research on drip irrigation trial was established in Tshenkhar under Lhuentse District, with active engagement from the Tongphugang women's group. Two separate experimental sites were established. The first location comprised 6 beds with a total area of 22 m2 (22 m × 1 m), where three beds were maintained and irrigated manually (controls) (Manual irrigation required) and three beds were equipped with a drip irrigation system. The second location comprised four experimental beds covering a total of 18.5 m^2 (18.5 m × 1 m each), equally divided between drip-irrigated and control treatments. Both trial sites maintained standardized 60 cm × 60 cm spacing for both plant-to-plant and row-to-row arrangements, ensuring consistency in plant density across all treatments and crops.

At the Tsakaling research site in Mongar District, a comparative trial was established to evaluate the performance of drip irrigation against traditional methods. The experimental design featured eight cultivation beds (11 m × 1 m each), with identical dimensions maintained for both treatment and control plots. Cole crop seedlings were transplanted maintaining uniform plant-to-plant and row-to-row distance.

2.2.3. Sustainable Land Management (SLM)

Salamji village at Tsangkha Gewog in Dagana District is located on the right side of the Punatsangchhu River between Wangdue phodrang District and Tsirang District. The entire village falls under the tropical parts of Bhutan with altitude ranging from 250 to 750 meters above sea level (masl). At present, there are 17 households managing 494 acres of land sustainably, consisting of forests, farmland, and residential areas. These households have formed a farmer's group named Salamji Phashing Zinchoung Tshokpa, which literally translates to "Salamji Land Management Group" highlighting the importance given to land management in this village by all the households. Salamji is one of the first villages in west central Bhutan where SLM technologies were successfully implemented. After 14 ears, participatory research was conducted involving 15 beneficiaries of the project.

2.3. Participatory Research Approach

2.3.1. Description of prioritized CSA technologies and rationale for their selection

Protected cultivation

Protected agriculture is practiced increasing crop yields, produce quality crops, and generate revenue. It gives year-round production, allowing farmers to take advantage of market seasonality and fetch higher prices. Additionally, it saves significant amounts of water and reduces significant pesticide use (CGIAR, 2023). This approach involves the use structures like greenhouses, poly-houses, or plastic tunnels to create a warmer microenvironment that extends the growing season, shields crops from adverse weather, and protects them from pests. While protected cultivation is widely practiced across the country, it has proven particularly beneficial in the southern regions, where it enables the winter production of high demand crops like chili and tomatoes that would otherwise be limited due to seasonal constraints.

This method also allows farmers to create a conducive environment that mitigates the challenges posed by cold winters and unpredictable weather, leading to higher yields and improved crop quality. By extending the growing season, farmers can meet local demand during winter months when traditional cultivation is not feasible, thereby increasing their income and reducing reliance on imported vegetables. The Bhutanese government actively supports this initiative providing training and resources to facilitate its adoption among farmers. Overall, the implementation of protected cultivation for vegetables not only enhances food security, it also strengthens the economic resilience of Bhutanese farmers in a changing climate.

Drip irrigation

Drip irrigation is increasingly recognized as an effective water management technique in Bhutan, especially given the country's diverse topography and the challenges posed by climate change. This method delivers water directly to the plant roots through a system of tubes and emitters, significantly reducing water wastage compared to traditional irrigation methods, which often result in runoff and evaporation. In Bhutan, where water resources are limited, especially during dry seasons, drip irrigation optimizes water usage and ensures that crops receive necessary moisture needed for healthy growth.

By allowing precise water delivery, farmers can maintain optimal soil moisture levels, improving crop yields even in less fertile areas. Moreover, drip irrigation reduces labor requirements, which is critical in rural Bhutan, where labor shortage is common due to urban migration. The government, in collaboration with various organizations, is promoting the adoption of drip irrigation systems to enhance agricultural productivity, reduce water usage, and support sustainable farming practices.

Sustainable land management

Sustainable Land Management (SLM) is crucial in Bhutan due to the country’s rugged terrain and steep slopes, which significantly contribute to soil erosion and land degradation. Most agricultural land in Bhutan is located on hillsides, making it especially vulnerable to erosion and nutrient loss, particularly during the monsoon season.

SLM technologies implemented in Bhutan include terrace consolidation, bench terracing, contour stone bunding, fruit orchard establishment, hedgerow plantations, and the construction of check dams. These practices aim to enhance soil conservation, combat erosion, improve water retention, and create more accessible land for mechanized farming, thereby increasing agricultural productivity in the country's challenging topography.

By promoting rainwater infiltration into the soil rather than surface runoff, SLM also supports groundwater recharge and helps maintain consistent soil moisture-addressing water scarcity concerns. Overall, SLM plays a vital role in Bhutan's agricultural strategy, aligning with national goals for food security, environmental sustainability, and resilient rural livelihoods.

The C-SUCSeS Project has supported agricultural land development as part of SLM initiatives through field demonstrations and farmer awareness programs. It has also provided financial support for training programs related to other climate-smart agriculture (CSA) technologies, such as biochar and bokashi.

2.3.2. Team building, collaboration, partnership

The conduct of participatory research in various blocks under different districts enhanced the and strengthened the relationship between the researchers, extension and the farmers. The constant interaction for data recording and crop monitoring provided opportunities for deeper and meaningful insights into the opportunities and challenges associated with the adoption of climate smart technologies in agriculture. Although CSA has been promoted through various area development projects, participatory research on CSA was the first of few interventions to generate the data on the benefits of the technologies.

The exposure visits and training programs involving farmers and extension officials in the countries within the region exposed them to the knowledge and advancement in the region and it was relatable as those farmers were also small and resource constrained. For all the farmers, it was their first time participating in such programs. This exposure visit encouraged them to adopt climate smart practices, as they could see and hear its benefits in the farms they visited in Nepal and India. Further, it ignited an optimism and enthusiasm that with the right technologies, they can continually adapt to climate change with minimal or no negative impact on crop production.

2.3.3. Biophysical, Climatic, and socioeconomic conditions

Protected Cultivation

Sarpang District experiences a hot and humid climate, marked by high temperatures and heavy rainfall, particularly during the monsoon season. On average, the region experiences around 235 days with temperatures exceeding 25°C (77°F) annually, with daily temperatures ranging from 20°C to 37°C. The monsoon season, which lasts from May to September, brings substantial rainfall, often resulting in flooding in the plains. In contrast, the winters, lasting from October to February, are cooler and more moderate, providing a refreshing respite from the heat. With 88% of its land covered by forests, Sarpang District has 27,788.16 acres of arable land where farmers cultivate vegetables and fruits. Sarpang's main sources of income come from agriculture and livestock farming, of which the primary agriculture source of income is the export of arecanut, followed by the sale of vegetables.

Drip Irrigation

The activity on the participatory research on drip irrigation system was implemented in three sites under Mongar and Lhuentse Districts involving three farmers' groups with the majority of women participants. The farmers' groups are Kilikhar women's group, Tsakaling vegetable group under Mongar District and Tongphugang women's group under Lhuentse District.

Both districts are located in the eastern region of Bhutan and are characterized by rugged and mountainous terrain, with elevations ranging from approximately 400 to over 5,000 meters above sea level. Their biophysical environment includes a mix of subtropical forests at lower altitudes and temperate to alpine vegetation at higher elevations, with soils that are mostly sandy loam and prone to erosion. Both districts are enriched with perennial rivers such as the Kurichhu and Kuri-Gongri, which support irrigation and local livelihoods. The climate ranges from subtropical in the lowlands to temperate in the uplands, with annual rainfall between 1,500 to 2,500 mm.

Socio-economically, these regions are relatively remote and less developed, relying heavily on subsistence agriculture, with limited access to markets and infrastructure. However, recent improvements in road connectivity and development programs are gradually advancing livelihoods.

Sustainable Land Management (SLM)

SLM technologies have been implemented in the gewogs of Salamji, Tsangkha, Nichula, and Karmaling under Dagana District. These areas lie at elevations ranging from 250 to 750 meters above sea level and fall within a humid subtropical climate zone. The region receives medium to heavy rainfall, averaging between 1,000 to 1,200 mm annually, and experiences warm summers and mild winters, with average temperatures ranging from 18°C to 30°C. Salamji is one of the first villages where SLM technologies were successfully implemented. Approximately 92 acres of sloping farmland-featuring gradients between 8° and 30° have been developed using various SLM technologies. These include bench terracing, stone bunding, contour plantations, and the construction of check dams. Farming in these areas is primarily subsistence-based, with households relying on crops and livestock mainly for home consumption. A Participatory Research (PR) study was conducted in the area to evaluate the impact of these interventions, with the aim of informing future upscaling efforts.

The village reflects typical rural socio-economic conditions, marked by subsistence and cash crop farming, particularly cardamom and citrus. In the past, the area had limited vegetable cultivation due to seasonal remoteness and difficult terrain. However, this has changed with the introduction of SLM practices. The farmers are now focused on commercial vegetable cultivation, which is improving household livelihoods through increased income generation.

