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Report 2025

CLIMATE RESILIENT RURAL DEVELOPMENT

in the Asia-Pacific Region

Challenges and the Way Forward

Centre on Integrated
Rural Development for
Asia and the Pacific

CIRDAP

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in the Asia-Pacific Region

CHALLENGES AND THE WAY FORWARD

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Centre on Integrated Rural Development for Asia and the Pacific

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Climate Resilient Rural Development in the Asia-Pacific Region: Challenges and the Way Forward

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Preface

The Centre on Integrated Rural Development for Asia and the Pacific (CIRDAP) is an intergovernmental organization mandated to promote Integrated Rural Development (IRD) in the Asia-Pacific through regional cooperation. CIRDAP has 15 member countries: Afghanistan, Bangladesh (Host State), Fiji, India, Indonesia, Iran, Lao PDR, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand, and Vietnam.

The Centre's goal is to meet the felt needs of developing states and act as a servicing institution for promoting integrated Rural Development (IRD) in the region. CIRDAP promotes regional cooperation through designated contact ministries and member-state link institutions. It plays a supplementary and reinforcing role in supporting and furthering the effectiveness of IRD programmes in Asia and the Pacific region.

Capturing emerging challenges in rural development, CIRDAP undertakes research to identify gaps in rural development policies, practices, and challenges amongst member countries. The Rural Development Report 2025, 'Climate Resilient Rural Development for Asia-Pacific Region: Challenges and Way forward', (CIRDAP Biannual report), of the CIRDAP Study Series No. 226, deals with the climate resilience and actions that lead to sustainable development of the region providing the current status and the future perspectives in connection with rural livelihood in Asia and the Pacific. The Centre prepares this publication as part of its efforts to share knowledge and experience, promote regional cooperation and support the effectiveness of the IRD programmes in the Asia-Pacific region.

Acknowledgements

The preparation of this detailed report was made possible with the support and valuable inputs and contributions from a large number of individuals and institutions.

The preparation and completion of the report would not have been possible without the active support, suggestions, and input from members of the CIRDAP Technical Committee and CIRDAP-linked institutes. We sincerely acknowledge the organizations and individuals whose articles, analyses, and photographs were used or consulted in the preparation of this report. We extend our sincere gratitude to some of the key IRD experts from CIRDAP, who have reviewed the report and guided the editorial team in scrutinizing the technical aspects and structure of the report.

This report was prepared extensively using information and reports from numerous international, regional, and national organizations and research institutions. The preliminary groundwork for the report was conducted with valuable suggestions from Dr. P. Chandra Shekara, DG, CIRDAP, and later the report was prepared by Dr. Sreekanth Attaluri, a former senior professional at the SAARC Agriculture Centre. Dr. Muhammad Israr, IRD Expert & Secretary, Agriculture, livestock, fisheries, and Cooperative Department, Government of Khyber Pakhtunkhwa, Pakistan, constructively reviewed the first draft report. The second draft report was shared with the Technical Committee members of CIRDAP, of which Sri Lanka, Bangladesh, Iran, Philippines, India, and Pakistan provided valuable suggestions to enrich the report, and Myanmar endorsed the report. The second review of the draft RDR 2025 was conducted by Dr. Sreenath Dixit, Principal Scientist and Strategic Advisor at the Office of the Director General, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, Telangana, India.

Ms. Hurain Jannat, Communication Officer of CIRDAP, effectively coordinated the overall report-making process.

Foreword

The Asia-Pacific region, home to over 60% of the world's population, stands on the frontlines of the climate crisis. From devastating floods in Pakistan to existential threats faced by Pacific Island nations, rural communities endure disproportionate impacts.

Rising temperatures, erratic monsoons, and intensifying cyclones destabilize agriculture, the lifeline for millions, while sea-level rise and glacial melt jeopardize water and food security. These challenges demand urgent, coordinated action. Climate-Resilient Rural Development (CRRD) is not merely an environmental imperative but a socioeconomic necessity. Rural areas, where infrastructure gaps and governance constraints compound vulnerability, require transformative strategies to adapt and thrive. This document highlights the importance of integrating resilience into the core of rural development, providing a roadmap for policymakers, practitioners, and communities.

The challenges are stark: agriculture's sensitivity to climate shocks, limited access to technology, financial barriers, and entrenched social inequities. Yet, solutions exist. Climate-smart agriculture, strengthened infrastructure, and inclusive policies can empower communities. Innovations like drought-resistant crops, decentralized renewable energy, and digital platforms for climate information bridge the gap between vulnerability and resilience. The private sector's role in scaling technologies and the power of grassroots knowledge further enrich this mosaic of strategies.

Case studies from CMCs, Bangladesh's floating gardens, India's watershed management, and Nepal's climate-smart villages, demonstrate that

resilience is achievable. These successes hinge on collaboration. Governments must prioritize policy coherence and funding; international organizations should amplify technical and financial support; and local communities must lead with indigenous wisdom.

This document is a call to action. As the region's warming outpaces the global average, delaying CRRD risks irreversible ecological and human costs. CIRDAP's role in fostering regional cooperation, promoting a long-term vision, and ensuring robust monitoring is pivotal. By uniting stakeholders, leveraging innovation, and centring equity, we can transform rural landscapes into bastions of resilience.

The time to act is now. Let this report guide us toward a future where rural communities survive and thrive amid climate uncertainties.

Dhaka,
September 2025

Dr. P. Chandra Shekara
Director General, CIRDAP

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Abbreviations and Acronyms

ADB	:	Asian Development Bank
ASEAN	:	Association of Southeast Asian Nations
CGIAR	:	Consultative Group for International Agricultural Research
CIRDAP	:	Centre on Integrated Rural Development for Asia and the Pacific
CMC	:	CMCs
CRRD	:	Climate Resilient Rural Development
CSA	:	Climate-Smart Agriculture
CSV	:	Climate-Smart Villages
DoA	:	Department of Agriculture
EU	:	European Commission
FAO	:	Food and Agriculture Organization
GCF	:	Green Climate Fund
GEF	:	Global Environment Facility
GFW	:	Global Forest Watch
GHG	:	Greenhouse Gases
ICCASA	:	Inclusive Climate Change Adaptation for a Sustainable Africa
ICAR	:	Indian Council of Agricultural Research
ICIMOD	:	International Centre for Integrated Mountain Development
IEA	:	International Energy Agency
IFC	:	International Finance Corporation
IFAD	:	International Fund for Agricultural Development
IMF	:	International Monetary Fund
IOM	:	International Organization for Migration
IRENA	:	International Renewable Energy Agency
IRRI	:	International Rice Research Institute
IPCC	:	Intergovernmental Panel on Climate Change
KAS	:	Khmer Agriculture Site
MoAFW	:	Ministry of Agriculture and Farmers Welfare, India
NDC	:	Nationally Determined Contributions
SAAMBAT	:	Sustainable Assets for Agriculture Markets, Business and Trade
SEI	:	Stockholm Environment Institute Africa
SHGs	:	Self-Help Groups
SPCR	:	Strategic Program for Climate Resilience
SSRI	:	Strengthening the Resilience of Small Scale Rural Infrastructure
UN	:	United Nations
UNDP	:	United Nations Development Programme
UNESCAP	:	United Nations Economic and Social Commission for Asia and the Pacific
UNESCO	:	United Nations Educational, Scientific, and Cultural Organization
UNEP	:	United Nations Environment Programme
UNFCCC	:	United Nations Framework Convention on Climate Change
UNFCCC	:	United Nations Framework Convention on Climate Change
UNDRR	:	United Nations Office for Disaster Risk Reduction
USAID	:	United States Agency for International Development
WHO	:	World Health Organization
WMO	:	World Meteorological Organization

EXECUTIVE SUMMARY

The Asia-Pacific region, encompassing diverse economies and ecosystems, is among the most vulnerable to climate change, with rural communities facing significant risks to their livelihoods, food security, and economic stability. The Centre on Integrated Rural Development for Asia and the Pacific (CIRDAP), a regional organization established in 1979, plays a critical role in promoting climate-resilient rural development across its 15 member countries: Afghanistan, Bangladesh, Fiji, India, Indonesia, Iran, Lao PDR, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand, and Vietnam. This executive summary outlines the challenges, key approaches, stakeholder roles, case studies, and strategic pathways forward for fostering climate-resilient rural development in the region, drawing on insights from various sources, including the World Bank, Asian Development Bank (ADB), and International Fund for Agricultural Development (IFAD).

Rural communities in CMCs face multifaceted challenges due to climate change. Agriculture, a cornerstone of rural economies, is highly vulnerable to climate variability, with projections indicating a decline in crop productivity of 15-20% by 2050 under a business-as-usual scenario. Smallholder farmers, particularly in countries like Bangladesh, India, and Nepal, are at risk due to their reliance on rain-fed agriculture and limited access to climate-smart technologies. For example, only 44% of rural populations in Vietnam have access to centralized water supply systems, underscoring the critical need for improved water security. Limited infrastructure, including inadequate irrigation systems and poor rural road networks, restricts access to markets and essential services, thereby exacerbating vulnerability. Governance and policy gaps further complicate efforts, as many countries struggle to integrate climate resilience into rural development frameworks, often due to insufficient data and institutional capacity. Financial constraints pose a significant barrier, with a notable financing gap for climate adaptation requiring innovative solutions to catalyze public and private investment. Social and cultural barriers, including resistance to change and traditional practices not aligned with climate resilience, also hinder progress, necessitating targeted awareness and education efforts.

To address these challenges, several evidence-based approaches have been identified and implemented across the region. Climate-Smart Agriculture (CSA) is a cornerstone strategy that promotes practices that enhance productivity, build resilience, and reduce greenhouse gas emissions. For instance, the World Bank's Sustainable Agriculture Transformation Project in Vietnam and the Climate-Resilient and Low-Carbon Agriculture Development Project in Indonesia have scaled CSA techniques, benefiting millions of smallholder farmers, including 30% of women-led producers. Strengthening rural infrastructure, including irrigation, flood protection, and rural roads, is crucial for climate adaptation. As of 2021, ADB's investments, including $2 billion in irrigation and $477 million in rural flood protection, exemplify this approach. The role of start-up ecosystems and digital platforms is increasingly recognized, with IFAD's ASPIRE project in Cambodia establishing business clusters and an online platform to connect farmers with markets, enhancing resilience against climate and other shocks. Capacity building and knowledge sharing are vital, with CIRDAP organizing webinars and training programs on topics like resilient aquaculture and agricultural economics. Inclusive and gender-responsive policies ensure that marginalized groups, particularly women, benefit from climate-resilient initiatives. Financial mechanisms, such as carbon pricing and public-private partnerships, are crucial for bridging the funding gap, as highlighted by the World Bank and the ADB. Simulation modeling, although less explicitly documented, supports planning by predicting the impacts of climate change. Meanwhile,

agro- and eco-tourism offer alternative livelihoods and promote conservation, as seen in initiatives that emphasize investments in natural capital.

Stakeholder collaboration is fundamental to the success of climate-resilient rural development. Governments in CMCs establish policies, allocate resources, and implement programs, often in partnership with international organizations such as the World Bank, ADB, IFAD, and the United Nations. These organizations provide technical assistance, funding, and knowledge sharing, with ADB committing $100 billion in climate financing from 2019 to 2030. The private sector contributes through investments in climate-resilient technologies and services, such as innovative financing instruments and digital platforms. Local communities and farmers are the primary implementers, leveraging their local knowledge to adopt and adapt resilient practices. Collaborative platforms, such as ADB's Asia-Pacific Rural Development and Food Security Forum 2022, facilitate knowledge exchange and partnership building, ensuring that diverse stakeholders align their efforts toward common goals.

Case studies from CMCs illustrate the potential of integrated approaches. In Bangladesh, the ADB-supported Climate-Resilient Livelihood Improvement and Watershed Management Project in the Chittagong Hill Tracts is enhancing livelihoods through small-scale community infrastructure, watershed protection, agricultural improvements, nonfarm skill development, and better road connectivity. In India, climate-resilient agriculture practices, supported by geospatial and AI tools, are addressing water scarcity and ensuring food security. Similar initiatives in Nepal and Thailand have demonstrated success in community-based adaptation, combining structural interventions, such as infrastructure development, with non-structural measures, including capacity building and policy reforms.

The way forward for climate-resilient rural development in the Asia-Pacific region hinges on regional collaboration, long-term policy vision, and robust monitoring and evaluation. CIRDAP, with its mandate to promote integrated rural development, is well-positioned to facilitate knowledge exchange, capacity building, and regional cooperation through initiatives like its webinar series and training programs. A long-term policy vision that integrates climate resilience into national and regional development plans is essential, ensuring that climate risks are systematically addressed across sectors. Robust monitoring and evaluation frameworks are crucial for assessing the effectiveness of climate-resilient strategies and facilitating adaptive management in response to changing climate conditions. Innovative financing mechanisms, such as climate funds and public-private partnerships, must be scaled up to meet the growing demand for adaptation investments, as emphasized by the World Bank's call for innovative climate finance.

In conclusion, climate-resilient rural development in the Asia-Pacific region is both a necessity and an opportunity to build a sustainable and inclusive future. By addressing the multifaceted challenges, adopting evidence-based approaches, fostering stakeholder collaboration, and learning from successful case studies, the region can transform its rural landscapes to withstand climate impacts. Governments, international organizations, the private sector, and local communities must unite in a collective commitment to prioritize and invest in climate-resilient rural development, ensuring that no one is left behind in the face of a changing climate. The urgency of this task cannot be overstated, and the time to act is now.

INTRODUCTION

1. INTRODUCTION

1.1 Brief Overview of Climate Change in the Asia-Pacific Region:

The Asia-Pacific region is highly vulnerable to climate change, with impacts such as more frequent natural disasters, sea-level rise, floods, droughts, and changing weather patterns. Rural areas, particularly those reliant on agriculture, are disproportionately and non-identically affected. The Asia-Pacific region, home to over 60% of the world's population, is among the most vulnerable to climate change due to its diverse geography, dense coastal populations, and socioeconomic disparities [IPCC, 2022a]. Climate change is an emerging threat that affects all countries to varying degrees. The recently released IPCC Assessment Report identified agriculture as one of the critical sectors both susceptible to climate change and contributing to it through Greenhouse Gas (GHG) emissions. Countries in the Asia-Pacific region are investing significant resources to strengthen agriculture on various fronts. These investments focus on the research and development of new varieties and agro-technologies to adapt agriculture to emerging climatic threats and, simultaneously, mitigate GHG emissions from the agricultural and allied sectors. These initiatives are in their early stages, and there is a need to assess the current status of countries' vulnerability to climate change and the measures taken to address it, so that regional bodies can step forward to assist with climate change risks. Stretching from small Pacific Island nations to densely populated South and East Asian countries, the region faces escalating climate risks that threaten ecosystems, livelihoods, and stability.