2.3.4. Prevailing cultivation practices

Protected Cultivation

In Sarpang, agriculture is more commercially oriented compared to eastern Districts, owing to better market access. The district has fertile lowland areas and a warm, humid climate, which supports the cultivation of paddy rice, maize, millet, vegetables, and citrus fruits. Wetland paddy cultivation is common in the plains, while dryland crops like maize and millet are grown on sloped terrain. Farmers are also engaged in horticulture, particularly citrus (mandarin), ginger, and areca nut, which are important cash crops. Cropping systems in the district are a mix of subsistence and commercial farming, with increasing adoption of improved seeds, fertilizers, and irrigation in more accessible areas.

Due to extreme weather conditions in summer with excessive and erratic rainfall, very high temperatures with high humidity levels, which encourage the incidence and spread of many pests and diseases, vegetables cultivation is almost impossible during summer in open field conditions. As a result, farmers in Sarpang depend solely on winter vegetables cultivation for self-consumption and market sales. Summer cultivation of crops is mostly limited to rice and maize. With the intervention and support from the government, some progressive farmers have been initiating year-round cultivation of vegetables for income under protected cultivation. Nonetheless, most of the poly-houses lacked insect nets, leading to high incidences of pests and diseases inside the structures as the sides were left open for air circulation. Thus, it serves only as rain shelter and not a protected structure as it was intended to be. Learning from this lesson, farmers are now encouraged to procure only those poly-houses which have side nets and the same is being promoted through the government subsidy programs.

Drip Irrigation

In Mongar and Lhuentse, agriculture remains predominantly subsistence-based, with most households cultivating crops mainly for their own consumption rather than for commercial sale. The mountainous terrain necessitates the use of terrace farming, especially for paddy cultivation in the lower valleys and river basins where irrigation is available. Maize is the most widely grown crop in the dryland areas, followed by other cereals such as millet, wheat, and barley, depending on altitude, soil conditions, and seasonal rainfall. Cropping systems are largely rainfed, with limited access to reliable irrigation infrastructure, making farming highly vulnerable to climate variability. Farmers often practice mixed cropping and crop rotation to maintain soil fertility and reduce risk. While some households are beginning to engage in vegetable and citrus production for local markets, overall agricultural productivity remains modest due to terrain challenges, limited mechanization, and market access constraints.

Drip irrigation is one of the micro-efficient irrigation systems promoted by the government to reduce water loss and lower labour demands for manual irrigation and increase crop productivity. It is a fairly new technology promoted in the country about a decade ago. Drip irrigation is most commonly used in vegetable cultivation and to a lesser extent, in fruit orchards. As a result, the area coverage under this water conveyance system is still quite limited. Thus, traditional farming practices with manual irrigation remain the most prevalent and commonly practiced in local communities. However, manual irrigation is labor intensive, leads to inefficient water use, and often results in uneven crop performance.

Sustainable Land Management (SLM)

The adoption of Sustainable Land Management (SLM) practices has created significant opportunities for farmers to transition from traditional subsistence farming to more commercially oriented agriculture. In Salamji, for instance, households have diversified their income sources and improved their livelihoods by cultivating high-value crops such as bananas, lychee, mangoes, papaya, and a variety of vegetables. These crops, which were previously difficult to grow on degraded or sloped land, have become viable through the implementation of SLM technologies such as bench terracing and contour planting. In addition to crop cultivation, many households supplement their income through the collection and sale of non-wood forest products, as well as livestock rearing, which remains an integral part of their farming systems.

Marketing of agricultural produce has also improved. Farmers in Salamji are able to sell their fruits and vegetables with relative ease at roadside stalls along the Wangdue–Tsirang highway. This convenient access to the market has enabled them to earn steady incomes without facing major logistical or pricing challenges.

Similarly, agricultural land development in Tsangkha, Nichula, and Karmaling gewogs has significantly improved farmers' livelihoods. Previously uncultivable or underutilized lands often characterized by steep gradients and poor soil structure have been rehabilitated and brought 29.5 acres under cultivation. With improved land conditions, farmers in these areas have expanded into commercial farming, focusing on crops like maize and various vegetables. This shift has not only boosted household income but has also enhanced food security and contributed to creating more resilient rural communities.

Implementation of CSA technologies

The climate-smart agriculture (CSA) initiatives began with consultations involving the District agriculture sector, specifically engaging with agriculture extension supervisors. These consultations were essential to understand the local agricultural landscape, identify key challenges, and gather insights on effective strategies for implementing CSA technologies.

Following these initial discussions, relevant farmers were selected for participation in the project. The selection process aimed to empower women in agriculture, ensuring their voices and needs were adequately represented. Wherever feasible, co-funded sites that demonstrated potential for impact were identified to maximize resource efficiency and community involvement.

Once the sites and participants were established, the selected farmers received a comprehensive briefing on CSA technologies and the overarching objectives of the project. This briefing included detailed information about the benefits of adopting these technologies, such as improved resilience to climate change, enhanced crop yields, and sustainable farming practices. By equipping farmers with knowledge about CSA, the project aimed to foster a strong sense of ownership and commitment among the participants.

To ensure the successful implementation of the CSA practices, regular monitoring was conducted by extension officials. This monitoring served to track progress, assess the effectiveness of the technologies, and provide ongoing support to the farmers. The involvement of extension officials addressed the challenges promptly and made necessary adjustments to the implementation strategy.

In addition to monitoring, training sessions were organized for farmers to enhance their skills in adopting CSA technologies effectively. Researchers conducted data collection, gathering valuable insights on the adoption of practices and their impacts on agricultural productivity and sustainability.

As the project progressed, feedback and insights from the Districts, women farmers, and youth farmers were crucial for upscaling successful practices. This collaborative approach ensured that the initiatives were responsive to the needs of the community, leading to broader adoption of CSA technologies and contributing to the overall goal of enhancing agricultural resilience to climate change.

2.4.5. Need for research interventions

Protected Cultivation

In Sarpang, vegetable cultivation is currently limited to the winter season due to environmental stresses and the low adoption of protective farming practices beyond nursery raising. Most farmers use poly-houses or simple protective structures only to raise vegetable nurseries, after which seedlings are transplanted into open fields where they are highly exposed to unpredictable weather conditions, including heavy rains, thunderstorms, excessive solar radiation, and high temperature and humidity levels. These factors, combined with high pressure from insect pests and fungal diseases, significantly constrain crop productivity and quality. Despite the proven benefits of protected cultivation, its application remains minimal due to limited technical knowledge, economic constraints, and lack of context-specific solutions. This highlights the critical need for participatory research approaches that actively involve farmers in the development, testing, and adaptation of protective cultivation technologies suited to local conditions. Through collaborative trials, feedback loops, and hands-on learning, it can help align with farmers' needs and capacities, while also enhancing resilience, yield stability, and year-round production to encourage more farmers to adopt this technology.

Drip Irrigation

Research interventions are crucial for the successful introduction and adoption of drip irrigation in Mongar and Lhuentse due to the region's complex terrain, variable water availability, and predominantly traditional farming systems. These Districts face unique challenges such as steep slopes, fragmented landholdings, and limited access to irrigation infrastructure. Targeted research interventions can help develop and adapt drip irrigation technologies that are affordable, easy to use, and suitable for local crops and environmental conditions. Additionally, it was intended to identify best practices for water management, system maintenance, and integration with existing farming methods. Without such focused interventions, there is a risk that drip irrigation may be inappropriate or underutilized, limiting its potential benefits. Therefore, the intervention was essential to generate evidence-based recommendations, provide training and technical support, and create scalable models that enhance water efficiency, improve crop yields, reduce labour cost and support sustainable livelihoods. Since, manual irrigation of the crop is usually done by the female farmers, it reduces drudgery and time taken to water the crops leaving them with more time to spend on other leisure activities or engage in additional economic activities for additional income to the family.

Sustainable Land Management (SLM)

Sustainable Land Management (SLM) is not only a diverse approach but also a long-term research endeavor, where short-term studies may not fully capture its wide-ranging impacts. Comprehensive research is needed to understand changes over time, particularly in the accumulation of soil nutrients, organic matter, and soil moisture conservation in areas where SLM has been implemented. Additionally, there is a need for land suitability mapping, soil health assessments, and evaluation of climate-resilient practices to effectively address soil erosion and land degradation on steep slopes. Further studies should also focus on assessing the effectiveness, adaptability, and scalability of different SLM technologies, improving water management strategies, and integrating agroforestry practices to enhance both biodiversity and rural livelihoods.

2.4.6. Key Learning points during the PR process

Protected Cultivation

i. Protected agriculture structures must be adapted to Bhutan's unique agro-ecological zones and socio-economic conditions. In locations like Sarpang, where temperature and humidity are high, poly-houses need to be customized to ensure adequate ventilation, proper air circulation, and effective temperature and humidity control.

ii. Regular hands-on training will help build farmers' confidence in managing protected structures and applying inputs like fertigation and pest controls in a timely manner.

iii. Engaging women and youth in the research process led to more equitable outcomes, stronger ownership and boosts household resilience.

iv. We have institutional and government policies that provide cost sharing mechanisms to the interested farmers on agriculture inputs such as poly-houses, machineries and other agriculture tools and equipment. Such policies support the increased adoption of technologies by the farmers.

v. Farmers prioritize affordability and availability since the upfront cost of pre-fabricated poly-houses is high and not affordable for most small holder farmers.

vi. Constant monitoring and technical support are required to keep the farmers engaged and interested in growing crops under protected cultivation for need based interventions like managing pests and diseases on time.

Drip Irrigation

Here are the key learning points often observed during the participatory research (PR) process for drip irrigation in regions like Mongar and Lhuentse:

i. Understanding farmers' specific agroecological conditions, cropping patterns, and water availability is essential to design effective drip systems.

ii. Actively involving farmers ensures that the technology is adapted to their needs, preferences, and capacities, increasing adoption and sustainability.

iii. Training farmers on installation, operation, and maintenance of drip irrigation systems builds confidence and reduces dependency on external support.

iv. Affordability and availability of materials are major barriers; research must explore low-cost, locally available options without compromising efficiency.

v. Modifying drip designs to fit uneven terrain, fragmented plots, and mixed cropping systems enhances usability and water use efficiency.

vi. Combining drip irrigation with other water-saving practices and soil nutrient management improves overall productivity and sustainability.

vii. Continuous evaluation and farmer feedback help refine technology and extension approaches in real time.

viii. Gender roles, community dynamics, and traditional practices impact acceptance and use, requiring sensitive and inclusive engagement strategies.

ix. Visible success stories and farmer-to-farmer knowledge exchange significantly boost wider adoption.

x. Collaboration with local administration and extension services strengthens outreach, technical assistance, and long-term sustainability.

Sustainable Land Management (SLM)

The following are key learning points observed during the implementation of SLM technologies:

i. The use of the “A-frame” tool to identify contour lines and navigate slope gradients requires skilled manpower. Accurate application of this technique is critical but demands proper training and experience.

ii. Farmers initially showed limited understanding of the benefits of SLM technologies, particularly regarding water and energy conservation. Many were unaware that these practices contribute significantly to water savings and resource efficiency.

iii. The implementation of SLM technologies in Salamji village positively engaged local farmers and helped reduce rural-to-urban migration to some extent. All 16 households that adopted the technology recognized its role in improving crop productivity and mitigating the negative impacts of climate change on agriculture.

iv. Although the full impact of recently implemented SLM practices is yet to be fully assessed, initial outcomes from Salamji indicate improved land productivity. The area has seen the development of more diverse cropping systems, which have enhanced rural livelihoods through increased agricultural output and market sales.

Chapter 3

Results and Discussion of Participatory Research

3.1 Farmers' knowledge of climate change impacts on agriculture and indigenous adaptive methods / practices

3.1.1 Protected cultivation

Farmers in Sarpang are increasingly aware of climate change and its impacts on agriculture. A study by Chhogyel et al. (2020) found that farmers in Sarpang reported significant consequences of climate change, including drying irrigation sources and crop losses caused due to extreme weather events such as untimely rains, droughts, and windstorms. These experiences have heightened their awareness of climate-related challenges. Additionally, initiatives like the Climate Smart Agriculture project have been working to enhance farmers' skills and knowledge to adapt to the impacts of climate change.

Despite this growing awareness, detailed knowledge about the causes and long-term effects of climate change remains limited among many farmers. This underscores the need for targeted research interventions and capacity-building programs to further educate farmers and equip them with the tools necessary to adapt to changing climatic conditions.

3.1.2 Drip irrigation

The farmers in Lhuentse and Mongar are also increasingly aware of climate change and its impacts on agriculture, though the depth of understanding varies. A study by Chhogyel et al. (2020) found that over 83% of farmers in Bhutan's northern biological corridors, which include parts of Lhuentse and Mongar, recognized changes in climate patterns over the past decade. The most commonly reported changes were rising temperatures, erratic precipitation, altered plant growth cycles, and shifts in wildlife behavior. These observations align with the challenges faced by farmers in these Districts, such as unpredictable rainfall, an increased frequency of extreme weather events, and changing pest and disease dynamic.

3.1.3 Sustainable Land Management (SLM)

Farmers in Dagana have become increasingly aware of climate change and its impacts on agriculture, primarily through direct experiences and targeted interventions. A study conducted in four gewogs of Dagana, that is; Goshi, Kana, Geserling, and Khebisa, highlighted that climate change awareness among farmers was low at the outset. However, after participating in capacity building and awareness programs, there was a significant improvement in their adaptive capacity and resilience. The interventions led to better farming practices, enhanced water management, and increased engagement in off-farm activities. These findings suggest that while initial awareness may be limited, targeted research interventions and participatory approaches can effectively enhance farmers' understanding and adaptation to climate change in Dagana.

3.2 The participating farmers are aware of the benefits of using CSA practices

3.2.1 Arrangements of inputs for the implementation of CSA technologies (e.g.: seeds, custom hiring, fertilizers, etc.)

The input support varied between the farmers across regions based on the technology supported and the location of the sites. So, support from the project varied from hybrid vegetable seeds, drip sets on cost sharing basis, water storage tanks, pipes in drip sites to mulching plastics, sprayers and stationeries for data recording in protected cultivation sites. The farmers for whom SLM was supported with fuel or hiring of machines for land development. The farmers on the other hand contributed to all the activities. They also purchased fertilizer or organic manure, crates for harvesting and storing vegetables on their own.

3.2.2 Farmers' perception of CSA technologies and its adoption

Farmers' perception of CSA technologies such as drip irrigation, protected cultivation, and Sustainable Land Management is shaped by direct experience, local knowledge, and the extent of institutional and technical support. Across districts like Sarpang, Mongar, Lhuentse, and Dagana, many farmers are increasingly open to CSA innovations when they observe clear benefits such as improved yields, greater resource efficiency, and enhanced resilience to climate stresses. The technology-wise perceived benefits/costs are summarized below.

i. **Drip Irrigation:** Perceived positively as a water-saving and labor-efficient method, especially in sloped or water-scarce areas. However, high costs, technical complexity, and maintenance issues often limit wider adoption without ongoing support and training.

ii. **Protected Cultivation** (e.g., poly-houses): Farmers recognize its potential to enhance seedling survival, extend growing seasons, and reduce weather related risks. Yet, adoption beyond nursery stages remains low due to high humidity, pest pressure, and limited knowledge of ventilation and integrated management.

iii. **Sustainable Land Management:** SLM practices, such as terracing are viewed as helpful for reclaiming land on steep slopes and improving land productivity. However, adoption is often limited by high cost, land fragmentation, and limited access to machineries.

While perceptions are generally positive, the actual uptake of these CSA technologies remains varied and highly dependent on awareness, economic feasibility, and access to participatory research and extension services. To scale adoption effectively, there is a pressing need for location and context specific demonstrations, technical training, and co-learning platforms that integrate farmers' knowledge with scientific innovation.

Recognizing the challenges farmers face in adopting CSA technologies such as protected cultivation, drip irrigation, and SLM, the government has made the promotion of these technologies along with other CSA technologies a national priority. These technologies are being scaled up across the country, primarily through cost-sharing arrangements to make them more accessible to farmers. Adoption levels vary, but progress has been significant. By the end of the 12th Five Year Plan (FYP), approximately 11,260 acres had been brought under SLM, around 2,875 acres under micro-efficient drip irrigation, and about 5,129 greenhouses had been established to support year-round vegetable production. These figures reflect the government's ongoing commitment to enhancing agricultural resilience and productivity in the face of climate change.

3.3 Benefit–Cost Analysis of CSA Technologies

3.3.1 Protected Cultivation

Observations indicate a substantial difference in vegetable yields between poly-houses (Protected) cultivation and open-field farming. Vegetables grown inside poly-houses produced an average yield of 2,150 kg per acre, which is nearly double that of open-field conditions.

In addition to higher yields, poly-houses cultivation resulted in better fruit quality and larger fruit size. While the total labor input (in man hours) did not vary significantly between the two systems, individual tasks such as land preparation, sowing, weeding, and harvesting required less time under protected cultivation. Notably, crops grown in poly-houses also exhibited extended productivity, with examples like chillies continuing to bear fruit for up to 12 months, compared to the shorter, single-season cycle observed in open-field cultivation. These findings highlight the potential of protected cultivation to improve productivity, efficiency, and crop longevity (Table 3.1).