The region is warming at a rate faster than the global average, and heat waves are intensifying, particularly in South Asia. India and Pakistan, for example, have recently recorded temperatures exceeding 50°C (122°F) [WMO, 2023]. It is estimated that the region could lose between 10% to 50% of crop production by the end of the century due to global warming (Gurung et al, 2017). While South Asia is the fastest-growing region in the world, it continues to face numerous challenges in meeting the growing food demands of its increasing population amid socio-economic changes. The region is also challenged by population density, rapidly degrading natural resources due to overexploitation, mismanagement, and climate change impacts. Low-lying coastal zones and Pacific Island nations, such as Kiribati and Tuvalu, face existential threats, with forecasts suggesting that some islands may become uninhabitable by 2050. Cyclones, typhoons, and floods are increasing in frequency and intensity. The 2022 floods in Pakistan submerged a third of the country [World Bank, 2022], while Super Typhoon Haiyan in 2013 devastated the Philippines [FAO, 2014].

Himalayan glacial melt threatens major rivers, such as the Ganges and Mekong, which are vital for agriculture and drinking water [ICIMOD, 2020]. Regarding agriculture and food security, erratic rainfall and droughts disrupt crop yields, risking hunger for millions, particularly in regions that rely heavily on subsistence farming. Coral reefs, including Australia's Great Barrier Reef, suffer from bleaching due to warming oceans [Great Barrier Reef Marine Park Authority, 2022], while deforestation in Indonesia exacerbates carbon emissions [Global Forest Watch, 2023]. Heat-related illnesses, dengue fever, and air pollution crises in cities the rising health vulnerabilities [WHO, 2022].

The Centre on Integrated Rural Development for Asia and the Pacific (CIRDAP) Member Countries (CMCs), primarily located in South and Southeast Asia, face significant challenges in attaining climate-resilient rural development that aligns with the Sustainable Development Goals (SDGs). These challenges stem from the impacts of climate change, socio-economic vulnerabilities, and institutional constraints. Most of the key problems and their corresponding solutions in the CMCs in this report were focused on SDGs 1 (No Poverty), 2 (Zero Hunger), 13 (Climate Action), and 15 (Life on Land).

Climate change amplifies inequality, displacing vulnerable communities and straining urban infrastructure. Coastal megacities, such as Manila and Mumbai, face flooding and saltwater intrusion, while rural populations struggle with resource scarcity. Pacific Islanders and indigenous groups often endure disproportionate impacts despite minimal contributions to global emissions [UNDP, 2020]. Countries are adopting renewable energy (China and India lead in solar/wind expansion) and early warning systems [UNDRR, 2022]. Regional cooperation, such as the ASEAN Agreement on Disaster Management [ASEAN, 2020], and international climate finance initiatives aim to bolster resilience. However, challenges persist, including coal dependency in nations such as China and India [IEA, 2022] and limited adaptation resources for poorer countries [World Bank, 2023].

Achieving climate-resilient rural development in CMCs requires addressing interconnected challenges through integrated solutions aligned with the SDGs. By focusing on sustainable agriculture, infrastructure development, policy integration, and ecosystem restoration, these countries can build resilience, reduce poverty, and ensure sustainable livelihoods. Collaboration among governments, regional organizations, and communities is crucial to overcoming financial and capacity constraints and achieving the 2030 Agenda.

Urgent, coordinated action is critical to mitigate emissions and enhance adaptive capacity. The region's future hinges on equitable climate finance, technology transfer, and inclusive policies to safeguard its people and ecosystems. Without swift intervention, the Asia-Pacific risks irreversible ecological and human tolls.

1.2 Importance of Climate-Resilient Rural Development

Rural development is integral to the broader socio-economic well-being of the region. Resilience means the ability of rural communities to adapt and thrive in the face of climate-related challenges. The Asia-Pacific region, home to over 60% of the world's population, faces acute vulnerabilities to climate change, particularly in its rural areas [IPCC, 2022b]. Climate-resilient rural development (CRRD) is crucial for safeguarding livelihoods, ecosystems, and economies.

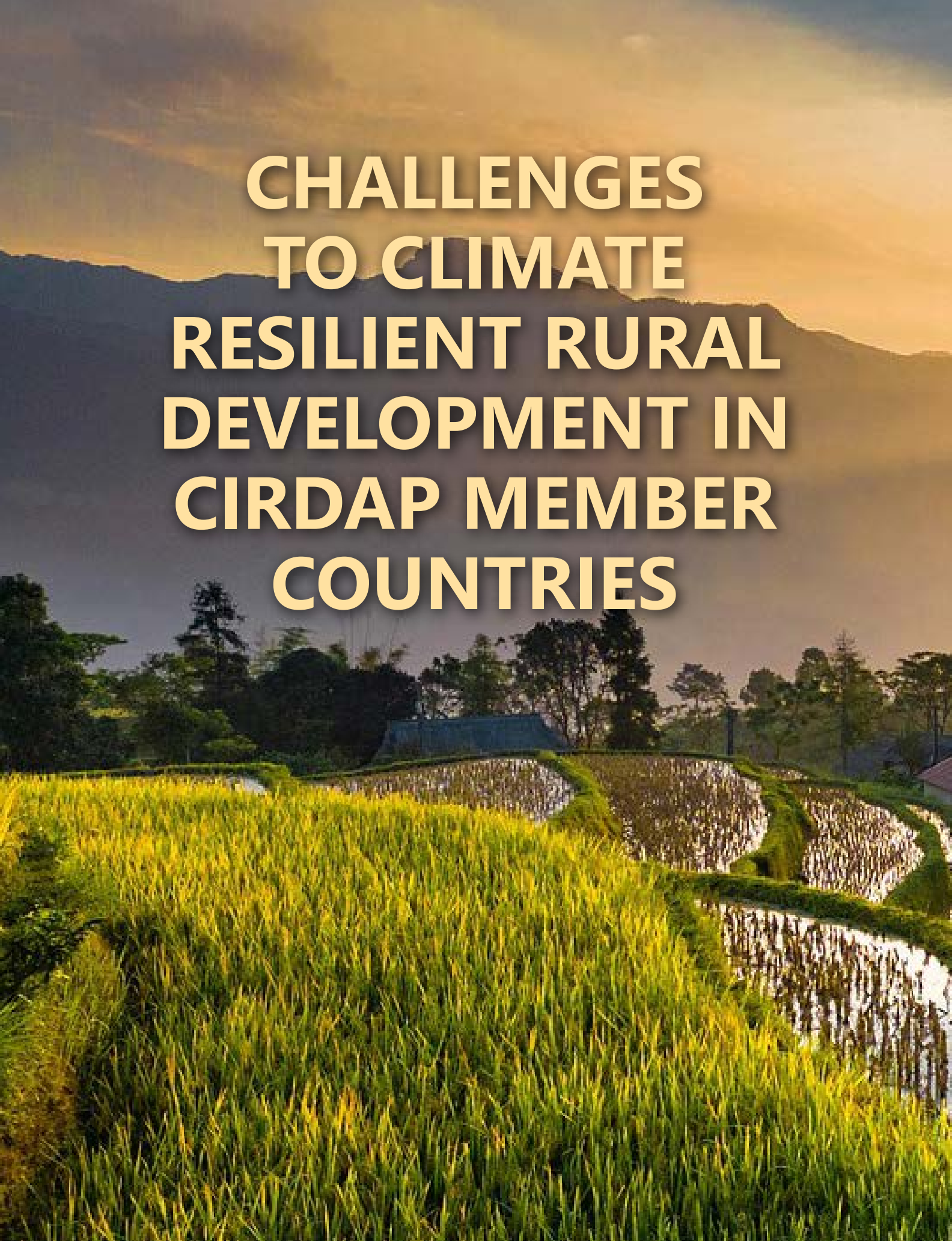
Climate-resilient rural development is not merely an environmental imperative but a socioeconomic necessity for the Asia-Pacific. By integrating adaptive infrastructure, equitable policies, and community-led innovation, CRRD ensures that rural populations thrive in the face of climate uncertainties, thereby securing the region's sustainable future [UNESCAP, 2023].

Table 1: Detailed analysis of CRRD's importance, contextualized for the Asia-Pacific region

Factors	Description	CRRD importance	Source
High Vulnerability to Climate Hazards	Due to its geography, the Asia-Pacific region is disproportionately affected by climate disasters. Rural areas, where infrastructure is often weak, are exposed to cyclones (e.g., Philippines, Bangladesh), floods (Mekong Delta), droughts (India, Pakistan), and sea-level rise (Pacific Islands like Kiribati)	CRRD mitigates risks through adaptive infrastructure (e.g., flood-resistant housing, storm shelters) and early warning systems, reducing disaster-related losses.	UNEP, 2021

Factors	Description	CRRD importance	Source
Economic Dependence on Climate-Sensitive Sectors	Agriculture, fisheries, and forestry employ over 50% of the rural workforce. Climate disruptions, including erratic monsoons, coral bleaching, and pest outbreaks, pose significant threats to these sectors. For instance, salinity intrusion in Vietnam's Mekong Delta has reduced rice yields.	CRRD promotes climate-smart agriculture (drought-resistant crops, agroforestry) and diversified livelihoods (eco-tourism), enhancing economic stability	World Bank, 2022 and ADB, 2021
Food Security and Nutrition	The region accounts for nearly 90% of global rice production. Climate-induced crop failures jeopardize food access for millions of people.	CRRD ensures sustainable food systems via water-efficient irrigation, soil conservation, and resilient seed varieties. For example, Bangladesh's floating farms adapt to flooding, securing nutrition for vulnerable communities.	UNDP, 2020
Poverty Alleviation and Social Equity	Rural poverty is deeply entrenched in regions such as South Asia and Melanesia. Climate shocks (e.g., Cyclone Amphan in 2020) erase hard-earned gains, pushing households into debt.	CRRD integrates social protection (climate risk insurance, cash transfers) and asset-building (e.g., livestock diversification), reducing inequality and protecting marginalized groups, including women/ indigenous communities	
Mitigating Displacement and Conflict	Climate-driven migration from rural to urban areas strains cities (e.g., Dhaka, Jakarta)	CRRD reduces displacement by improving rural viability. In Nepal, community-based adaptation programs have curbed out-migration by reviving local economies. Stability in rural areas also prevents resource-based conflicts, such as water disputes in transboundary river basins.	IOM, 2023
Health Resilience	Rural populations face climate-linked health risks, including waterborne diseases following floods, heat stress, and vector-borne illnesses (e.g., dengue in Indonesia).	CRRD enhances healthcare access and sanitation systems while promoting climate-aware public health strategies, including the design of malaria-resistant housing.	WHO, 2023

Factors	Description	CRRD importance	Source
Advancing Sustainable Development Goals (SDGs)	National Rural Schemes aligned to the SDGs, such as India's National Rural Employment Guarantee Scheme, incorporate watershed management, aligning livelihood creation with ecological restoration.	CRRD directly supports SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 13 (Climate Action), and SDG 15 (Life on Land)	Ministry of Rural Development, India, 2022, and UN, 2023
Ecosystem and Biodiversity Conservation	Rural areas overlap with biodiversity hotspots (e.g., Sundarbans mangroves, Borneo rainforests)	CRRD protects ecosystems through community-led reforestation and sustainable fishing, and mangrove restoration in Thailand buffers coastal villages from storms while preserving marine habitats.	Global Forest Watch, 2023
Renewable Energy Access	Over 400 million people in the region lack electricity.	CRRD prioritizes decentralized renewables (solar microgrids, biogas) to reduce reliance on fossil fuels and enhance energy security. Bhutan's rural hydropower projects exemplify climate-resilient energy solutions.	IEA, 2023 and ADB, 2021
Indigenous Knowledge and Innovation	Traditional practices, such as Fiji's qoliqoli (community-based fisheries) or the Philippines' rice terraces, offer time-tested resilience strategies.	CRRD bridges indigenous wisdom with modern technology, ensuring culturally appropriate solutions.	FAO 2023 and UNDP 2020
Regional Cooperation	Tans-boundary challenges (e.g., glacial melt affecting Himalayan rivers) necessitate collaboration.	Initiatives like the ASEAN Agreement on Disaster Management foster shared strategies, enhancing collective resilience.	ASEAN, 2020
Gender Considerations	Women, often primary caregivers and agricultural workers, face disproportionate climate impacts.	CRRD must empower women through land rights, education, and leadership roles in decision-making.	UN Women, 2021



CHALLENGES TO CLIMATE RESILIENT RURAL DEVELOPMENT IN CIRDAP MEMBER COUNTRIES

2. Challenges to Climate Resilient Rural Development in CIRDAP Member Countries

2.1 Vulnerability of Agriculture and Livelihoods

The vulnerability of agriculture and livelihoods in the Member Countries of the Centre on Integrated Rural Development for Asia and the Pacific (CIRDAP) poses a significant threat to achieving climate-resilient rural development. CIRDAP includes 15 member countries: Afghanistan, Bangladesh, Fiji, India, Indonesia, Iran, Laos, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand, and Vietnam [CIRDAP, 2023].]. In many Asian countries, agriculture is still practiced using traditional methods that do not incorporate climate data or modern techniques. This reliance leads to several challenges, such as reduced productivity and crop diversity, increased vulnerability to weather fluctuations, and hindrance in establishing resilient value chains. For example, in Iran's rural sector, challenges such as centralized planning, patriarchal norms, inefficient extension systems, and weak inter-agency coordination are uniquely defining features (CIRDAP, 2025). However, evidence shows these challenges are widespread across the region:

- **Centralized Governance:** Countries such as Bangladesh, Myanmar, Laos, and Vietnam also experience centralized governance, with decentralization reforms being initiated only recently (World Bank, 2023; FAO, 2022).