Table 3.1 Yield difference under protected and open field conditions for chilli and cabbage

PR site	Chilli		Cabbage	
	PA Yield	Open field	PA Yield	Open field
	Kg/ha			
1	1000	3500	9500	3001
2	499	1499	2001	9500
3	800	1499	11999	1000
4	869	299	20000	3001
5	1000	200	11999	600
6	299	499	2001	3001
7	3001	1499	3001	16099
8	1499	299	3001	299
9	1000	1000	10001	1000
10	2001	499	600	3999
Average	**1197**	**1079**	**7410**	**4150**

3.3.2. Drip irrigation

Yield difference between dripted irrigated and manually irrigated vegetable crops are shown in table 3.2. Results show that drip irrigation resulted in higher yield as compared to manually irrigation.

Table 3.2. Yield comparison between drip and manual irrigation

Replication	Cabbage		Cauliflower		Broccoli	
	Drip Irrigation	Manual irrigation	Drip Irrigation	Manual irrigation	Drip Irrigation	Manual irrigation
	(kg/ha)					
1	31297	6402	16421	10779	7282	4925
2	24204	2213	17564	9211	6639	5140
3	18206	3498	24702	5567	7640	3712
Average	**24569**	**4038**	**19562**	**8519**	**7187**	**4593**

3.3.3. Sustainable Land Management (SLM)

Unlike other CSA technologies, SLM, in particular, Agriculture Land Development requires a longer time frame to produce tangible results. In the first and second years of implementation, farmers often leave the land fallow to allow the soil to recover and rebuild its nutrient reserves. Some farmers also grow cover crops such as legumes, mustard, and fodder grasses to enhance soil health and improve soil structure. Commercial and subsistence crops are generally introduced only after the third year, once the soil has undergone adequate nutrient restoration.

A similar trend was observed in a cost-benefit analysis conducted on terrace cultivation in Sikkim, which found that terracing typically has a two-year payback period before it becomes profitable. During the initial years, the costs incurred are higher than the benefits. However, by the third year, the cost-benefit ratio improves to 1:1.56, indicating a return that exceeds the initial investment (MishraandRai, 2011).

As most farmers in ALD sites also leave the land fallow for first one-two years, delaying the return on investment, collecting reliable crop yield data in the early stages of ALD is challenging, making it difficult to conduct an accurate cost-benefit analysis during the initial phase of implementation.

Chapter 4

Prospectus, Challenges and Recommendations for CSA technologies and Conclusion

4.1 Women's perception of CSA technologies

The perception of women farmers toward CSA technologies like protected cultivation (poly-houses), drip irrigation, and Sustainable Land Management has generally been positive as these interventions align with their daily responsibilities. These technologies are increasingly recognized not only as tools for improving productivity but also as enablers of women's empowerment in agriculture as farms in Bhutan are becoming increasingly feminized.

i. **Protected Cultivation (Poly-houses):** Women perceive poly-houses as highly beneficial due to the reduced exposure to harsh weather, improved working conditions, and the ability to manage crops closer to home, which aligns with their dual roles in farming and household responsibilities. The extended cropping cycles and higher quality yields also provide greater income opportunities without increasing their workload.

ii. **Drip Irrigation:** Drip systems are appreciated for reducing the time and physical burden of irrigation, a task often managed by women in smallholder systems. The technology ensures more efficient water use and allows for more flexible time management, enabling women to engage in other productive or leisure activities. It also minimizes weed growth, reducing the labor required for weeding, another typical labor-intensive task performed by women.

iii. **Sustainable Land Management (SLM):** Women recognize the value of ALD practices, such as terracing and bund stabilization, in reducing land degradation and improving accessibility on sloped or fragile lands. These interventions often make farming safer and more manageable, especially for women working alone or with limited equipment. The agricultural land development (ALD) enables the use of small machinery, which otherwise would be unsuitable, resulting the need for manual management. The reduction in soil fertility and land degradation is a mid to long term benefit, providing a sense of security and encouraging investment in agriculture.

Overall, CSA technologies have helped ease women's labor burdens, improve farm productivity, and strengthen their role in decision making around crop planning and resource management. However, for their full potential to be realized, gender-sensitive training, targeted subsidies, and inclusive participatory approaches are essential to ensure women can access, adopt, and benefit equitably from these technologies.

4.2 Participants' responses to the CSA technologies

Farmers' responses to CSA technologies introduced through participatory research and scaling initiatives have been positive and encouraging. Their enthusiasm stems from firsthand experience with the tangible and immediate benefits of technologies such as drip irrigation, protected cultivation, and sustainable land management, including increased yields and improved water efficiency to reduced labor demands and enhanced crop quality.

When these technologies are scaled up, they are typically provided through a cost-sharing arrangement, with the government covering 80% of the cost and farmers contributing 20%, either financially or through in-kind support. Farmers have responded well to this model, often expressing appreciation for the affordability it offers while actively contributing labor and local resources. Many have willingly invested time and effort into activities like land preparation, installation of irrigation systems, and maintenance of poly-houses, reflecting a strong sense of ownership and interest in the technologies.

Their active involvement not only reinforces the relevance of these interventions but also indicates a growing trust in the process and confidence in the outcomes. Overall, farmers' responses suggest that when technologies are introduced in a participatory, supportive, and cost-effective manner, adoption and sustained use are significantly more likely.

4.3 Prospects of scaling up CSA technologies

The promotion of CSA technologies in Bhutan has gained momentum in recent years as part of the government's broader strategy to enhance agricultural resilience, productivity, and sustainability in the face of climate change. Climate Smart Technologies are being actively promoted through policy support, targeted programs, and cost-sharing schemes, with the government typically covering 70-80% of the cost and farmers contributing 20% in cash or kind. The positive responses from farmers in adopting these technologies indicate strong prospects for upscaling CSA technologies across Bhutan. With continued institutional support, capacity building, and market linkages, the country is well-positioned to expand the reach of CSA technologies and build more climate-resilient farming communities.

So, recognizing the need for the agriculture sector to adapt to a changing climate, the government has prioritized the promotion of Climate-Smart Agriculture (CSA) technologies, such as protected cultivation, drip irrigation, and sustainable land management. These technologies are being scaled up across the country, largely through cost-sharing initiatives. Adoption has been significant, with 11,260 acres of land under sustainable land management practices. By the end of the 12th Five-Year Plan, approximately 2,875 acres were equipped with water-efficient dripf irrigation systems. Additionally, around 5,129 greenhouses have been established nationwide to support vegetable cultivation. This widespread adoption indicates strong potential for further upscaling of CSA technologies. The support to promote CSA technologies will continue under the 13th Five Year Plan as well.

4.4 Policy intervention and institutional support

Bhutan has been promoting Climate-Smart Agriculture (CSA) technologies to increase resilience in its agriculture sector, which is vital given the country's vulnerability to climate change. The Royal Government of Bhutan has integrated CSA initiatives into its Five-Year Plans, aiming to ensure that farming practices are sustainable and climate-resilient.

Likewise, international organizations like the Royal Society for Protection of Nature (RSPN) and other international partners collaborate with Bhutanese agencies to provide training, resources for promotion of the technologies and awareness programs. These efforts target smallholder farmers and vulnerable communities, building their capacity to adapt to changing climatic conditions. Pilot projects and community-based initiatives help demonstrate the benefits of CSA practices, including improved yields, water conservation, and reduced pest damage, which are crucial for maintaining food security and rural livelihoods.

Enhanced promotion of research and development in climate resilient practices is critical, particularly for developing crop varieties that can withstand both biotic and abiotic stresses such as drought, heat, pests, and diseases. Given Bhutan's increasingly erratic monsoon patterns and limited crop growing windows, short duration and high yielding crop varieties must be further prioritized and integrated into crop intensification programs. Improving financial access for farmers will empower them to adopt resilient technologies and practices. Capacity building and knowledge dissemination on CSA practices must be scaled up, targeting both extension services and farming communities.

4.5 Issues and challenges of scaling up CSA technologies

In Bhutan, scaling up Climate-Smart Agriculture (CSA) technologies encounters specific challenges due to its geographical, economic, and cultural contexts:

High initial costs and financial constraints: While the Bhutanese government offers cost-sharing initiatives (typically 80% government and 20% farmer contribution), the upfront costs for technologies like greenhouses, drip irrigation, and improved soil management practices remain significant for many smallholder farmers. Many Bhutanese farmers rely on subsistence farming and may find it difficult to meet even the subsidized costs, especially without access to affordable credit.

Limited technical skills and awareness: Bhutan's rural communities often lack sufficient knowledge and training to use CSA technologies effectively. Although organizations like SNV and RSPN provide training, widespread awareness and skill- building are still limited. Lack of technical support in remote areas exacerbates the challenge, as many farmers are unfamiliar with the maintenance and best practices associated with technologies like drip irrigation and protected cultivation

Topographical challenge: Bhutan's mountainous terrain and remote villages present logistical challenges. Reliable access to water sources for irrigation, transportation infrastructure for moving goods, and power supply are limited in many areas, making the deployment of technologies like drip irrigation and greenhouses more challenging. Limited market access also hinders the economic viability of increased production achieved through CSA

Dependence on government and donor support: Scaling of CSA technologies in Bhutan relies heavily on government and donor funding. The Bhutanese government, alongside international partners, provides significant support; however, this dependency means that CSA adoption may wane if funding or policy priorities shift. A lack of long-term, locally driven financing models could make sustainable scaling difficult.