- **Patriarchal Norms and Gender Disparities:** These social dynamics affect land rights, leadership, and livelihoods across South and Southeast Asia (FAO, 2022; UNDP, 2024).

- **Extension System Inefficiencies:** Fragmented governance and inefficiencies are shared in India, Nepal, Afghanistan, and beyond (FAO, 2019; UNESCAP, 2024).

Most of the nations are predominantly agrarian and rural nations, which employ 40–70% of their populations and contribute significantly to GDP (e.g., 24% in Nepal, 40% in Laos) [FAO, 2023], face unique challenges due to their dependence on agriculture, exposure to climate change impacts, and socio-economic constraints. However, climate change threatens rural livelihoods and food security, exacerbating socio-economic inequalities [IPCC, 2022b]. Low-income farmers and communities lack access to resources (e.g., climate information, insurance) to mitigate these risks [World Bank, 2023]. Rural communities rely heavily on subsistence farming, livestock rearing, and fisheries for food security and income. Livelihoods are diverse but climate-sensitive, encompassing rain-fed crop cultivation (such as rice, wheat, and maize), horticulture, pastoralism, and aquaculture. Non-farm activities, such as handicrafts and seasonal migration, supplement incomes but are also vulnerable to climate disruptions [UNDP, 2020]. High poverty rates and limited access to education, credit, and infrastructure exacerbate vulnerability, particularly for marginalized groups like women, youth, and landless farmers. Many small-scale farmers face significant barriers, including a lack of collateral for securing bank loans, an inability to access government loans or low-interest credit, and difficulties in affording or adopting new technologies. Inadequate Infrastructure in rural areas often lacks essential infrastructure, including adequate water storage, drip irrigation, drainage systems, and safe transportation routes, especially during disasters such as floods or landslides.

2.1.1 Exposure to Climate Hazards

Extreme Weather Events: The increasing frequency and intensity of droughts, floods, cyclones, and heatwaves disrupt agricultural cycles. For instance, Sri Lanka experienced severe flooding in 2017 and a historic drought in 2016, which devastated rice production [FAO, 2017]. Similarly, Bangladesh and the Philippines are prone to typhoons, with storms like Typhoon Haiyan (2013) causing widespread crop losses [FAO, 2014]. Erratic monsoons and prolonged dry spells affect rain-fed agriculture,

Table 2: Some key climate vulnerabilities and Impacts in CMCs

Country	Key Climate Vulnerabilities	Impacts on Rural Communities
Afghanistan	Droughts, floods, and extreme temperatures	Reduced agricultural yields, livestock losses, and food insecurity
Bangladesh	Sea-level rise, cyclones, flooding, salinity intrusion	Crop damage, loss of arable land, displacement, reduced fisheries
Fiji	Cyclones, sea-level rise, coral bleaching	Coastal erosion, reduced fish stocks, disrupted tourism-based livelihoods
India	Monsoon variability, droughts, floods, heat waves	Crop failures, water scarcity, and increased rural poverty
Indonesia	Floods, landslides, sea-level rise, and forest fires	Loss of farmland, disrupted fisheries, and increased food insecurity
Iran	Droughts, desertification, water scarcity	Reduced agricultural productivity, rural migration, and degraded ecosystems
Lao PDR	Floods, droughts, typhoons	Crop losses, infrastructure damage, and limited access to markets
Malaysia	Floods, sea-level rise, and temperature increases	Reduced palm oil yields, coastal community displacement, and disrupted fisheries
Myanmar	Cyclones, floods, and droughts	Agricultural disruption, food insecurity, and increased poverty
Nepal	Glacial lake outbursts, floods, landslides, and droughts	Loss of farmland, disrupted hydropower, and increased vulnerability of mountain communities
Pakistan	Floods, droughts, glacial melt, heat waves	Crop failures, water shortages, livestock losses, rural displacement
Philippines	Typhoons, sea-level rise, floods, droughts	Damage to crops and fisheries, loss of livelihoods, and increased rural poverty
Sri Lanka	Droughts, floods, sea-level rise, landslides, and high intensity of rainfall	Reduce rice production, and productivity losses of other crops, livelihood losses, increased food insecurity
Thailand	Floods, droughts, and sea-level rise	Rice production losses, disrupted fisheries, rural income decline
Vietnam	Sea-level rise, typhoons, floods, salinity intrusion	Loss of rice paddies, aquaculture damage, and coastal community displacement

Source: Adapted from Climate Change Vulnerability - Cases from CMCs (2016) and regional climate reports.

which dominates in India, Nepal, and Laos. For example, delayed monsoons in India have reduced yields of kharif crops up to 4% in some regions [Indian Council of Agricultural Research, 2022]. Rising temperatures (e.g., 0.37°C per decade in parts of South Asia) stress crops such as wheat and rice, reducing yields by 8–22% by 2050 in Asia [IPCC, 2022]. Heat stress also impacts livestock fertility and milk production. Coastal areas in Bangladesh, Vietnam, and Fiji are facing saltwater intrusion, which is degrading arable land and impacting rice and aquaculture production. For instance, Vietnam's Mekong Delta, a global rice basket, loses 500 hectares of farmland annually to salinization. Climate vulnerabilities of CMCs were also discussed in Figure 1.

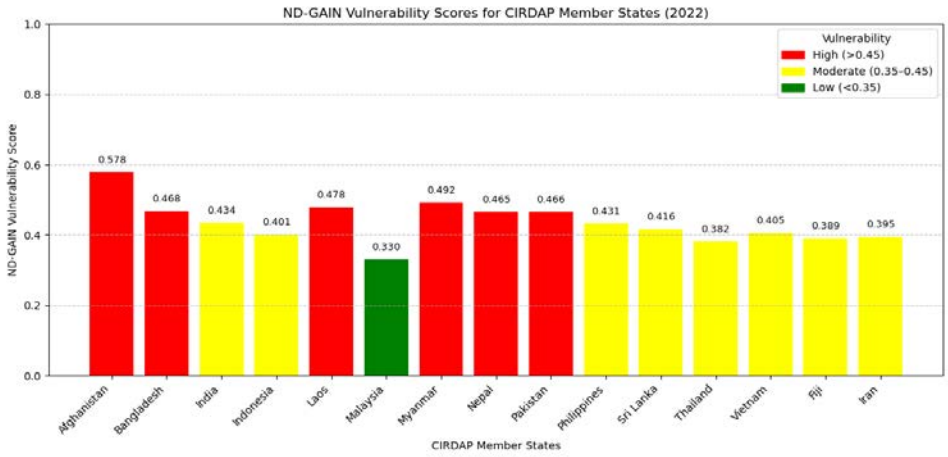


Figure 1: Climate Vulnerability Index of CMCs

Data Source: Notre Dame Global Adaptation Initiative (ND-GAIN) website (https://gain.nd.edu/our-work/country-index/). The scores were obtained from the ND-GAIN 2022 Country Index, accessed via https://gain-new.crc.nd.edu/ranking/vulnerability.

The bar chart shows the Notre Dame Global Adaptation Initiative (ND-GAIN) Vulnerability Index scores for CMCs, highlighting their exposure, sensitivity, and adaptive capacity to climate change. Lower scores indicate lower vulnerability. These scores range from 0 to 1, with higher values indicating greater vulnerability to climate change. This graph illustrates the urgent need for targeted adaptation strategies in vulnerable regions or countries. The vulnerability to climate change can be attributed to factors such as flooding, sea-level rise, cyclones, coastal and agricultural risks, climate-related risks, water scarcity issues, political instability, conflicts, poor infrastructure, mountainous terrain, glacial melt risks, heatwaves, coastal erosion, and droughts.

2.1.2 Sensitivity of Agricultural Systems

Over 60% of agriculture in CIRDAP countries relies on rainfall, making it highly sensitive to variability. Limited use of irrigation, drought-resistant seeds, or mechanization increases sensitivity. For example, only 30% of Nepal's farmland is irrigated, leaving farmers vulnerable to dry spells [Ministry of Agriculture, Nepal, 2022]. Overexploitation, erosion, and declining fertility (e.g., in Pakistan's Punjab) reduce agricultural resilience. Climate-induced flooding exacerbates soil loss, as seen in Myanmar's Ayeyarwady Delta [UNEP, 2021]. Key crops (rice, maize, wheat) and livestock (cattle, goats) are susceptible to pests, diseases, and heat stress, which are rising with climate change. For instance, pest infestations in Thailand have increased by 15% since 2000.

2.1.2.1 Livestock and Fisheries sensitivities

The livestock and fisheries sectors in CMCs are highly exposed and sensitive to climate hazards due to their reliance on natural resources, socio-economic constraints, and environmental degradation. Key hazards include rising temperatures, changing precipitation, extreme weather events, sea-level rise, and increased disease prevalence. Vulnerability is particularly high among smallholder farmers and artisanal fisherfolk, who lack adaptive capacity. Addressing these challenges requires targeted adaptation (e.g., climate-resilient breeds, integrated farming systems) and mitigation strategies (e.g., reducing GHG emissions), supported by stronger institutions, financing, and regional cooperation. Tailored policies and investments are critical to safeguard livelihoods and food security in these climate-vulnerable regions.

Livestock: High temperatures cause heat stress, reducing growth rates, milk production, egg

production, and reproductive performance. For example, dairy cows and poultry are particularly vulnerable, with mortality rates increasing at temperatures above 37.7°C and humidity over 50%. Reduced water availability impacts animal hydration and forage production, particularly in rangelands (e.g., Nepal's Mustang District). Declining pasture quality forces pastoralists to reduce herd sizes or seek alternative livelihoods. Livestock diseases kill 20% of ruminants and over 50% of poultry annually in developing countries, with climate change worsening outbreaks.

Fisheries: Warmer water temperatures disrupt aquatic ecosystems, affecting fish growth, reproduction, and survival. Species like tilapia and carp, common in aquaculture in countries like Bangladesh and Vietnam, are sensitive to temperature shifts beyond their optimal range. Altered rainfall affects freshwater availability for inland aquaculture and fisheries, which are crucial in countries such as Lao PDR and Cambodia. Flooding can lead to the loss of aquaculture infrastructure, while droughts reduce water levels in ponds and rivers, impacting fish production. Warmer waters increase the prevalence of pathogens in aquaculture, including bacterial and fungal infections, which negatively affect fish health.

Regional Variations in Exposure and Sensitivity

South Asia (e.g., India, Bangladesh, Pakistan, Nepal, Sri Lanka):

High exposure to floods, cyclones, and heat stress due to tropical climates and dense populations. Livestock systems, particularly those involving dairy and poultry, are highly sensitive to heat stress and disease outbreaks. Fisheries in Bangladesh and Sri Lanka face threats from sea-level rise and salinity intrusion. Socio-economic vulnerability is high due to poverty and reliance on smallholder farming.

Southeast Asia (e.g., Vietnam, Thailand, Philippines, Indonesia, Malaysia): Exposed to cyclones, sea-level rise, and erratic monsoons, impacting aquaculture and coastal fisheries. Vietnam's Mekong Delta is highly sensitive to salinity intrusion, affecting rice-fish systems. Urbanization and growing demand for livestock products increase pressure on production systems.

Central Asia (e.g., Afghanistan, Iran): Arid climates exacerbate water scarcity and drought, which in turn impact rangeland-based livestock systems. Limited infrastructure and veterinary services heighten sensitivity to climate-driven diseases.

Pacific Islands (e.g., Fiji): Fisheries are highly sensitive to ocean warming, coral bleaching, and sea-level rise, threatening livelihoods. Limited land for livestock and high reliance on marine resources increase vulnerability.

Adaptation and Mitigation Challenges for the Livestock and Fisheries Sector

Adaptation Needs: For Livestock, improved feed systems, heat-tolerant breeds, better water management, and strengthened veterinary services are critical. For Fisheries, Climate-smart aquaculture, such as integrated rice-fish systems or saline-tolerant species, can enhance resilience. Community-based adaptation, such as early warning systems and disaster preparedness, is crucial for mitigating the impact of extreme weather events.

Mitigation Needs: Livestock contributes 7.1 gigatonnes of CO_2 equivalent (18% of anthropogenic greenhouse gas emissions), necessitating practices such as improved feed efficiency and manure management. In addition, increasing the genetic makeup of animals, refining feeding strategies, and enhancing health management can improve productivity by increasing efficiency. Fisheries can reduce emissions through sustainable aquaculture practices and by minimizing energy use in processing and transportation.

Challenges: Limited access to climate finance and technology in CIRDAP countries hinders the adoption of climate-smart practices. Policy coordination across sectors (e.g., agriculture, fisheries, and environment) is weak in many countries, complicating the development of integrated responses.

The livestock and fisheries sectors in CMCs are highly exposed and sensitive to climate hazards due to their reliance on natural resources, socio-economic constraints, and environmental degradation. Key hazards include rising temperatures, changing precipitation, extreme weather events, sea-level rise, and increased disease prevalence. Vulnerability is particularly high among smallholder farmers and artisanal fisherfolk, who lack adaptive capacity. Addressing these challenges requires targeted adaptation (e.g., climate-resilient breeds, integrated farming systems) and mitigation strategies (e.g., reducing GHG emissions), supported by stronger institutions, financing, and regional cooperation. Tailored policies and investments are critical to safeguard livelihoods and food security in these climate-vulnerable regions.

Tropical climates in many CIRDAP countries amplify sensitivity, as livestock and fish are already near their thermal tolerance limits.

2.1.3 Limited Adaptive Capacity

Smallholder farmers, who dominate CIRDAP agriculture, lack access to finance, insurance, and modern inputs. In Bangladesh, only 20% of farmers have access to formal credit, limiting investments in resilient practices. Low awareness of climate-smart agriculture (CSA) techniques, such as crop diversification or water harvesting, hinders adaptation. Extension services are often underfunded, reaching only 10% of farmers in remote areas of Indonesia [Ministry of Agriculture, Indonesia, 2022]. Weak governance, inadequate disaster preparedness, and fragmented policies limit coordinated responses. For example, Afghanistan's agricultural extension system covers less than 5% of rural areas due to conflict and underinvestment. Women, comprising 43% of the agricultural workforce in CIRDAP countries, face restricted access to land, training, and decision-making, reducing household resilience (Table 3). In the Philippines, women farmers report 30% lower adaptive capacity than men [UN Women, 2021].