Climate and environmental risks: Bhutan’s farming sector is highly vulnerable to climate variability, including erratic rainfall, seasonal water shortages, and increasing wildlife damage to crops. These environmental factors not only increase the costs and risks associated with CSA technologies but also challenge their effectiveness. For instance, drip irrigation depends on a reliable water supply, which is not always available during dry spells in Bhutan.

Cultural preferences and resistance to change: Traditional agricultural practices are deeply rooted in Bhutanese culture, and some farmers may resist adopting modern CSA technologies. There may be a preference for traditional methods, especially if CSA practices are perceived as more complex or labor-intensive. Cultural acceptance of new techniques is gradual, requiring concerted efforts to demonstrate the long-term benefits of CSA for Bhutanese livelihoods.

Market limitations: The Bhutanese agricultural market is relatively small, with limited export opportunities and low demand for high-value crops domestically. Farmers may not see enough economic benefit from the additional yields or higher quality produce achieved through CSA technologies if market access remains restricted. Enhancing market links and offering incentives for climate-resilient produce would be essential to motivate CSA adoption.

Overall, addressing these challenges in Bhutan would require continued government commitment, expanded training programs, improved infrastructure, and strategies to support long-term adoption and market access.

4.6 Way forward and recommendations for scaling up CSA technologies

To effectively scale up CSA technologies in Bhutan, several strategies and recommendations can be considered, focusing on enhancing access, building local capacity, and ensuring sustainable support systems:

Strengthen financial support and subsidy programs: Increasing financial assistance through enhanced subsidies or low interest agricultural loans can make CSA technologies more accessible to smallholder farmers. Expanding cost-sharing schemes and creating revolving funds specifically for CSA would enable more farmers to adopt these technologies despite the high initial costs.

Expand training and extension services: Providing targeted training and building technical expertise at the grass-root levels is essential. The government and partner organizations should invest more in strengthening agricultural extension services to provide consistent, hands-on guidance. Mobile training units and digital platforms should be utilized to reach remote areas and provide farmers with the knowledge to operate and maintain CSA technologies effectively.

Develop localized and climate-resilient infrastructure: Investment in infrastructure is needed to support CSA, particularly in water management and transportation. Developing small-scale water storage facilities and improving road access to markets would reduce logistical barriers and improve the sustainability of CSA initiatives.

Encourage community-based approaches: Promoting CSA through community-based organizations, such as Water User Associations (UWAs) and Climate Smart Farmers Groups/Cooperatives, can build collective ownership and enhance participation. These groups can serve as platforms for sharing resources, knowledge, and labor, reducing individual farmers' costs and risks associated with adopting new technologies.

Enhance institutional and policy support: Scaling CSA requires consistent government commitment and alignment across policies. Allocation of dedicated annual budget for the promotion of CSA technologies in the farmers' fields will greatly enhance farmers' adaptive capacity. Further, developing a national CSA roadmap with clear targets would further support scaling efforts.

Promote research and development (R&D) in CSA: Investing in R&D to adapt CSA technologies to Bhutan's unique climatic and geographic conditions is crucial. Research to develop technologies suited to mountainous terrain and rain-fed agriculture, ensuring that CSA practices are effective and relevant to Bhutanese farmers has to be enhanced through adequate fund allocation.

Facilitate market access and value-added opportunities: To ensure economic benefits for farmers adopting CSA, improving access to markets and creating value-added chains is vital. Developing local and regional markets for climate resilient crops and offering incentives for sustainable produce can make CSA adoption economically attractive. Government backed marketing cooperatives could also help in aggregating and selling products from CSA farms

4.7 Conclusion

The C-SUCSeS initiative has demonstrated the potential of Climate Smart Agriculture (CSA) technologies in South Asia, particularly in Bhutan, where the adoption of protected cultivation, drip irrigation, and Sustainable Land Management (SLM) practices has resulted in improvements in agricultural productivity, resource efficiency, and resilience to climate variability. These benefits have translated into higher yields, better water management, and sustainable land use, enhancing both economic outcomes and environmental sustainability for Bhutanese farmers.

Looking ahead, it is essential to address key challenges such as funding inadequacy and limited human capacity to support effective scaling of CSA technologies. Sustainable up-scaling will require targeted investments, strategic capacity building, and institutional strengthening to empower local institutions and communities. It is imperative to develop a dedicated financing mechanism, enhancing technical support, and fostering a multi-stakeholder approach to policy and implementation. Collaborative partnerships with governmental, non-governmental, and international organizations will be crucial to mobilize resources and create a conducive environment for widespread CSA adoption.

Scaling up Climate-Smart Agriculture (CSA) technologies in Bhutan will require strengthened institutional frameworks, targeted financial support, and inclusive policy interventions. Addressing structural challenges such as labor shortages, land fragmentation, and high initial investment costs is essential. Overall, integrating CSA practices through participatory approaches can empower rural communities, enhance agricultural productivity, and build a more resilient and sustainable food system in Bhutan.

Glimpses of Participatory Research Activities


Figure 1. Chili cultivation under greenhouse


Figure 2. Broccoli cultivation inside greenhouse


Figure 3. Drip layout in chilli in open field


Figure 4. Laying drip for the PR


Figure 5. Bench terracing in Phuntshopelri


Figure 6. Land reclaimed at Senogasa


Figure 7. Public consultation at Dagana


Figure 8. Field layout for PR at Sarpang

Figure 9. Participants of PR, Sarpang

Figure 10. Creation of awareness on CSA technologies to highlanders

5 Annexures

Annexure I. List of officials for CSA consultation meeting (DoA)

SN	Name of the Farmer/Researcher/ Extensionist/ Policymaker/Others	Designation	Village/Locality
1	Yonten Gyamtsho	Director	DoA HQ
2	Namgay Thinley	Chief, APD	Agriculture Production Division
3	Rinchen Wangmo	National focal point	DoA HQ
4	Passang Wangmo	Offtg. Program Director	ARDC-Wengkhar
5	Ngawang	Program Director	ARDC, Samteling
6	Pema Chophel	Program Director	ARDC, Bajo
7	Kinley Tshering	Research focal officer	ARDC Bajo
8	Kesang Euden	Research focal officer	ARDC, Samtenling

Annexure II: Participants of PR on Protected cultivation (first phase)

SN	Name	Citizenship Identity Number	House No	Village
1	Tshering	11703001848	288	Dekiling
2	Yugal Chandra Rasaily	11303001276	618	Dekiling
3	Migma Lhamo Sherpa	11307002573	780	Dekiling
4	Leki Dawa	11303002638	306	Dolungang
5	Harka Bdr Mahat	11303002525	211	Dolungang
6	Mani Raj Rai	11206002220	664	Dolungang
7	Harka May a Mongar	11303001845	653	Dekiling
8	Pema Lathro	11303001287	859	Jigmeling
9	Pema Dorji Tamang	11303001289	371	Jigmeling
10	Kuenzang Dorji	11701001748	291	Dekiling

Annexure III: Participants of PR on Protected Cultivation

SN	Name of the Farmer	Gender (M/F)	NID number*	Village/ Locality	Support/Input provided	Cropping System (50 m^2 area)
1	Tshering	F	11703001848	Dekiling	Seeds, Water sprinkler, Flexible pipe, Mulching plastic, Register, Sprayer machine, fencing net, green shade net	Mixed
2	Yugal Chandra Rasaily	M	11303001276	Dekiling		
3	Migma Lhamo Sherpa	F	11307002573	Dekiling		
4	Leki Dawa	M	11303002638	Dolungang		
5	Harka Bdr Mahat	M	11303002525	Dolungang		
6	Mani Raj Rai	M	11206002220	Dolungang		
7	Harka Maya Mongar	F	11303001845	Dekiling		
8	Pema Lathro	M	11303001287	Jigmeling		
9	Pema Dorji Tamang	M	11303001289	Jigmeling		
10	Kuenzang Dorji	M	11701001748	Dekiling		
11	Tshering Lhamo	F	11315000211	Dangling	Seeds, Water sprinkler, Flexible pipe, Mulching plastic, Register, Sprayer machine, fencing net, green shade net, Water sintex	
12	Dorji Wangchuk	M	11315000745	Dungmin		
13	Pema Wangchuk	M	11315002450	Thongjazor		
14	Kunzang Choden	F	11315002014	Rijoog		
15	Amber Bdr. Adhikari	M	11315002197	Gaden		
16	Gyem Lhamo	F	11315002547	Dungmin		
17	Phul Maya Moktan	F		Dungmin		
18	Wangchuk	M	10204000482	Linger		
19	Leki Drukgyel	M	11315002305	Tashithang		
20	Kinga	M	11315002342	Tashithang		
21	Sherab Wangmo	F		Gaden		
22	Leki Dema	F	11315000034	Chuborthang		
23	Dhan Maya Sinchuri	F	11109100942	Gaden		
24	Kinley	M	11315001986	Dungmin		
25	Tshering Dorji	M	11315001237	Gaden		
26	Dil Maya Rai	F	11314000052	Tashithang		
27	Yeshi Tshering	M	10904003843	Dangling		
28	Tshechum	F	11315001602	Linger		
29	Duba	M	11315001709	Linger		
30	Guman Singh Tamang	M	11308003103	Rijoog		