Table 3: Climate Resilient Rural Development Strategies

Country	Adaptation Strategies	Mitigation Strategies
Afghanistan	Drought-resistant crops, water harvesting, community-based disaster risk reduction	Afforestation, renewable energy promotion
Bangladesh	Floating gardens, saline-tolerant rice, elevated housing, early warning systems	Mangrove restoration, solar microgrids
Fiji	Coral reef restoration, climate-smart agriculture, coastal protection measures	Renewable energy expansion, carbon sink preservation
India	Climate-smart agriculture, watershed management, flood-resistant infrastructure	Solar irrigation, agroforestry, and methane capture
Indonesia	Mangrove restoration, early warning systems, climate-resilient crops	REDD+ programs, renewable energy adoption
Iran	Water-efficient irrigation, drought-tolerant crops, and soil conservation	Wind energy, carbon sequestration through reforestation
Lao PDR	Flood-resistant crops, community forestry, and improved irrigation systems	Hydropower expansion, forest conservation
Malaysia	Precision agriculture, flood mitigation infrastructure, coastal ecosystem protection	Palm oil sustainability, renewable energy investments

Country	Adaptation Strategies	Mitigation Strategies
Myanmar	Cyclone shelters, climate-resilient crops, community-based adaptation	Forest restoration, small-scale renewable energy
Nepal	Terracing, rainwater harvesting, and early warning systems for floods	Micro-hydropower, community forest management
Pakistan	Drip irrigation, flood-resistant seeds, and glacial lake management	Solar pumps, afforestation programs
Philippines	Typhoon-resistant infrastructure, agroforestry, diversified livelihoods	Geothermal energy, mangrove reforestation
Sri Lanka	Rainwater harvesting, drought-tolerant crops, coastal setbacks, crop diversification, home gardening, organic farming, and engage in non-farm income	Solar energy, sustainable crop production, tea plantation practices, and income
Thailand	Water management systems, climate-smart rice varieties, flood barriers	Bioenergy, forest conservation
Vietnam	Salt-tolerant crops, dyke systems, and aquaculture diversification	Wind power, mangrove restoration

Note: Strategies are based on documented initiatives and regional best practices from CIRDAP and World Bank reports.

2.1.4 Impacts on Livelihoods

The vulnerability of agriculture translates into profound impacts on rural livelihoods, threatening food security, income stability, and social cohesion:

a. Food Insecurity and Malnutrition

Projected yield losses (e.g., 8% for maize in South Asia by 2050) reduce food availability [IPCC, 2022]. In Nepal, drought-induced crop failures have increased food insecurity for 25% of rural households. Lower crop quality (e.g., reduced protein in rice due to higher CO2) and disrupted fisheries threaten dietary diversity. In Fiji, declining fish catches have resulted in a 10% reduction in per capita protein intake since 1990. Climate shocks drive food price spikes, disproportionately affecting those living in poverty. For instance, the floods in Pakistan in 2022 caused wheat prices to rise by 40%, exacerbating food insecurity.

b. Income and Employment Losses

Agriculture is a primary source of income for many rural communities. Droughts can result in crop failures, reduced agricultural productivity, and loss of livelihoods. Crop and livestock losses directly cut incomes. In Iran, drought reduced pastoralists' incomes by 50% in Kerman province, forcing many into debt [FAO, 2023]. This can lead to increased poverty levels in rural areas, where alternative employment opportunities may be limited. Climate impacts constrain non-farm opportunities, as seen in Laos, where flooding disrupts rural markets and tourism, key income sources. Failing agriculture drives rural-to-urban migration, often under distress. In Bangladesh, 20% of rural youth migrated to Dhaka after cyclones, facing precarious urban livelihoods [IOM, 2023].

c. Social and Gender Inequities

Landless labourers, indigenous communities, and women face heightened risks. In India, Scheduled Castes and Tribes report 25% higher livelihood losses from droughts than other groups. Unviable agriculture discourages youth from farming, leading to rural depopulation. In Sri Lanka, 30% of rural youth left the agricultural sector between 2010 and 2020.

The vulnerability of agriculture and rural livelihoods to climate change poses a significant challenge to sustainable rural development in CMCs. Without immediate and integrated action, the risks will deepen existing poverty, food insecurity, and environmental degradation. Climate-resilient development is not only necessary but urgent, and must centre around on inclusive, adaptive, and locally driven solutions [CIRDAP, 2023]. In Iran various initiatives has been implemented aimed at empowering rural and nomadic women, including training female facilitators, developing professional trainers, and supporting small business development in agriculture. These efforts enhance project success rates and promote entrepreneurship among women in rural areas.

2.1.5 Impact of Climate Change on Rural Artisans

The CMCs rely heavily on rural economies, where artisans such as potters, smiths, carpenters, masons, weavers, washermen, and others play critical roles. Climate change poses significant challenges to these artisans, affecting their livelihoods, resource availability, and market dynamics.

1. Resource Scarcity and Quality Degradation

- **Potters:** Clay, a primary resource for pottery, is affected by erratic rainfall, flooding, and soil erosion, which degrade clay quality and availability. In countries like Bangladesh and India, riverbank erosion due to intensified monsoons disrupts clay collection sites.
- **Smiths:** Access to raw materials like iron and charcoal is disrupted by deforestation and mining restrictions driven by climate policies or environmental degradation.
- **Carpenters:** Timber shortages due to deforestation, stricter regulations, and climate-induced forest fires reduce access to quality wood. Droughts also affect tree growth, which impacts the quality of the wood.
- **Masons:** Sand and stone availability is disrupted by riverbed drying or flooding, which alters river courses. Extreme weather also damages quarries, increasing costs.
- **Weavers:** Natural fibers like cotton, jute, and silk are affected by irregular rainfall and temperature shifts. For example, cotton yields in Pakistan and India decline due to heat stress, while silk production in Thailand and Vietnam faces challenges from temperature fluctuations affecting silkworms.
- **Washermen:** Water scarcity from droughts in countries limits washing activities, while flooding contaminates water sources, affecting cleaning quality.
- **Other Artisans:** Basket makers, leatherworkers, and rope makers face similar issues with raw materials like bamboo, hides, and natural fibers, impacted by droughts, floods, and changing agricultural patterns.

2. Extreme Weather Events

- Floods, cyclones, and storms destroy workshops, tools, and stored materials, disrupting production. For instance, Cyclone Amphan (2020) in Bangladesh damaged looms and pottery kilns. Heatwaves in India, Pakistan, and Iran reduce working hours for labor-intensive crafts like masonry and blacksmithing, lowering productivity. Unpredictable monsoons disrupt work schedules, particularly for outdoor artisans like masons and washermen, affecting income stability.

3. Market and Economic Disruptions

Reduced agricultural output due to climate change (e.g., droughts in India and Thailand) lowers rural purchasing power, decreasing demand for artisanal products like pottery, woven goods, and tools. Urban migration, driven by climate-induced rural economic decline, reduces local customer bases in countries like Nepal and Lao PDR. Global supply chain disruptions (e.g., during extreme weather events) increase costs of imported tools or materials, affecting artisans in import-dependent countries like Fiji and Sri Lanka.

4. Health and Livelihood Impacts

- Heat stress and waterborne diseases reduce artisans' ability to work consistently. Displacement due to rising sea levels forces artisans to relocate, disrupting community-based craft networks.

Measures to Mitigate Climate Change Impacts

1. Resource Adaptation and Sustainable Sourcing

Promoting research on climate-resilient materials, such as recycled metals for smiths and synthetic fibers for weavers, will contribute to sustainability. Establishing community-managed resource banks (e.g., clay pits or timber plantations) in countries like Nepal and Indonesia can ensure sustainable access to raw materials. Providing washermen with access to rainwater harvesting systems and water purification technologies in drought-prone areas can help to a greater extent.

2. Climate-Resilient Infrastructure

To protect workshops, elevated or flood-resistant structures could be built in flood-prone areas. Use of low-cost, locally sourced materials can reduce costs and developing climate-proof storage facilities to protect tools and raw materials from floods and humidity, particularly for weavers and potters. Promoting solar-powered kilns for potters and forges for smiths reduce reliance on charcoal and mitigate deforestation.

3. Skill Development and Diversification

Offer training in climate-adaptive techniques, such as eco-friendly dyeing for weavers or heat-resistant masonry methods. CIRDAP can coordinate with NGOs in India and Vietnam to implement these programs. As a part of livelihood diversification, encouraging artisans is necessary to diversify into related fields, such as carpentry training for masons or pottery skills for weavers, to reduce dependency on single crafts. Artisans can be trained to market products online, reduce reliance on local markets.

4. Financial and Market Support

Climate-risk insurance can be made available, and low-interest loans can be provided to artisans for replacing damaged tools or materials. Microfinance models in Bangladesh and India can be scaled across CIRDAP countries. Market access can be established through cooperatives to connect artisans with urban and international markets, ensuring stable demand. For instance, Sri Lanka's handloom cooperatives have successfully marketed products abroad. Governments in CIRDAP countries should offer subsidies for climate-resilient tools and materials, such as stainless steel for smiths or drought-resistant cotton seeds for weavers.

5. Policy and Community Support

Integrating national policies that support artisans into national climate adaptation plans is greatly needed in the CMCs. For example, India's National Rural Livelihoods Mission could include specific provisions for artisans. Community networks could be strengthened through artisan cooperatives to share resources, knowledge, and climate adaptation strategies. In Nepal, community forestry models could be adapted for artisans. Implement weather forecasting and early warning systems in rural areas of the Philippines and Vietnam to help artisans prepare for extreme weather events.

6. Research and Innovation

Investment or funding research into climate-adaptive craft techniques, such as heat-resistant pottery glazes or water-efficient dyeing methods, through CIRDAP's technical cooperation programs would be beneficial. This is in addition to facilitating the transfer of climate-smart technologies, like solar dryers for washermen or energy-efficient looms, across member countries. Moreover, establishing a CIRDAP-led regional framework to monitor climate impacts on artisans and evaluate the effectiveness of adaptation measures is thus needed.

Climate change poses significant challenges to rural artisans in CIRDAP member countries, threatening their resources, workspaces, markets, and health. However, through targeted measures like

sustainable resource management, climate-resilient infrastructure, skill diversification, financial support, and policy integration, these artisans can adapt and thrive. CIRDAP's regional platform can play a pivotal role in coordinating these efforts, fostering collaboration among member countries to ensure the resilience of rural artisanal livelihoods in the face of climate change.

2.2 Limited Infrastructure and Technology

Rural areas often lack infrastructure (e.g., irrigation systems, roads, and electricity) and technology to build resilience. Lack of access to climate-smart agricultural practices and technologies that can help reduce vulnerability must be focused on. Limited infrastructure and technology pose significant barriers to sustainable, climate-resilient development in the CMCs. Some of the dimensions of limited infrastructure and technology are:

2.2.1 Inadequate Physical Infrastructure

Rural areas in CMCs often lack robust physical infrastructure, such as irrigation systems, flood-resistant roads, drainage networks, and renewable energy facilities [ADB, 2021]. For instance, irrigation deficiencies in Bangladesh and India, droughts strain agricultural productivity. Limited irrigation infrastructure and financerestrict farmers' ability to adopt climate-smart practices like drip irrigation or rainwater harvesting. Poor connectivity in remote areas of Afghanistan, Nepal, and Myanmar, as well as underdeveloped road networks, hinders access to markets, agricultural inputs, and disaster relief, exacerbating the situation. In Myanmar, underdeveloped road networks exacerbate vulnerability to climate shocks. Flood and cyclone vulnerability in low-lying areas of the Philippines and Vietnam, which lack sufficient embankments or early warning systems, exposes communities to recurrent flooding and typhoons [UNDRR, 2022].

2.2.2 Limited Access to Modern Technology

Technological advancements, such as climate forecasting tools, precision agriculture, and resilient crop varieties, are critical for climate adaptation. However, their adoption is constrained in countries due to the low penetration of digital tools in rural Pakistan or Laos. Limited internet connectivity and smartphone access restrict farmers' ability to use weather apps, satellite-based crop monitoring, or digital extension services. The high costs of technologies like solar-powered pumps or drought-resistant seeds are often unaffordable for smallholder farmers, who form the backbone of rural economies in countries such as Sri Lanka and Thailand. Knowledge gaps exist even when technology is available; lack of training and awareness, especially among women and marginalized groups, limits its practical use. Reliable energy access is foundational for climate-resilient development, powering irrigation, cold storage, and agro-processing. Yet, rural electrification remains uneven in countries like Afghanistan and Papua New Guinea; many villages lack grid connectivity, forcing reliance on fossil fuels or biomass, which are unsustainable and exacerbate environmental degradation [IEA, 2023]. Renewable energy solutions (e.g., solar or micro-hydropower) are underutilized due to high upfront costs and limited technical expertise for installation and maintenance [ADB, 2021].

2.2.3. Weak Institutional Infrastructure

Beyond physical and technological limitations, institutional gaps amplify the challenge. In many CIRDAP countries, rural governance structures are unable to implement or maintain infrastructure projects. For example, in Bangladesh, local governments struggle to maintain flood embankments due to funding shortages [World Bank, 2022]. Coordination between national and local agencies is often or resulting in delays in the deployment of climate-resilient technologies, such as early warning systems, in the Maldives and Fiji [UNDRR, 2022].

Implications for climate-resilient rural development without adequate infrastructure, rural communities cannot effectively respond to climate variability. For instance, a lack of storage facilities leads to post-harvest losses during floods, undermining food

security in India or Vietnam. Limited technology adoption perpetuates low agricultural productivity, trapping farmers in a cycle of poverty. In Nepal, reliance on rain-fed agriculture restricts income diversification, making households more vulnerable to climate shocks. Marginalized groups, including women, indigenous communities, and landless farmers, face disproportionate barriers to accessing infrastructure and technology, deepening inequalities in countries like Indonesia and the Philippines. Over-reliance on outdated practices, such as deforestation for fuel wood in Pakistan or excessive groundwater extraction in India, accelerates resource depletion, undermining long-term resilience [Global Forest Watch, 2023].

2.2.3.1 Strategies to Address Challenges in Institutional Infrastructure:

Limited infrastructure and technology remain critical bottlenecks in achieving climate-resilient rural development in CMCs. These challenges undermine adaptive capacity, exacerbate poverty, and deepen inequalities, particularly for vulnerable rural populations. Addressing these issues requires a multidimensional approach—combining strategic investments in both physical and digital infrastructure, promoting affordable and accessible technologies, and strengthening institutional frameworks. By prioritizing scalable and inclusive solutions, CIRDAP countries can empower rural communities to withstand the impacts of climate change, ensuring sustainable development and enhanced resilience for future generations.

Investing in Climate-Resilient Infrastructure: Prioritize low-cost, scalable solutions such as rainwater harvesting systems, solar-powered irrigation, and cyclone-resistant community shelters. For instance, Bangladesh's coastal embankment projects could be replicated in other vulnerable CIRDAP countries.

Promote Participatory Planning: Ensure infrastructure meets local needs, as seen in Thailand's community-based flood management initiatives. Addressing local needs and developing infrastructure accordingly is vital for the economic growth of many countries in the Asia-Pacific.

Leverage Public-Private Partnerships: Fund rural roads and energy grids, drawing inspiration from India's rural electrification programs [IEA, 2023]. PPP mode and enabling people-friendly policies can bring the needed regional development and economic growth.

Enhance Technology Access and Adoption: Subsidize climate-smart technologies, such as drought-tolerant seeds or affordable weather stations, to reach smallholder farmers in Laos or Sri Lanka. Expand digital infrastructure, including rural broadband and mobile networks, to enable access to forecasting tools and market information, as piloted in Vietnam's innovative agriculture programs.

Strengthen Extension Services: Extension services in rural areas can rapidly mobilise the new initiatives taken and build the infrastructure of the institutions. Through training and mobile-based platforms to bridge knowledge gaps, particularly for women farmers in Afghanistan and Iran has been encouraging and were result oriented.

Promote Renewable Energy Solutions: To strengthen rural livelihoods, scaling up off-grid renewable energy projects, such as micro-hydropower in Nepal or solar mini-grids in the Philippines, were some of the key successful examples of promoting renewable energy solutions. Providing financing mechanisms, like microloans or pay-as-you-go models, made clean energy affordable for rural households.

Building Institutional Capacity: Strengthening local governance through capacity-building programs enables communities to manage infrastructure projects effectively, as Fiji's climate adaptation committees have demonstrated. Foster regional cooperation among CIRDAP countries to share technologies, best practices, and funding, such as through knowledge-sharing platforms on disaster risk reduction. Integrate climate resilience into national development plans, ensuring sustained investment in rural infrastructure and technology [UNESCAP, 2023].

2.3 Governance and Policy Gaps

Weak policy frameworks that do not integrate climate change adaptation into rural development plans and poor coordination among stakeholders (governments, NGOs, private sector) in addressing climate risks can hinder the achievement of sustainable solutions to climate change effects. Centralized governance remains prevalent in Bangladesh, Myanmar, Laos, and Vietnam, with decentralization reforms having been initiated only recently (World Bank, 2023; FAO, 2022). Bureaucratic hurdles sometimes impede the execution of policies, with over 60% of countries with National Adaptation Plans, lacking systematic assessments due to governance issues and limited resources. These challenges are compounded by inadequate monitoring frameworks and politicized public sectors, which hinder effective service delivery. Provincial resource allocation disparities further exacerbate the issues wherein Pakistan's Punjab benefits from advanced infrastructure, such as brick-lined water channels to reduce irrigation wastage, while Balochistan faces acute water scarcity, worsened by unequal water distribution and minimal investment in hydrological infrastructure. CMCs, predominantly agrarian and vulnerable to climate change, face significant governance and policy gaps in achieving climate-resilient rural development (Table 4). Some of the governance-related and policy gaps are discussed below.

Table 4: Policy Frameworks and Institutional Support in various countries

Country	Key Policies/Initiatives	Institutional Support
Afghanistan	National Adaptation Plan (NAP), Climate Change Strategy	Ministry of Agriculture, Irrigation and Livestock; international NGOs
Bangladesh	Bangladesh Climate Change Strategy and Action Plan, Delta Plan 2100	Ministry of Environment, Forest and Climate Change; BARD, CIRDAP
Fiji	National Climate Change Policy, Coastal Management Plan	Ministry of Environment; regional organizations (SPC, SPREP)
India	National Action Plan on Climate Change, PM-KUSUM (solar irrigation)	Ministry of Agriculture and Farmers Welfare; ICAR, state-level institutions
Indonesia	National Action Plan for Climate Change Adaptation, Village Fund Program	Ministry of Environment and Forestry; local governments
Iran	National Strategic Plan on Climate Change, Water Resource Management Plan	Department of Environment, Ministry of Energy; Ministry of Agriculture Jihad, agricultural research institutes
Lao PDR	National Adaptation Programme of Action (NAPA), Rural Development Strategy	Ministry of Agriculture and Forestry; international donors
Malaysia	National Policy on Climate Change, Green Technology Master Plan	Ministry of Natural Resources and Environment; research universities
Myanmar	Myanmar Climate Change Strategy (2018-2030), National Adaptation Plan	Ministry of Natural Resources and Environmental Conservation; NGOs
Nepal	National Climate Change Policy, Local Adaptation Plans of Action (LAPAs)	Ministry of Forests and Environment; ICIMOD
Pakistan	National Climate Change Policy, Ten Billion Tree Tsunami Programme	Ministry of Climate Change; provincial agricultural departments

Philippines	National Climate Change Action Plan, Climate-Resilient Agriculture Program	Department of Agriculture; Climate Change Commission
Sri Lanka	National Adaptation Plan for Climate Change Impacts, NDCs, National Environment Policy Climate Smart Agriculture Policy, National Renewable Energy Policy, etc.	Ministry of Mahaweli Development and Environment; agricultural research institutes
Thailand	Climate Change Master Plan (2015-2050), Sustainable Agriculture Policy	Ministry of Agriculture and Cooperatives; national research institutes
Vietnam	National Strategy on Climate Change, Mekong Delta Plan	Ministry of Natural Resources and Environment; international partners

Source: Compiled from national climate policies and CIRDAP's regional cooperation framework.

2.3.1. Lack of Integrated Policy Frameworks

Many CIRDAP countries lack cohesive national policies integrating climate resilience into rural development planning. Policies on agriculture, water management, Disaster Risk Reduction (DRR), and rural infrastructure often operate in silos, leading to fragmented efforts [UNESCAP, 2023]. In Afghanistan and Myanmar, agricultural policies focus on productivity but rarely incorporate climate adaptation measures, such as drought-resistant crops or soil conservation [FAO, 2023]. Similarly, DRR policies may address post-disaster recovery but neglect pre-emptive resilience-building in rural areas.

While most CIRDAP countries are signatories to the Paris Agreement and Sustainable Development Goals (SDGs), national rural development strategies often inadequately reflect Nationally Determined Contributions (NDCs) [UNFCCC, 2022]. For instance, Nepal's NDCs emphasize renewable energy but lack specific targets for climate-smart agriculture in rural areas [Government of Nepal, 2021]. Policies like the National Mission for Sustainable Agriculture exist in India and Pakistan. Still, implementation varies across states/provinces due to differing priorities and capacities, undermining uniform resilience outcomes [Ministry of Agriculture, India, 2022]. This fragmentation results in missed opportunities for synergistic interventions, such as combining irrigation improvements with flood-resistant infrastructure, and leaves rural communities vulnerable to climate shocks.

2.3.2 Inadequate Institutional Coordination

Weak coordination among government agencies, local authorities, and non-state actors hampers effective CRRD. Centralized decision-making in countries like Iran and Lao PDR, as well as centralized governance structures, limit the involvement of local governments in tailoring climate resilience strategies to regional needs. For example, rural communities in Lao PDR's highlands face unique landslide risks, but national policies prioritize lowland flooding [Government of Lao PDR, 2022]. In Bangladesh, the Ministry of Agriculture and the Ministry of Environment operate with overlapping mandates on climate adaptation, leading to duplicated efforts or conflicting priorities [World Bank, 2022]. This is evident in the lack of unified guidelines for mangrove restoration versus agricultural expansion in coastal areas.

The exclusion of Non-State Actors like NGOs, community-based organizations (CBOs), and the private sector is underutilized in policy design and implementation. Despite active civil society engagement in climate advocacy in Fiji, rural development plans rarely incorporate grassroots insights, reducing their effectiveness. Local institutions in countries like Nepal and Afghanistan lack the technical expertise to implement complex resilience projects, such as early warning systems or climate-smart irrigation [ICIMOD, 2020]. Poor coordination leads to inefficient resource allocation, delays in project execution, and reduced trust

among rural stakeholders, who often feel excluded from decision-making processes.

2.3.3. Insufficient Financing and Resource Allocation

Limited funding and misaligned resource allocation constrain the scale and impact of CRRD initiatives. Rural development budgets in countries like Indonesia and Sri Lanka allocate minimal funds to climate resilience, with preference for urban infrastructure or immediate economic growth, for instance, Sri Lanka's post-civil war reconstruction prioritized roads over climate-adaptive rural systems. Countries like Bangladesh and Vietnam rely heavily on international donors (e.g., ADB, World Bank) for climate projects. Still, these funds often come with restrictive conditions or short-term horizons, limiting long-term resilience planning [ADB, 2021]. In India, wealthier states access more central funds for climate programs, while poorer states like Bihar struggle to implement resilience measures [Ministry of Rural Development, India, 2022]. Similarly, in the Philippines, urban-centric funding leaves remote rural areas under-resourced.

Lack of Private Sector Engagement: Private investment in rural resilience (e.g., green technology, insurance) is minimal due to perceived low returns. Malaysia has piloted some public-private partnerships, but scaling remains challenging across the region [ADB, 2021]. Insufficient and uneven financing restricts the adoption of climate-resilient technologies, infrastructure, and capacity-building, perpetuating vulnerability in rural areas.

2.3.4. Data and Knowledge Gaps

Inadequate data collection, dissemination, and application undermine evidence-based policymaking for CRRD. Limited climate data can lead to a lack of comprehensive climate risk assessments at the village level, making it difficult to design targeted interventions. For example, Myanmar's Dry Zone faces severe droughts, but data on local water table trends are scarce. In Pakistan, the absence of robust monitoring and evaluation (M&E) frameworks for rural resilience programs means policymakers cannot assess their effectiveness or adjust strategies [World Bank, 2022]. This contrasts with Thailand, where M&E systems are more developed but underutilized in rural contexts [Government of Thailand, 2022]. Farmers in countries like Nepal and India often lack access to climate forecasts or training on adaptive practices due to language barriers, illiteracy, or poor extension services. While extension services are stronger in Vietnam, they focus on high-yield crops rather than resilience. Data collection rarely accounts for gender-specific vulnerabilities or marginalized groups. Despite their critical role in agriculture in Bangladesh, women farmers' needs are often overlooked in resilience planning [UN Women, 2021]. Without reliable data and knowledge sharing, policies fail to address specific local needs, reducing their effectiveness and exposing vulnerable populations to climate-related risks. Iran's agricultural extension services, particularly through Agricultural Extension Model Sites (AEMSs), have demonstrated significant positive impacts. Extension interventions have increased irrigated wheat yields by an average of 0.66 tons per hectare, with every dollar invested generating approximately $60 in net profit for farmers (Shokati Amghani et al., 2023). These services have improved farm management, input use efficiency, and fostered behavioral changes. While challenges remain, they are not unique to Iran but shared regionally (Mojtahedi et al., 2025).

2.3.5. Weak Legal and Regulatory Frameworks.

Legal and regulatory systems in many CIRDAP countries are outdated or inadequately enforced, hindering CRRD. Outdated land tenure systems in specific countries led to unclear land tenure, which discouraged farmers from investing in long-term resilience measures, such as agroforestry or soil conservation. Environmental regulations, such as those protecting wetlands or forests, are poorly enforced in some countries, allowing unsustainable practices to exacerbate climate vulnerability. While Malaysia and Thailand have introduced climate-related legislation, countries like Afghanistan and Fiji

lack comprehensive legal frameworks to mandate resilience in rural planning. Weak legal frameworks create uncertainty, discourage investment, and allow environmentally harmful practices to persist, undermining resilience efforts.

2.3.6. Socio-Cultural and Behavioural Barriers

Socio-cultural norms and resistance to change impede the adoption of climate-resilient practices in rural areas. In India and Nepal, traditional farming practices are deeply ingrained, and farmers may resist adopting climate-smart techniques due to risk aversion or lack of trust in new methods. In some countries, gender inequities are high, and women's contributions to agriculture are undervalued, and they are often excluded from resilience training or decision-making, reducing overall community adaptive capacity. Policymakers sometimes prioritize urban development, viewing rural areas as less economically significant, marginalizing CRRD efforts. In remote areas of Laos and Papua New Guinea, communities may not fully understand the impacts of climate change, which reduces their engagement with resilience programs. Socio-cultural barriers slow the adoption of resilience measures and perpetuate inequities, limiting the effectiveness of governance and policy interventions.

To address gaps in governance and policy, we need to develop integrated policies that create national CRRD frameworks and align agricultural, water, and disaster risk reduction (DRR) policies with the Nationally Determined Contributions (NDCs) and Sustainable Development Goals (SDGs). Establishing cross-ministerial task forces to ensure coherence, as seen in some countries' National Climate Change policies, is helpful.

Decentralized Decision-Making: Empower local governments, as piloted in Indonesia's village fund program. Foster Partnerships: With NGOs and CBOs to leverage local knowledge, as demonstrated by Bangladesh's community-based adaptation projects. Pakistan's local governance structures, such as panchayats in Sindh and jirgas in Khyber Pakhtunkhwa (KP), play a pivotal role in community-based disaster risk reduction, planning and monitoring by fostering participatory decision-making and leveraging local knowledge. These traditional systems engage communities in identifying vulnerabilities, prioritizing needs, and implementing tailored solutions. For instance, in KP, jirgas have facilitated community-led initiatives to construct flood-resistant housing, using local materials and indigenous techniques to enhance resilience against recurring floods. Similarly, in Gilgit-Baltistan, women-led cooperatives have emerged as vital platforms for CRRD, empowering women to lead efforts in resource mobilization, disaster preparedness training, and sustainable livelihood programs. These initiatives demonstrate how local governance structures bridge traditional wisdom with modern disaster management, ensuring community ownership and effective monitoring of CRRD strategies.