SN	Name of the Farmer	Gender (M/F)	NID number*	Village/ Locality	Support/Input provided	Cropping System (50 m^2 area)
31	Sonam Yuden	F		Sangaythang	Seeds, Water sprinkler, Flexible pipe, Mulching plastic, Register, Sprayer	
32	Ruk Maya Chhettri	F		Sangaythang		
33	Chandrika Rai	F	11313000467	Sangaythang		
34	Amita chhettri	F	11808000583	Sangaythang		
35	Jasuta Rai	F	11313000413	Sangaythang		
36	Deo Maya Basnet	F		Sangaythang		
37	Amrita subbha	F	1131300084	Sangaythang		
38	Asha Subba	F	11313001349	Sangaythang		
39	Phool Maya Gurung	F		Sangaythang		
40	Kelzangmo	F		Sangaythang		
41	Karma Chogyal	M	12004003077	Sangaythang		
42	Cheki Dema	F	12007001752	Ziserthang		
43	Khem Bdr Subba	M	11313001360	Yarpheling		
44	Dhan Maya Rai	F	11313000069	Yarpheling		
45	Cheki	F	11608001777	Shariphu		
46	Kumar Subba	M	11313001262	Nyenyul A		
47	Bhakti Prasad Rai	M	11802002643	Nyenyul A		
48	Karna Bdr Mongar	M	11313000282	Nyenyul A		
49	Bhudhiman subba	M	11313000661	Nyenyul A		
50	Tashi Dorji	M	11608003865	Nyenyul B		
51	Dorji Wangchuk	M	11603002780	Sangaythang		
52	Prasad Singh Subba	M	11313000645	Nyenyul B		
53	Leki Wangmo	F	11105002804	Laptshakha		
54	Agam Singh Subba	M	11313000137	Shariphu		

Annexure IV: List of PR participants on Drip irrigation

SN	Name	Gender	Location	Citizenship Identity Number
1	Dorji Tshomo	F	Kidheykhar	10709001400
2	Sangay Pemo	F	Kidheykhar	10709001393
3	Yeshi Tshomo	F	Kidheykhar	10709001345
4	Tshewang choden	F	Kidheykhar	10709001299
5	Phuntsho Wangmo	F	Kidheykhar	10709001289
6	Ngawang Choden	F	Kidheykhar	10709001367
7	Nidup Pemo	F	Kidheykhar	10709001666
8	Wangda la	M	Tongphugang	10606000654
9	Singye Wangmo	F	Tongphugang	10608002967
10	Nima Zangmo	F	Tongphugang	10608001034
11	Sangkamo	F	Tongphugang	10608002796
12	Karmo	F	Tongphugang	10608002136
13	Chungkumo	F	Tsakaling	10716000022
14	Namgyelmo	F	Tsakaling	10716000034
15	Nakimo	F	Tsakaling	10716000037
16	Pema Chezom	F	Tsakaling	10716001865
17	Tshering Mo	F	Tsakaling	10716001893
18	Pema Gyeltshen	M	Tsakaling	10716001873
19	Sonam Gyelmo	F	Tsakaling	10716001877
20	Lungtenmo	F	Tsakaling	10716001842
21	Tshewang Pelden	F	Tsakaling	10716001847
22	Choney Wangmo	F	Tsakaling	10716001909

Annexure V: List of officials for SLM technology awareness

SN	Name of the Farmer/Researcher/Extensionist/ Policymaker/Others	Gender (M/F)	National Identity Number (NID)	Village/Locality
1	Sonam Chophel	M	10606001878	ARDC Bajo
2	Tanka Maya Pulami	F	11805000163	ARDC Bajo
3	Cheku Dorji	M	11505003767	ARDC Bajo
4	Yeshi Zangpo	M	11109002982	ARDC Bajo
5	Kinley Gyeltshen	M	11602001536	ARDC Bajo
6	Sangay Gyeltshen	M	10905000464	ARDC Bajo
7	Jigme Lhamo	F	10907001375	ARDC Bajo
8	Deki Lhamo	F	10704001695	ARDC Bajo
9	Dechen Zangmo	F	10907001189	ARDC Bajo
10	Kinley Tshering	M	11410004833	ARDC Bajo

Annexure VI: List of SLM PR participants

SN	Name	Gender	Age	Village	Contact No.	Citizenship Identity Number
1	Maita Bdr. Subba	Male	62	Salamji	77953411	10311001713
2	Mon Bdr. Rai	Male	36	Salamji	17342195	10311002261
3	Shetu Rai	Male	46	Salamji	17502164	10311002288
4	Kabi Raj Rai	Male	31	Salamji	17375927	10311000075
5	Karna Bdr. Rai	Male	75	Salamji	77437189	10311002416
6	Shamdol Subba	Male	40	Salamji	17740387	10311002329
7	Sancha Maya	Female	52	Salamji	17684195	10311000504
8	Budhiman Subba	Male	65	Salamji	-	10311000810
9	Mangal Singh Rai	Male	53	Salamji	17878627	Case file, tsi-em 021
10	Lakhdam	Male	63	Salamji	-	Case file, tsi-em 021
11	Lal Bdr. Rai	Male	65	Salamji	-	303000075
12	Phul Maya Rai	Female	52	Salamji	-	10311000817
13	Mon Bdr. Subba	Male	72	Salamji	17579226	10311000767
14	Dambar Kumar Subba	Male	32	Salamji	17740262	10311008134
15	Dhan Bdr. Rai	Male	24	Salamji	77831515	10311000799
16	Kritiman Rai	Male	34	Salamji	17734521	Case file, tsi-em 021

Annexure VII: Beneficiaries of SLM, Punakha and Dagana

SN	Name of the Farmer	Gender (M/F)	NID number*	Village/ Locality	Area (ha)	Support/Input provided	Cropping System**
1	Namgay Zam	F	B1004000285	Phuntshopelri	1.2	Hiring of excavator	Rice-fallow
2	Kinley Zangmo	F	11005002381	Sonagasa	0.8	Hiring of excavator	Rice-fallow
3	Indra Wati Gurung	M	11310000811	Yarpeling	0.45	Fueling for excavator	Maize-vegetable
4	Padam Bdr. Gurung	M	11310000810	Yarpeling	1.22	Fueling for excavator	Maize-vegetable
5	Chatur Mon Gurung	M	11310000780	Yarpeling	0.3	Fueling for excavator	Maize-vegetable
6	Santa Maya Gurung	F	10314000376	Yarpeling	0.15	Fueling for excavator	Maize-vegetable
7	Dil Maya Gurung	F	11310000804	Yarpeling	2.72	Fueling for excavator	Maize-vegetable
8	Purna Bdr. Gurung	M	10314000410	Yarpeling	0.15	Fueling for excavator	Maize-vegetable
9	Dolma Tamang	F	11310000094	Damchuna	0.5	Fueling for excavator	Maize-vegetable
10	Tandin Wangchuk	M	10311001495	Tshangka	2	Hiring of excavator	Maize-vegetable

Annexure VIII: Beneficiaries of SLM, Karmaling, Dagana

SN	Name of the Farmer	Gender	Citizenship Identity Number	Village	Area (Ac)	Support/Input provided	Cropping system
1	Sani Raj Limboo	M	11304000360	Semchungthang	2.5	Fuel for hiring of excavator for Bench terracing	Maize, Millet followed by winter chili
2	Leki Phuntsho	M	11304002277	Upper Dorjiphu	0.9		
3	Tolo	M	11304002270	Upper Dorjiphu	0.5		
4	Suk Maya Subba	M	11304000390	App Gazhi	0.3		
5	Bhuda Bir Subba	M	11304002176	Lower Dorjiphu	0.3	Fuel for hiring of excavator wet land consolidation	
6	Mangal Moti Subba	F	11304000837	Semchungthang	0.5		
7	Pema Choden	F	11304000227	Ganglina	0.3	Fuel for hiring of excavator for Bench terracing	
8	Suk Raj Subba	M	11304002178	Lower Dorjiphu	0.5		
9	Shyam Kumar Limboo	M	10312000740	Laptsakha B	1.2		Maize, Millet, Buckwheat followed by winter vegetables
10	Bhuda Maya Limboo	F	11304000628	Laptsakha A	1		
11	Panche Limboo	M	10312000739	Laptsakha A	1		
12	Lal Bdr Limboo	M	10312000741	Laptsakha A	1.5		
13	Harka Dhoj Subba	M	11304000556	Laptsakha B	2.5		
14	Tanka Bdr Limboo	M	11304000497	Laptsakha B	1.5		
15	Shah Bdr Subba	M	11304000599	Laptsakha B	1		
16	Dil Bdr Subba	M	11304000626	Laptsakha B	0.78		
17	Sriman Limboo	M	11304000751	Laptsakha C	0.5		
18	Dil Bdr Gurung	M	11304000768	Laptsakha A	1		
19	Tek Bdr Rai	M	11304000509	Laptsakha A	0.5		
20	Durgaman Rai	M	11304000510	Laptsakha A	0.5		
21	Karna Maya Rai	F	11304000567	Laptsakha A	1		
22	Ramey Subba	M	11304000604	Laptsakha B	3		
23	Leela Maya Subba	F	11304002103	Laptsakha B	0.8		
24	Jash Raj Subba	M	11304000710	Laptsakha A	1.5		
25	Ratna Bdr Subba	M	11304000708	Laptsakha B	1.5		
26	Tek Bdr Subba	M	11304000509	Laptsakha B	3		
27	Tika Maya Gurung	F	11304000779	Laptsakha C	0.25		
28	Santa Kumar Gurung	M	11304000678	Laptsakha A	2		