Encourage Private Sector Investment: Through incentives such as tax breaks for green technology and green financing models, investment is necessary [ADB, 2021].

Invest in Localized Climate Data Collection: As Thailand's meteorological services have done, and strengthen extension services to deliver gender-sensitive training, learning from India's Self-Help Group model.

Reforms in Legal Frameworks: Need to clarify land tenure to encourage long-term investments, and enforce environmental regulations with stricter penalties and monitoring.

CMCs face multifaceted governance and policy gaps that hinder climate-resilient rural development. These include fragmented policies, weak coordination, inadequate financing, data deficiencies, outdated legal systems, and socio-cultural barriers. Addressing these requires a holistic approach that integrates global commitments with local realities, empowers communities, and leverages partnerships. CIRDAP countries can build rural resilience by closing these gaps, ensuring sustainable livelihoods and food security in the face of climate change.

2.4 Transformation of Current Rural Development Programs for Climate Resilience

Rural areas in CMCs are particularly vulnerable to climate change due to their heavy reliance on agriculture, limited infrastructure, and socio-economic constraints. The increasing frequency of droughts, floods, cyclones, and heatwaves disrupts agricultural productivity and food security. For instance, Bangladesh and India face recurring flooding, while Afghanistan and Pakistan struggle with droughts that affect water availability. Soil erosion, deforestation, and water scarcity, exacerbated by climate change, undermine rural livelihoods. In Nepal and Sri Lanka, declining soil fertility and water shortages pose significant threats to smallholder farming. Poverty, limited technological access, and inadequate institutional capacity restrict adaptive responses. For example, rural communities in Lao PDR and Myanmar lack the resources to adopt climate-smart practices [UNDP, 2020].

Many existing rural development programs in CIRDAP countries were designed without a strong focus on climate resilience, leading to fragmented efforts. Coordination between ministries and local institutions remains weak in states like Afghanistan and Indonesia. Farmers and local officials often lack awareness of climate risks or access to training on resilient practices, as seen in remote areas of Fiji and Vietnam.

2.4.1 Transformation Strategies

To address these challenges, rural development programs in CMCs must integrate climate resilience as a core objective. The following strategies outline how this transformation can be achieved:

a. Mainstreaming Climate Resilience into Policy Frameworks

Policy Integration: Under the Paris Agreement, rural development policies should align with national climate adaptation plans, such as Nationally Determined Contributions (NDCs). For example, India's National Mission for Sustainable Agriculture emphasizes climate-resilient crops, which can be scaled across CIRDAP states [Ministry of Agriculture, India, 2022].

Participatory Planning: Engage local communities in designing programs to ensure context-specific solutions. In the Philippines, community-driven disaster risk reduction plans have improved typhoon resilience.

Budget Allocation: Dedicate funding for climate-resilient infrastructure and practices. The EU's Common Agricultural Policy, which allocates 30% of rural development funds to environmental measures, offers a model for CIRDAP states [European Commission, 2022].

b. Promoting Climate-Smart Agriculture (CSA)

Resilient Crop Varieties: Introduce drought-tolerant and flood-resistant crops, such as saline-tolerant rice in Bangladesh or heat-resistant wheat in Pakistan. India's promotion of millets provides a low-water, climate-resilient option [Ministry of Agriculture, India, 2022].

Sustainable Practices: Encourage conservation agriculture, agroforestry, and crop diversification to enhance soil health and reduce emissions. Nepal's community forestry programs have successfully combined livelihoods with ecosystem restoration [ICIMOD, 2020].

Technology Adoption: Provide access to precision farming tools, seasonal forecasts, and index-based insurance. In Thailand, mobile apps deliver weather alerts to farmers, improving preparedness.

c. Strengthening Infrastructure and Ecosystem Services

Water Management: To combat water scarcity, invest in rainwater harvesting, micro-irrigation, and watershed restoration. Notable examples are Iran's revival of the qanat system (traditional irrigation system) and Sri Lanka's tank rehabilitation projects.

Renewable Energy: Promote solar-powered irrigation and biogas to reduce reliance on fossil fuels. Malaysia's rural solar programs enhance energy access while cutting emissions.

Ecosystem Restoration: Protect forests, wetlands, and mangroves to buffer against climate impacts. Bangladesh's mangrove restoration in the Sundarbans has reduced cyclone damage.

d. Enhancing Capacity and Knowledge Systems

Training Programs: Expand CIRDAP's capacity-building initiatives, such as CSA and disaster preparedness workshops, to reach a broader audience of farmers and officials. Fiji's training on climate-resilient fisheries is a replicable model.

Knowledge Sharing: Leverage CIRDAP's network to disseminate best practices across Member Countries. The organization's e-library (dspace.cirdap.org) can host case studies, such as Vietnam's success with integrated rice-fish farming.

Community Empowerment: Support farmer cooperatives and women's groups to foster peer learning. In India, self-help groups have driven the adoption of resilient farming techniques [Ministry of Rural Development, India, 2022].

e. Building Institutional and Financial Mechanisms

Public-Private Partnerships: Collaborate with the private sector to fund resilient infrastructure, as seen in Indonesia's partnerships for sustainable palm oil.

Climate Finance Access: Facilitate access to funds, such as the Green Climate Fund (GCF) or the Adaptation Fund. The Philippines' People's Survival Fund supports community-led resilience projects.

Insurance and Safety Nets: Scale up weather-based and social protection programs to cushion farmers against losses. Pakistan's crop insurance schemes have shown promise in stabilizing incomes.

2.4.2 Examples of Transformation in CMCs

Several CIRDAP countries have initiated transformations in their rural development programs, offering lessons for broader adoption:

Bangladesh: The Coastal Climate-Resilient Infrastructure Project improves roads, markets, and shelters to withstand cyclones and flooding, integrating climate risk into rural planning. Mangrove restoration and the cultivation of saline-tolerant crops further enhance resilience.

India: The Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) has shifted focus to climate-resilient assets like water harvesting structures, benefiting tribal communities in states like Madhya Pradesh [Ministry of Rural Development, India, 2022].

Vietnam: The Mekong Delta Integrated Climate Resilience and Sustainable Livelihoods Project promotes diversified farming systems (e.g., rice-shrimp models) to adapt to salinity intrusion and flooding.

Philippines: The Communities for Resilience (CORE) program trains local governments to develop climate-informed rural plans emphasizing disaster risk reduction and sustainable agriculture.

Nepal: Community-based watershed management programs combine soil conservation with livelihood diversification, reducing vulnerability to landslides and droughts [ICIMOD, 2020].

Sri Lanka: The Divineguma program focuses on poverty alleviation through home gardens, small enterprises, and rural livelihoods. The Samrurdhi program focuses on social protection, micro-credit, and self-employment for low-income families. The Agriculture Sector Modernization Project (ASMP) promotes agri-business, value chains, and climate-smart practices. The Climate Resilience Improvement Project (CRIP) focuses on reducing vulnerability to floods and landslides. Similarly there are other programs like Dry Zone Livelihood Support and Partnership Program (DLZLiSPP), Smallholder Tea and Rubber Revitalization Project (STaRR), Integrated Watershed Management Projects and Village Irrigation Rehabilitation Programs.However, challenges do remain while implementing key CRRD strategies in CMCs, and they are discussed in Table 5.

Table 5:Implementation Challenges and Opportunities in CMCs

Country	Key Challenges	Opportunities
Afghanistan	Conflict, limited funding, weak infrastructure	International aid, community-based adaptation, renewable energy potential
Bangladesh	High population density, resource constraints, frequent disasters	Strong NGO network, innovative adaptation practices, regional cooperation
Fiji	Limited land area, reliance on tourism, high adaptation costs	Ecotourism, regional climate finance, resilient fisheries
India	Scale of implementation, regional disparities, bureaucratic delays	Large-scale programs, technology adoption, private sector engagement
Indonesia	Deforestation, governance issues, and disaster frequency	Biodiversity, REDD+ funding, community forestry
Iran	Water scarcity, economic sanctions, and limited technology access	Renewable energy potential, traditional knowledge, regional partnerships
Lao PDR	Low technical capacity, reliance on external funding, and remote communities	Hydropower, ecotourism, South-South cooperation
Malaysia	Urban-rural divide, high costs of green technology	Strong economy, research capacity, sustainable palm oil practices
Myanmar	Political instability, limited infrastructure, post-conflict recovery	Agricultural diversification, international support, resilient crops
Nepal	Mountainous terrain, limited resources, disaster risks	Community forestry, hydropower, eco-tourism
Pakistan	Political instability, water disputes, and extreme weather events	Green energy, youth engagement, climate-smart agriculture
Philippines	Frequent typhoons, funding gaps, and governance challenges	Renewable energy, disaster preparedness, community resilience
Sri Lanka	Post-conflict recovery, economic constraints, coastal erosion	Sustainable agriculture, tourism, and regional knowledge sharing
Thailand	Urban-rural disparities, water management issues, and an aging farmer population	Advanced agriculture, technology adoption, regional leadership
Vietnam	Mekong Delta vulnerability, rapid urbanization, funding needs	Aquaculture innovation, green energy, international climate finance

Note: Challenges and opportunities are derived from CIRDAP's Rural Development Reports and regional climate assessments.

2.4.3. Role of CIRDAP in Facilitating Transformation

CIRDAP is uniquely positioned to drive this transformation through its regional mandate and network. It can facilitate cross-country learning by sharing India's watershed management expertise with Afghanistan or Thailand's CSA innovations with

Myanmar. CIRDAP can conduct studies on climate impacts and solutions, building on CIRDAP's 2016 monograph on climate vulnerability in Member Countries. It can expand training programs for government officials and farmers by leveraging partnerships with organizations such as the FAO and the Asian Productivity Organization (APO). Need to emphasise climate-resilient policies at regional forums, ensuring rural voices are heard in global climate discussions.

To effectively transform rural development programs, Member Countries could:

Conduct Vulnerability Assessments: Map climate risks at local levels to tailor interventions, as practiced in Fiji's coastal communities.

Scale-Up Pilot Projects: Replicate successful models across regions with similar vulnerabilities, such as Bangladesh's climate-resilient infrastructure.

Empower Local Institutions: Strengthen link institutions (e.g., BARD in Bangladesh, AIRD in India) to implement and monitor resilient programs.

Integrate Gender and Equity: Prioritize women, youth, and marginalized groups in program design, as seen in India's women-led self-help groups.

Leverage Technology: Use digital platforms for real-time climate data and market access, building on Malaysia's rural digitalization efforts.

Secure Long-Term Funding: Advocate for sustained climate finance through CIRDAP's networks, ensuring short-term budgets do not disrupt programs.

2.4.4. Potential Barriers and Mitigation

Limited budgets can hinder scaling efforts. Mitigation includes tapping multilateral funds and promoting cost-effective solutions like agroforestry. Farmers may resist new practices due to tradition or risk aversion. Demonstration plots and incentives, as used in Thailand, can build trust. Fragmented governance can stall progress. CIRDAP can facilitate inter-ministerial and cross-country collaboration. Lack of localized climate data also hampers planning.

Transforming rural development programs for climate resilience in CMCs requires a holistic approach integrating policy reform, sustainable practices, infrastructure upgrades, capacity building, and inclusive financing. By leveraging CIRDAP's regional platform, Member Countries can share knowledge, scale innovations, and access resources to build resilient rural communities. Successful examples from Bangladesh, India, and Vietnam demonstrate the potential for transformation. However, sustained commitment, localized strategies, and cross-sectoral collaboration are critical to ensuring that rural development programs address current climate challenges and secure long-term prosperity and sustainability.

2.5. Financial Constraints

Financial constraints for climate-resilient rural development in CMCs stem from limited fiscal capacity, competing development priorities, and structural barriers to accessing climate finance. These constraints manifest in various forms, including insufficient domestic funding, restricted access to international climate funds, high costs of adaptation and mitigation measures, and inadequate private sector investment. The rural context exacerbates these challenges due to its dispersed populations, underdeveloped infrastructure, and lower investment returns compared to urban areas.

2.5.1. Key Financial Constraints

a. Limited Domestic Fiscal Capacity

- **Low Revenue Generation:** Many CMCs, particularly low-income countries like Afghanistan, Nepal, and Lao PDR, have limited tax bases and weak revenue collection systems. This restricts their ability to allocate sufficient budgets for climate-resilient rural development projects, such as building climate-smart infrastructure or subsidizing drought-resistant crops [IMF, 2023].
- **Competing Priorities:** Governments prioritize immediate needs like poverty alleviation, healthcare, and education over long-term

climate resilience investments. For instance, climate adaptation is critical in Bangladesh and India due to the frequent occurrence of cyclones and flooding; however, social welfare programs often take precedence in budget allocations.