Annexure IX: Training on CSA technologies, Gasa

SN	Name	Gender	Contact No.	Gewog
1	Damcho Dorji	Male	16288333	Khamoed (Gup)
2	Karma Lhaki	Female	17854753	DAO
3	Pema Wangdi	Male	17721519	Khamoed
4	Sonam	Male	17528275	Agri. Extension, Khamoed
5	Karam Chettri	Male	77398150	Agri. Extension, Khatoed
6	Jigme	Female	17689066	Khamoed
7	Sangay Dem	Female	77328132	Khamoed
8	Damcho Wangchuk	Male	17696828	Khamoed
9	Deki	Female	17808280	Khamoed
10	Nado	Male	17208310	Khamoed
11	Karma	Female	17899129	Khamoed
12	Rinchen	Male	17496441	Khamoed
13	Kinley Pem	Female	17977586	Khamoed
14	Karma Chuki	Female	17784026	Khamoed
15	Dorji Wangmo	Female	17583342	Khamoed
16	Zangmo	Female	17637271	Khamoed
17	Pema Yangden	Female	17942336	Khamoed
18	Dorji Bida	Female	17977076	Khamoed
19	Kencho Pem	Female	17536390	Khamoed
20	Gyemba	Female	17689957	Khamoed
21	Karma	Female	17696821	Khamoed
22	Chechey	Female	17673620	Khamoed
23	Kencho Pem	Female	17637288	Khamoed
24	Tshering Lham	Female	17620665	Khamoed
25	Kinley Pem	Female	17706483	Khamoed

SN	Name	Gender	Contact No.	Gewog
26	Gyem	Female	17519918	Khamoed
27	Dorji	Male	17612536	Khamoed
28	Shacha	Male	17288591	Khamoed
29	Pema	Female	17796071	Khamoed
30	Rinchen Dema	Female	17881865	Khamoed
31	Dema	Female	17309165	Khamoed
32	Gyem Lham	Female	17205794	Khamoed
33	Kencho Lham	Female	17580808	Khamoed
34	Pem	Female	17908884	Khamoed
35	Passang	Male	17417920	Khamoed
36	Kencho Zam	Female	17707640	Khamoed
37	Damcho	Male	17742415	Khamoed
38	Kinley Dorji	Male	17202888	Khamoed
39	Pem	Female	17859553	Khamoed
40	Sangay Wangmo	Female	17839896	Khamoed
41	Dorji Pem	Female	17703672	Khamoed
42	Kencho Zam	Female	17675800	Khamoed
43	Dawa Gyeltshen	Male	-	Khamoed
44	Pem Gyem	Female	17696829	Khamoed
45	Karma Lhamo	Female	17696806	Khamoed
46	Sangchuma	Female	17477613	Khamoed
47	Wangchuk	Male	17724564	Khamoed
48	Damcho Thinley	Male	17405946	Khamoed
49	Choden	Female	17583355	Khamoed
50	Kencho Wangmo	Female	17700379	Khamoed
51	Passang	Male	17695849	Khamoed

Annexure X: List of CSA Training Participants in Patshaling, Tsirang

SN	Name	Citizenship Identity Number	Gewog	Chiwog
1	Aeita Maya Tamang	11802002717	Patshaling	Thakhorling
2	Tshering Tamang	11802001724	Patshaling	Thakhorling
3	Deo Bdr Tamang	11802001539	Patshaling	Thakhorling
4	Kala Maya Gurung	11802000661	Patshaling	Thakhorling
5	Panchi Maya Tamang	10305002730	Patshaling	Thakhorling
6	Bir Bdr Tamang	11802001802	Patshaling	Thakhorling
7	Dhoj Mon Tamang	11802001638	Patshaling	Thakhorling
8	Gopi Maya Gurung	11802001619	Patshaling	Thakhorling
9	Gyelpo Dorji Tamang	11802001563	Patshaling	Thakhorling
10	Lassang Tamang Gyabke	11802001676	Patshaling	Thakhorling
11	Lhamo Sherpa	11802000102	Patshaling	Thakhorling
12	Lhassang Dolma Tamang	11802001511	Patshaling	Thakhorling
13	Mej Raj Tamang	11802001771	Patshaling	Thakhorling
14	Mon Maya Tamang	11802001239	Patshaling	Thakhorling
15	Nima Dolma Tamang	11802001375	Patshaling	Thakhorling
16	Nima Tamang	11802002707	Patshaling	Thakhorling
17	Passang Tamang	11802001844	Patshaling	Thakhorling
18	Prem dorji Tamang	11802001792	Patshaling	Thakhorling
19	Pema Dorji Tamang	11802001686	Patshaling	Thakhorling
20	Tika Rai	11802001810	Patshaling	Thakhorling
21	Ugyen Lhamo Tamang	11802002440	Patshaling	Thakhorling
22	Ran Maya Tamang	11802001640	Patshaling	Thakhorling
23	Buddhi Maya Lama	11802001864	Patshaling	Thakhorling
24	Lhasang Tamang	11802001769	Patshaling	Thakhorling
25	Nar Bdr Tamang	11802001770	Patshaling	Thakhorling
26	Passang Tamang	11802001722	Patshaling	Thakhorling
27	Passang Tamang	11802002832	Patshaling	Thakhorling
28	Tshering Wangdi Sherpa	11802000103	Patshaling	Thakhorling

SN	Name	Citizenship Identity Number	Gewog	Chiwog
29	Sonam Dorji Sherpa	11802000101	Patshaling	Thakhorling
30	Bhadri Maya Tamang	11802001548	Patshaling	Thakhorling
31	Bina Maya Tamang	11802001527	Patshaling	Thakhorling
32	Sher Bdr Tamang	11802001754	Patshaling	Thakhorling
33	Tal Man Tamang	11802001655	Patshaling	Thakhorling
34	Dhan Sighn Tamang	11802001922	Patshaling	Thakhorling
35	Dawa Lhamo Tamang	11802001643	Patshaling	Thakhorling
36	Dil Maya Tamang	11809001336	Patshaling	Thakhorling
37	Pancha Bir Tamang	11802001536	Patshaling	Thakhorling
38	Nima Dolma Tamang	11802002772	Patshaling	Thakhorling
39	Dhan Bdr Sunwar	1180200183	Patshaling	Thakhorling
40	Ganesh Sunwar	11802001778	Patshaling	Thakhorling

Annexure XI: List of CSA Training Participants in Nichula, Dagana

SN	Name	Chiwog	Citizenship Identity Number
1	Bhakta Bdr Chhetri	Gangtokha	11310000505
2	Purna Bdr Khati	Gangtokha	11310000490
3	Birkha Bdr Biswa	Gangtokha	11310000529
4	Bal Bdr Kami	Gangtokha	11310000559
5	Chandra Bdr Biswa	Gangtokha	11310000535
6	Budhi Man Rai	Gangtokha	31310000036
7	Biswajit Rai	Gangtokha	10314000546
8	Bhakta Bdr Mongar	Gangtokha	10314000360
9	Ash Kumar Majhi	Gangtokha	11310000213
10	Bhim Raj Limbu	Gangtokha	10314000230
11	Aita Raj Limbu	Gangtokha	11310000172
12	Jit Bdr Majhi	Gangtokha	11310000214
13	Depak Maya Rai	Gangtokha	11304000570
14	Tanka Bdr Chhetri	Gangtokha	11310000516
15	Barun Kumar Khati	Gangtokha	11310000489
16	Bhim Bdr Majhi	Gangtokha	11310000209
17	Sancha Moti Limbu	Gangtokha	11310000231
18	Kharka Bdr Chhetri	Gangtokha	11310000506
19	Budhi Maya Biswa	Gangtokha	11310000537
20	Baghi Maya Gurung	Gangtokha	11304000147
21	Padma Wati Guragai	Dangribu	11310000282
22	Kumar Karki	Dangribu	11310000361
23	Nandalal Karki	Dangribu	11310000419
24	Purna Bdr Bista	Dangribu	11310000298
25	Rudra Bdr Darjee	Dangribu	11310000369
26	Bir Bdr Darjee	Dangribu	11310000373
27	Pal Man Darjee	Dangribu	11310000368
28	Tul Bdr Bista	Dangribu	11310000296
29	Garja Man Karki	Dangribu	11310000408
30	Pushpa Lal Mainali	Dangribu	11310000335
31	Ratna Bdr Bista	Dangribu	11310000403
32	Bal Bdr Bhattarai	Dangribu	11310000430
33	Madan Singh Subba	Dangribu	11304000906
34	Ram Chandra Mainali	Dangribu	11310000327

SN	Name	Chiwog	Citizenship Identity Number
35	Ran Bdr Chuwan	Dangribu	11310000359
36	Birkha Bdr Bhattarai	Dangribu	11310000350
37	Karna Bdr Powrel	Dangribu	11310000310
38	Ganesh Powrel	Dangribu	11310000316
39	Karna Bdr Karki	Dangribu	11310000362
40	Duk Bdr Katwal	Dangribu	11310000278
41	Ratna Bdr Kafley	Dangribu	11310000392
42	Bal Bdr Basnet	Dangribu	11310000377
43	Dilip Basnet	Dangribu	11310000344
44	Karna Bdr Karki	Dangribu	11310000362
45	Manu Maya Bista	Dangribu	11310000301
46	Kharga Prasad Basnet	Dangribu	11304001671
47	Mon Maya Rizal	Dramzekesa	11310000596
48	Nandalal Adhikari	Dramzekesa	11310000623
49	Khem Prasad Adhikari	Dramzekesa	10314000274
50	Mon Bdr Powrel	Dramzekesa	11310000610
51	Hom Bdr Powrel	Dramzekesa	11310000699
52	Narapati Adhikari	Dramzekesa	10314000337
53	Tara Prasad Adhikari	Dramzekesa	11310000622
54	Tulsi Ram Dhakal	Dramzekesa	11310000670
55	Lekh Nath Subedi	Dramzekesa	11310000681
56	San Man Gurung	Dramzekesa	11310000654
57	Devi Charan Rizal	Dramzekesa	11310000588
58	Ratna Bdr Powrel	Dramzekesa	11310000709
60	Dug Bdr Bista	Damchuna	10314000350
61	Dilli Bdr Bista	Damchuna	10314000345
62	Bal Bdr Bista	Damchuna	11310000072
63	Eva Raj Mishra	Damchuna	11310000024
64	Jagat Bdr Gurung	Damchuna	10314000381
65	Som Nath Khatiwara	Damchuna	11310000032
66	Dhan Maya Gurung	Damchuna	10314000362
67	Dolma Tamang	Damchuna	11310000094
68	Brihaspati Adhikari	Damchuna	11310000052
69	Khina Maya Bhandari	Damchuna	11310000135
70	Ganga Ram Dulal	Damchuna	10314000343

SN	Name	Chiwog	Citizenship Identity Number
71	Santa Kumar Subba	Damchuna	11304001313
72	Nar Bir Gurung	Damchuna	10314000353
73	Oma Nath Bhattarai	Damchuna	11310000047
74	Dal Bdr Bista	Damchuna	11310000011
75	Janga Bdr Gurung	Damchuna	10314000426
76	Yen Bdr Gurung	Damchuna	10314000382
77	Jagat Bdr Gurung	Damchuna	11310000108
78	Pushpa Lal Dulal	Damchuna	10314000271
79	Purna Bdr Gurung	Damchuna	10314000410
80	Padam Bdr Gurung	Yarpheling	11310000810
81	Nar Bdr Gurung	Yarpheling	11310000823
82	Padam Bdr Gurung	Yarpheling	11310000824
83	Dim Maya Gurung	Yarpheling	11310000747
84	Kabi Raj Gurung	Yarpheling	11310000792
85	Tara Man Gurung	Yarpheling	11310000771
86	Hari Maya Rai	Yarpheling	11802001027
87	Kharga Singh Gurung	Yarpheling	11310000779
88	Mon Bdr Gurung	Yarpheling	11310000095
89	Badri Kedar Kafley	Yarpheling	11310000686
90	Chhatra Bdr Gurung	Yarpheling	11310000770
91	Ganga Bir Gurung	Yarpheling	11310000793
92	Purna Maya Gurung	Yarpheling	11310000833

Annexure XII: Hands on training on climate smart agriculture practices in Drepong, Mongar

SN	Name	Gender	Village	Gewog	Citizenship Identity Number	House No.
1	Sangay Rinchen	M	Tsangkhar	Drepong	10704001186	Ja-5-203
2	Sangay Dorji	M	Tsangkhar	Drepong	10704000014	JA-5-214
3	Choden	F	Tsangkhar	Drepong	10704001179	Ja-5-200
4	Choki Dema	F	Tsangkhar	Drepong	10704001187	Ja-5-201
5	Rinchen Zangmo	F	Tsangkhar	Drepong	10704001253	Ja-5-209
6	Seldon	F	Tsangkhar	Drepong	10704001266	Ja-5-211
7	Neten Zangmo	F	Tsangkhar	Drepong	10704001247	Ja-5-208
8	Chimi Dorji	M	Tsangkhar	Drepong	10704000703	Ja-5-207
9	Sangay Dema	F	Drepong	Drepong	10704000125	Ja-5-02
10	Sonam Zangmo	F	Drepong	Drepong	10704000304	Ja-5-28
11	Tshewang Choden	F	Drepong	Drepong	10704000311	Ja-5-29
12	Kezang	F	Drepong	Drepong	10704000330	Ja-5-33
13	Kinzang	F	Drepong	Drepong	10704000356	Ja-5-222
14	Sangay Dema	F	Drepong	Drepong	10704000328	Ja-5-256
15	Nima	M	Drepong	Drepong	10704000234	Ja-5-20
16	Dorji Wangchuk	M	Drepong	Drepong	10704000174	Ja-5-10
17	Singay	M	Drepong	Drepong	10704000249	Ja-5-nil 18
18	Dorji	M	Drepong	Drepong	10704000493	Ja-5-48
19	Phunsho Wangdi	M	Drepong	Drepong	10704000576	Ja-5-61
20	Ugyen Pelden	F	Drepong	Drepong	10704000162	Ja-5-236
21	Tshewang Dema	F	Drepong	Drepong	10704000179	Ja-5-11
22	Sangay Dema	F	Drepong	Drepong	10704000201	Ja-5-14
23	Chundu Tshering	M	Drepong	Drepong	10704000332	Ja-5-31
24	Sonam Wangdi	M	Drepong	Drepong	10704000257	Ja-5-47
25	Ugyen Wangchuk	M	Drepong	Drepong	10704000547	Ja-5-56
26	Jamtsho	M	Drepong	Drepong	10704000242	Ja-5-21
27	Jigme Choden	F	Drepong	Drepong	10704000269	Ja-5-24
28	Sonam Phuntsho	M	Drepong	Drepong	10704000454	Ja-5-234
29	Dechen Wangmo	F	Drepong	Drepong	10704000246	Ja-5-21
30	Sonam Lhaden	F	Drepong	Drepong	10704000126	Ja-5-254
31	Rinchen	F	Drepong	Drepong	10704000190	Ja-5-13
32	Chimi Zangmo	F	Drepong	Drepong	10704000271	Ja-5-nil-24
33	Choezum	F	Drepong	Drepong	10704000335	Ja-5-34
34	Pema Lhaden	F	Drepong	Drepong	10704000353	Ja-5-35
35	Chadu	M	Drepong	Drepong	10704000244	JA-5-24
36	Sangay Wangdi	M	Agri extension	Drepong	10709004728	-
37	Ugyen Wangchuk	M	Gewog driver	Drepong	10709004051	-
38	Sonam Zangmo	F	Mangmi	Drepong	10704001197	-
39	Tshering Yangden	F	GAO	Drepong	10209000683	-
40	Kuenzang Choden	F	ARDC Wengkhar	Mongar	11512005540	-

SN	Name	Gender	Village	Gewog	Citizenship Identity Number	House No.
41	Pema Yangden	F	ARDC Wengkhar	Mongar	10711001425	-
42	Tshering Yangchen	F	Drepong	Drepong	10704000247	Ja-5-21
43	Dorji Wangmo	F	ARDC Wengkhar	Mongar	10709000194	-
44	Namgay	M	ARDC Wengkhar	Mongar	10709002281	-
45	Yeshi Lhadon	M	ARDC Wengkhar	Mongar	10101003806	-

SAARC

SAARC Agriculture Centre (SAC)
BARC Complex, Farmgate, Dhaka-1215, Bangladesh
Website: www.sac.org.bd