- **Debt Burdens:** High public debt levels in countries can limit fiscal space for new investments. Debt servicing consumes a significant portion of national budgets, thereby reducing funds available for rural climate adaptation projects, such as irrigation systems or coastal embankments [IMF, 2023].

b. Inadequate Access to International Climate Finance

- **Complex Funding Mechanisms:** International climate funds, such as the Green Climate Fund (GCF) or Global Environment Facility (GEF), have stringent application processes that require technical expertise and robust project proposals. Smaller or less developed Member Countries often lack the institutional capacity to navigate these processes effectively.
- **Low Disbursement Rates:** Even when funds are approved, disbursements are often delayed due to bureaucratic hurdles or conditionality, slowing the implementation of resilience projects.
- **Bias Toward Mitigation:** Global climate finance prioritizes mitigation (e.g., renewable energy) over adaptation, which is critical for rural areas in CIRDAP states. Adaptation projects, such as building resilient agricultural systems, receive only a fraction of the available funds—estimated at $34 billion annually in the Asia-Pacific region, against a need of $102–431 billion [UNESCAP, 2023].
- **Unequal Distribution:** Wealthier Member Countries may have better access to climate finance due to stronger institutional frameworks, while poorer nations struggle to secure adequate funding.

c. High Costs of Climate-Resilient Interventions

- **Capital-Intensive Infrastructure:** Climate-resilient rural development requires significant upfront investments in infrastructure, such as flood-resistant roads, irrigation systems, and early warning systems. For example, retrofitting rural infrastructure in the Philippines to withstand typhoons is cost-prohibitive for local governments.
- **Technology Adoption:** Introducing climate-smart technologies, like drought-resistant seeds or precision agriculture, involves high initial costs for training, equipment, and inputs. Smallholder farmers, who dominate rural economies in CIRDAP states, often cannot afford these without subsidies or credit.
- **Maintenance Costs:** Sustaining climate-resilient infrastructure, such as mangrove restoration or watershed management, requires ongoing funding, which rural budgets struggle to provide.

d. Limited Private Sector Engagement

- **Low Investment Incentives:** The private sector is reluctant to invest in rural climate resilience due to perceived low returns and high risks. Rural projects often have long gestation periods and uncertain profitability, deterring investors in countries
- **Weak Financial Markets:** Underdeveloped financial systems in rural areas limit access to credit and insurance for climate-resilient projects. For instance, in some countries, rural farmers face challenges obtaining loans for climate-smart equipment due to high interest rates and collateral requirements.
- **Policy Uncertainty:** Inconsistent government policies and a lack of clear incentives, such as tax breaks or subsidies for green investments, discourage private sector participation in countries.

e. **Capacity and Knowledge Gaps**

- **Lack of Expertise:** Rural institutions in CMCs often lack the technical know-how to design bankable climate-resilient projects, reducing their ability to attract funding.
- **Data Deficiencies:** Inadequate climate risk data and impact assessments hinder accurate cost estimations and project planning. This is a significant issue in small island states like Fiji, where precise data on the impacts of sea level rise is often unavailable.
- **Low Financial Literacy:** Rural communities, especially smallholder farmers, may not fully understand financial instruments like micro-insurance or blended finance, limiting their ability to leverage available resources.

2.5.2. Implications of Financial Constraints

The financial barriers outlined above have far-reaching consequences for climate-resilient rural development in CMCs:

- **Increased Vulnerability:** Insufficient funding exposes rural communities to climate risks, exacerbating poverty and food insecurity. For instance, unaddressed flooding in Bangladesh's rural areas disrupts livelihoods and displaces populations.
- **Economic Losses:** Climate change could lead to significant GDP declines, with estimates suggesting a 17% drop across Asia-Pacific by 2070 under a high-emissions scenario, disproportionately affecting rural economies.
- **Inequitable Development:** Wealthier regions or urban areas receive more climate finance, widening rural-urban disparities. This is evident in India, where urban climate projects often overshadow the needs of rural areas.
- **Missed Opportunities:** Failure to invest in resilience undermines long-term development goals, such as the Sustainable Development Goals (SDGs), particularly SDG 1 (No Poverty), SDG 2 (Zero Hunger), and SDG 13 (Climate Action) [UN, 2023].

2.5.3. Strategies to Overcome Financial Constraints

To address these challenges, CMCs, with support from regional and international partners, can adopt the following strategies:

a. **Strengthening Domestic Resource Mobilization**

- **Improve Tax Systems:** Enhance revenue collection through progressive taxation and anti-corruption measures to fund rural resilience projects. For example, Indonesia could expand its tax base to support agricultural adaptation [IMF, 2023].
- **Budget Reallocation:** Prioritize climate resilience in national budgets by integrating it into sectoral plans, as seen in Thailand's water management programs [Government of Thailand, 2022].
- **Debt Relief:** Advocate for debt restructuring or relief for heavily indebted nations to free up resources for climate investments.

b. **Enhancing Access to International Climate Finance**

- **Capacity Building:** Provide training for government officials and rural institutions to develop fundable project proposals. CIRDAP could facilitate workshops on accessing GCF or ADB funds. Pakistan's reliance on international climate finance, such as the Green Climate Fund, underscores a critical gap in its ability to independently address climate challenges, exposing vulnerabilities to external funding volatility and conditionalities that may not align with national priorities. This dependency often stems from limited domestic fiscal capacity and underdeveloped mechanisms to attract private sector investment, which restricts the scale and speed of climate resilience projects. To mobilize domestic private sector investment, Pakistan could implement innovative financial instruments like green bonds and climate-focused public-private partnerships, offering tax incentives and risk guarantees to attract corporate

participation. Strengthening regulatory frameworks to ensure transparency and creating dedicated climate investment funds could further incentivize local businesses to invest in renewable energy, sustainable agriculture, and resilient infrastructure, fostering self-reliance and aligning climate action with economic growth.

- **Simplified Processes:** Advocate for streamlined application procedures in global funds to benefit smaller states like Fiji and Nepal.
- **Regional Cooperation:** Leverage CIRDAP's platform to pool resources and share best practices for securing climate finance, as seen in ESCAP's regional collaboration efforts.
- **Focus on Adaptation:** Push for a balanced allocation of global funds between mitigation and adaptation, emphasizing rural needs.

c. **Reducing Costs Through Innovation**

- **Nature-Based Solutions:** Promote low-cost, scalable solutions like mangrove restoration or agroforestry, which enhance resilience while requiring less capital. Vietnam has successfully used mangroves for coastal protection.
- **Digital Technologies:** Digital platforms are used to deliver extension services and climate information, reducing costs for farmers in remote areas of India or the Philippines [World Bank, 2022].
- **Community-Led Models:** Encourage participatory approaches, such as community-managed irrigation systems, to lower implementation and maintenance costs.

d. **Mobilizing Private Sector Investment**

- **Incentives:** Offer tax breaks, subsidies, or risk guarantees to attract private investment in rural resilience. Malaysia's green bond initiatives could serve as a model for other countries.
- **Blended Finance:** This method combines public and private funds to de-risk projects, as piloted in Indonesia's renewable energy sector.
- **Microfinance:** Expand rural farmers' access to microcredit and insurance, building on successful models like India's Self-Help Group-Bank Linkage Program [Ministry of Rural Development, India, 2022].

e. **Building Capacity and Knowledge**

- **Technical Training:** Strengthen local institutions' ability to design and manage climate projects through CIRDAP-led programs.
- **Data Systems:** Invest in climate risk assessments and open data platforms to support evidence-based planning, particularly in data-scarce regions like Afghanistan.
- **Farmer Education:** Promote financial literacy and climate awareness among rural communities to enhance adoption of resilient practices.

2.5.4 Role of CIRDAP

CIRDAP can facilitate knowledge exchange and share successful financing models across Member Countries, such as Bangladesh's community-based adaptation programs. Representing smaller nations in global climate finance discussions to ensure equitable access and piloting innovative financing mechanisms, such as climate bonds or crowdfunding for rural projects in collaboration with partners like the ADB or IFAD, may benefit Member Countries.

Financial constraints pose a formidable barrier to climate-resilient rural development in CMCs, driven by limited domestic resources, restricted access to international funds, high intervention costs, and low private sector engagement. These challenges threaten rural livelihoods and long-term development prospects in a region that is already grappling with severe climate impacts. By adopting a multi-pronged approach—enhancing

domestic budgets, simplifying global finance access, leveraging innovation, engaging the private sector, and building capacity—CMCs can overcome these barriers. CIRDAP's regional coordinator and advocate role is critical to mobilizing the necessary resources and fostering resilience in rural communities, ensuring they thrive in the face of climate change.

2.6 Social and Cultural Barriers

2.6.1. Social Barriers

- Traditional practices and resistance to change may impede the adoption of new, climate-resilient practices. Gender disparities, where women, particularly in rural areas, are disproportionately affected by climate change, but also underrepresented in decision-making. Social structures shape rural development outcomes, including hierarchies, norms, and community dynamics. Some of the key social barriers include:
- **Inequitable Access to Resources:** Rural communities in CMCs often exhibit disparities based on gender, caste, ethnicity, or economic status. For instance, in some South Asian countries lower-caste groups and women frequently lack access to land ownership, credit, or agricultural inputs. This limits their ability to adopt climate-resilient practices, such as drought-resistant crops or irrigation systems [FAO, 2020]. A 2020 Food and Agriculture Organization (FAO) report noted that Asian women farmers receive only 10% of agricultural extension services, hindering their resilience to climate impacts.
- **Limited Education and Awareness:** Low literacy rates and inadequate climate education in rural areas restrict communities' understanding of climate change. In countries like Afghanistan and Lao PDR, where literacy rates hover around 40-50%, farmers may not recognize the link between changing weather patterns and long-term climate trends [UNESCO, 2022]. This leads to reluctance to shift from traditional practices to resilient alternatives, such as crop diversification or soil conservation.
- **Weak Institutional Support:** Rural governance structures in many CIRDAP states suffer from inefficiencies, corruption, or a lack of coordination. For example, decentralized climate adaptation programs in some countries often fail to reach remote villages due to bureaucratic delays or elite capture of resources. This erodes trust in institutions, discouraging community participation in resilience-building initiatives.
- **Migration and Labor Shortages:** Climate-induced stressors, such as floods in Bangladesh or droughts in India, drive rural-to-urban migration, particularly among young men. This depletes the rural labor force, leaving women, the elderly, and children to manage farms with limited capacity to implement complex resilience strategies. A 2023 study by the International Organization for Migration highlighted that 30% of rural households in South Asia face labor shortages due to migration [IOM, 2023].
- Social Resistance to Change: Rural communities prioritize immediate survival over long-term resilience. For instance, in Indonesia and the Philippines, farmers may resist adopting climate-smart agriculture due to perceived risks or upfront costs, preferring familiar but vulnerable practices like monocropping.

2.6.2 Cultural Barriers

Cultural beliefs, traditions, and practices deeply influence rural livelihoods and adaptation to climate change. Key cultural barriers include:

- **Traditional Agricultural Practices:** In many CIRDAP countries, farming is guided by customs passed down through generations. For example, in Sri Lanka and Thailand, rice cultivation holds cultural significance, and farmers may resist switching to less water-intensive crops despite increasing

droughts. Similarly, in India's tribal regions, slash-and-burn agriculture persists due to cultural identity, despite its environmental unsustainability.

- **Gender Norms and Roles:** Patriarchal norms and gender disparities are persistent across South and Southeast Asia, affecting land rights, leadership, and rural livelihoods (FAO, 2022; UNDP, 2024). Cultural expectations often confine women to domestic roles, limiting their involvement in community-based disaster preparedness or agricultural innovation. A 2021 UN Women report indicated that only 15% of rural women in South Asia participate in climate-related community forums.
- **Religious and Spiritual Beliefs:** In some CIRDAP states, climate events are attributed to divine will, reducing the urgency to adopt scientific solutions. For instance, in parts of Nepal and Myanmar, communities may view floods or droughts as karmic or spiritual phenomena, leading to fatalism rather than proactive adaptation. This mindset can undermine efforts to promote early warning systems or infrastructure improvements.
- **Community Cohesion and Conflict:** While strong community ties can aid resilience, cultural divisions—such as ethnic tensions in Sri Lanka or caste hierarchies in India—can hinder collective action. For example, in multi-ethnic villages in Malaysia or Indonesia, mistrust between groups may prevent equitable sharing of climate adaptation resources, like a communal water system.
- **Taboos and Stigma:** Certain adaptation measures face cultural resistance due to taboos. In Bangladesh, for instance, floating gardens—a climate-resilient technique—may be stigmatized as "non-traditional" by conservative communities. Similarly, in Fiji, relocating villages due to sea-level rise can disrupt ancestral ties to land, creating cultural resistance despite existential risks

2.6.3. Implications for Climate-Resilient Rural Development

Implications for CRRD and the barriers have far-reaching consequences under social and cultural contexts which are explained below:

- **Delayed Adaptation:** Social and cultural resistance slows the adoption of resilient technologies, leaving communities vulnerable to climate shocks.
- **Inequitable Outcomes:** Marginalized groups, including women, indigenous peoples, and lower castes, are disproportionately excluded from resilience benefits.
- **Economic Losses:** Persistent reliance on outdated practices exacerbates crop failures and livelihood insecurity. For example, the Asian Development Bank estimated that climate change could reduce agricultural GDP in South Asia by 10-15% by 2050 without adaptation.
- **Social Fragmentation:** Unequal access to resources and cultural conflicts over adaptation measures can erode community trust and cohesion.

2.6.4. Strategies to Overcome Barriers under Social and Cultural context

To address these challenges, CMCs can adopt targeted interventions:

Social and cultural barriers in CMCs significantly hinder climate-resilient rural development. Inequitable access, traditional practices, gender norms, and institutional weaknesses must be addressed through inclusive, culturally sensitive, and community-driven approaches. By aligning adaptation strategies with local realities, CIRDAP countries can build resilient rural economies that withstand climate change while preserving socio-cultural identities. Collaborative efforts among governments, NGOs, and communities are essential to translate these strategies into actionable outcomes.

Inclusive Policies: Ensure equitable access to land, credit, and training for women, indigenous groups, and marginalized castes. Programs like India's National Rural Livelihoods Mission can be scaled up to include climate resilience components [Ministry of Rural Development, India, 2022].

Community-Based Education: Use local languages and culturally relevant methods to raise climate awareness. Radio campaigns in Nepal and village theatres in Bangladesh have effectively engaged rural audiences.

Cultural Sensitivity: Design interventions that respect traditions while promoting resilience. For instance, integrating climate-smart practices into traditional rice festivals can bridge cultural gaps in Thailand.

Strengthening Institutions: Enhance local governance through capacity-building and transparency to ensure climate funds reach vulnerable communities.

Empowering Women: Challenge gender norms by involving women in leadership roles within climate adaptation projects, as seen in successful cooperatives in the Philippines.

Leveraging Technology: As piloted in Vietnam, mobile apps and community radio can disseminate climate information tailored to low-literacy contexts.

KEY APPROACHES FOR CLIMATE-RESILIENT RURAL DEVELOPMENT

3. Key Approaches for Climate-Resilient Rural Development

3.1 Climate-Smart Agriculture

Climate Smart Agriculture (CSA) is an integrated approach to managing landscapes—cropland, livestock, forests, and fisheries—to address the interlinked challenges of food security, climate change adaptation, and mitigation [FAO, 2023]. In the context of the Centre on Integrated Rural Development for Asia and the Pacific (CIRDAP) Member Countries, which span diverse agro-ecological and socio-economic landscapes across South Asia, Southeast Asia, and the Pacific, CSA emerges as a pivotal strategy for fostering climate-resilient rural development [CIRDAP, 2023]. These countries, including Bangladesh, India, Indonesia, Pakistan, Vietnam, and others, face significant climate vulnerabilities such as rising temperatures, erratic rainfall, extreme weather events, and sea-level rise [IPCC, 2022]. CSA offers a framework to enhance agricultural productivity, strengthen resilience, and reduce greenhouse gas emissions, aligning with the region's Sustainable Development Goals (SDGs) and rural livelihoods improvement [UN, 2023]. The contribution of agricultural GHG emissions (in million tonnes CO2 equivalent) for selected CMCs, emphasizing the sector's role in climate change and the need for resilient practices, is shown in Fig. 2a

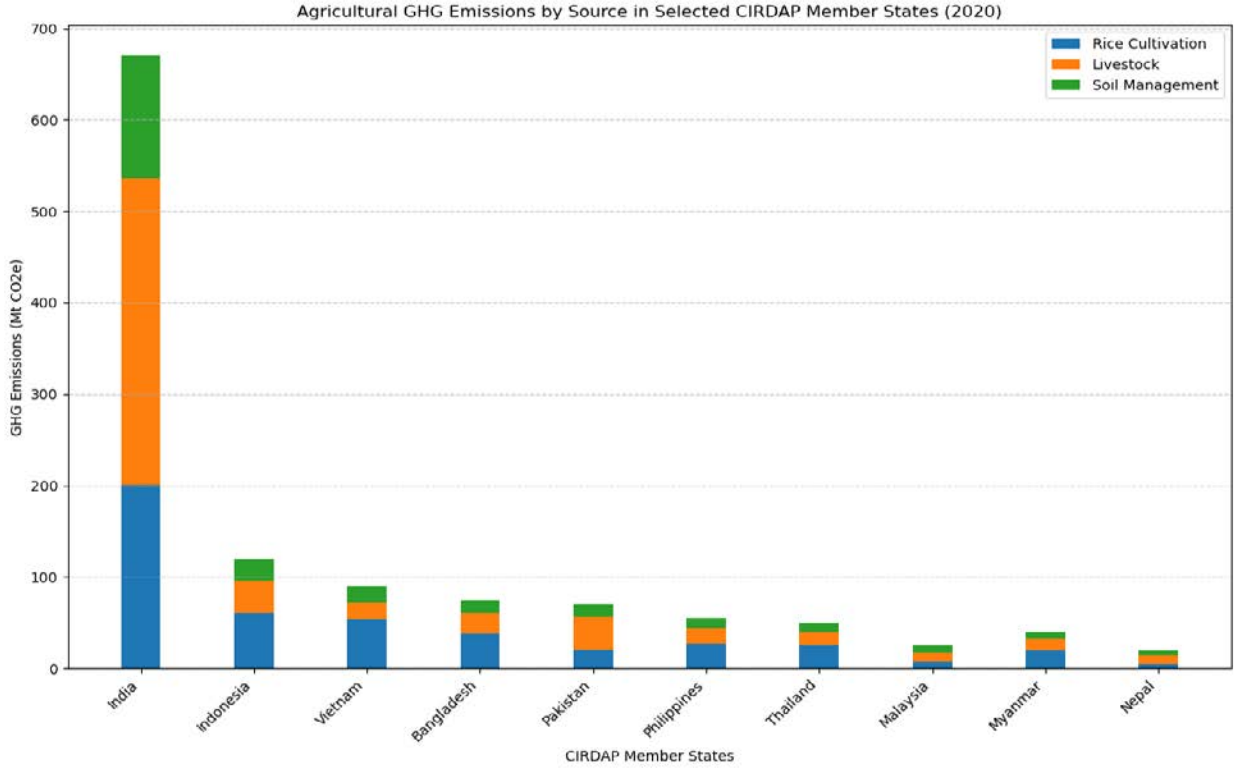


Figure 2 a: Agricultural GHG Emissions in CMCs (FAOSTAT 2020)

- *Source: FAOSTAT (2020): Emissions Database, Agriculture Total, Greenhouse Gas Emissions (CO2 equivalent). http://www.fao.org/faostat/en/#data/GT*
- *World Bank. (2020). Climate Change and Development Reports (CCDRs) for selected CMCs. https://www.worldbank.org/en/topic/climatechange*

The figure 2a emphasizes agriculture's significant role in climate change, particularly in methane-intensive rice cultivation and livestock sectors. Resilient practices—such as alternate wetting and drying in rice paddies, improved feed for livestock, and precision fertilizer use—can reduce emissions while maintaining productivity, which is critical for food security in CIRDAP nations. In the figure, India dominates due to its large agricultural sector, while smaller nations like Nepal and Fiji have lower emissions but high per-capita agricultural dependence, increasing vulnerability. Rice Cultivation is dominant in countries like Indonesia, Vietnam, Bangladesh, Thailand, the Philippines, and Myanmar due to extensive rice paddies (e.g., Mekong Delta, lowland systems). Estimated at 40–60% of emissions in these countries.

Greenhouse Gas Emissions Share by Sector in CIRDAP Member Countries (2022)

Using the FAOSTAT data on greenhouse gas (GHG) emissions from agrifood systems for 2022, a bar chart is compiled to represent the share of emissions from the agricultural sector compared to other major sectors (energy, industry, waste, and land use, land-use change, and forestry - LULUCF) for CIRDAP member countries. The FAOSTAT database provides detailed emissions data for agrifood systems, including farm-gate agriculture, land-use change, and pre- and post-production processes, which was aggregated and compared to total economy-wide emissions to estimate sectoral shares.

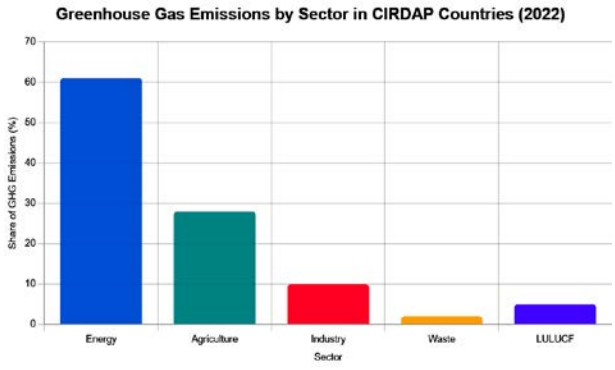


Figure 2 b: GHG Emissions in CMCs (FAOSTAT 2022)

Source: Data Source and Methodology

- The chart is based on FAOSTAT's 2022 data for agrifood systems emissions, covering farm-gate activities (crops and livestock), land-use change (deforestation, biomass fires, peatland degradation), and pre- and post-production processes (e.g., food processing, transport).
- Total agrifood system emissions for CIRDAP countries were aggregated from country-level data, with agriculture's share (including farm-gate and pre/post-production) estimated at approximately 28% of total GHG emissions, based on FAOSTAT's global estimate of agrifood systems contributing one-third of emissions and adjusted for CIRDAP's higher agricultural reliance.
- Energy, industry, waste, and LULUCF shares were estimated using FAOSTAT's economy-wide emissions data and regional trends for South and Southeast Asia, where most CIRDAP countries are located. Energy includes electricity, heat, and transport; industry covers manufacturing and chemical processes; waste includes landfills and wastewater; and LULUCF includes deforestation and soil emissions.
- Due to data gaps for some CIRDAP countries (e.g., Afghanistan, Myanmar), regional averages and global trends were used to estimate sectoral shares, ensuring consistency with FAOSTAT's methodology (IPCC Tier 1).

Breakdown of Emissions:

- **Energy (61%):** The energy sector is the largest emitter in CIRDAP countries, driven by fossil fuel use for electricity, transport, and heating. Countries like India and Indonesia, with large populations and growing energy demands, contribute significantly. However, this share is lower than the global average (72%) due to the region's higher agricultural dependence.
- **Agriculture (28%):** Agriculture, including farm-gate emissions (e.g., methane from livestock and rice, nitrous oxide from fertilizers)

and pre/post-production processes, accounts for a significant share. This is higher than the global average (22%) due to CIRDAP countries' reliance on agriculture. For example, rice cultivation in Thailand, Vietnam, and Bangladesh, and livestock in India and Pakistan, are major methane sources. FAOSTAT data indicates agrifood systems emitted 16.2 Gt CO2eq globally in 2022, with Asia contributing a substantial portion.

- **Industry (10%):** Industrial emissions, from cement production and manufacturing, are lower in CIRDAP countries compared to developed nations. Countries like Malaysia and Thailand have growing industrial sectors, but agriculture and energy dominate.
- **Waste (2%):** Waste emissions, mainly methane from landfills, are minimal but notable in densely populated countries like Bangladesh and the Philippines, where waste management infrastructure is limited.
- **LULUCF (5%):** Land-use change, including deforestation for agriculture (e.g., palm oil in Indonesia and Malaysia), contributes a smaller share but is significant in specific countries. FAOSTAT notes that land-use change emissions are critical in tropical regions.

CIRDAP-Specific Insights:

- **Agriculture's Prominence:** CIRDAP countries, particularly in South and Southeast Asia, have a higher agricultural emissions share (28%) than the global average due to extensive rice paddies, livestock farming, and fertilizer use. For instance, India's livestock sector and Vietnam's rice production are major methane contributors. FAOSTAT data highlights that farm-gate emissions alone account for a significant portion of agrifood emissions.
- **Country Variations:** In countries like Fiji and Laos, agriculture likely constitutes an even higher share due to limited industrial activity. In contrast, Malaysia and Thailand have more balanced emissions profiles due to stronger energy and industrial sectors.
- **Land-Use Change:** Indonesia and Malaysia have notable LULUCF emissions from deforestation for palm oil and logging, contributing to the regional total. FAOSTAT's focus on peatland degradation underscores this issue.
- **Trends Over Time:** FAOSTAT data shows a 10% increase in global agrifood emissions from 2000 to 2022, with CIRDAP countries following this trend due to population growth and agricultural intensification. Pre- and post-production emissions (e.g., food transport, processing) are also rising, reflecting supply chain growth.

Mitigation Opportunities:

- **Agriculture:** Strategies like improved rice water management, methane-reducing livestock feed additives, and precision fertilizer application can lower emissions while maintaining food security. FAOSTAT emphasizes these as viable options for CIRDAP countries.
- **Land Use:** Reforestation and sustainable land management in Indonesia and Malaysia can reduce LULUCF emissions.
- **Energy and Industry:** Transitioning to renewable energy and improving industrial efficiency can complement agricultural mitigation, especially in India and Thailand.

Limitations:

- FAOSTAT data for 2022 is comprehensive but lacks complete country-specific breakdowns for all CIRDAP nations (e.g., Afghanistan, Myanmar). Estimates rely on regional aggregates and IPCC Tier 1 methodology, which may underestimate emissions in some cases.
- Non-CO_2 emissions (methane, nitrous oxide) dominate agriculture, but CO_2 from land-use change is less consistently reported, especially for non-Annex I countries like most CIRDAP members.

- The chart assumes a consistent sectoral breakdown across CIRDAP countries, but variations exist due to economic and geographic differences.

The bar chart illustrates that agriculture is a major GHG emitter in CIRDAP countries (28%), second only to energy (61%), reflecting the region's agrarian economies. Compared to global averages, agriculture's share is higher, driven by rice cultivation, livestock, and land-use changes in countries like India, Indonesia, and Vietnam. FAOSTAT's 2022 data underscores the need for targeted mitigation in farm-gate and supply chain activities, alongside energy sector decarbonization, to address climate challenges in CIRDAP countries.

Livestock production is significant in India, Pakistan, Bangladesh, and Nepal due to large cattle populations (e.g., methane from enteric fermentation). Estimated at 30–50% in these countries, lower (20–30%) in rice-heavy nations. Soil management includes emissions from fertilizer use and soil disturbance, relevant across all countries but less dominant (20–30% in most cases). While India dominates with 670 Mt CO2e, driven by livestock and scale, while rice-heavy countries like Vietnam and Indonesia highlight the need for methane-reducing practices in rice cultivation. Smaller emitters like Nepal and Malaysia still require resilient practices due to their reliance on agriculture.

CORE PILLARS OF CSA

Productivity: Enhancing agricultural productivity and incomes sustainably to ensure food security, particularly for smallholder farmers who dominate rural economies in CIRDAP countries.

Adaptation: Enhancing the resilience of agricultural systems to climate variability and shocks, such as droughts, floods, and cyclones, which are frequent in countries like Bangladesh, the Philippines, and Sri Lanka [UNDRR, 2022].

Mitigation: Reducing or preventing greenhouse gas emissions from agriculture, where feasible, through practices like efficient fertilizer use, agroforestry, and methane capture from livestock.

Core Pillars of Climate-Smart Agriculture:

CSA is built on three interconnected pillars: Countries like India, Indonesia, Pakistan, Vietnam, and others face significant climate vulnerabilities. It is vital to protect the environment and introduce environment friendly technologies and at the same time following the basic principles of agro-ecology. These pillars are not mutually exclusive; CSA interventions often deliver co-benefits across all three, tailored to local contexts.

Relevance of CSA in CMCs

CMCs are predominantly agrarian, with agriculture employing 40-70% of their rural populations and contributing significantly to GDP [FAO, 2023]. However, climate change poses severe risks:

- **Monsoon Dependency and Variability:** Countries like India, Nepal, and Thailand rely heavily on monsoon rains, which are becoming unpredictable, affecting crop yields and farmer incomes [World Meteorological Organization, 2023].
- **Extreme Weather Events:** Tropical cyclones in the Philippines, floods in Pakistan, and droughts in Afghanistan disrupt food production and rural infrastructure [UNDRR, 2022].
- **Soil and Water Degradation:** Unsustainable practices in countries like Laos and Myanmar exacerbate soil erosion and water scarcity, worsened by climate-induced stresses [UNEP, 2021].
- **Food Insecurity:** Rising populations and declining arable land in countries like Bangladesh and Indonesia strain food systems, making resilient agriculture critical.

CSA addresses these challenges by promoting locally relevant, scalable, and inclusive practices, ensuring rural communities can withstand climate shocks while sustaining livelihoods [CIRDAP, 2023]

Key CSA Practices and Technologies

CSA encompasses a wide range of practices tailored to the diverse agro-ecologies of CIRDAP

countries. In Figure 3, a heatmap illustrates the adoption of climate-resilient agricultural practices (e.g., integrated rice-duck farming, drought-resistant crops, agroforestry) across CMCs, based on case studies and policy initiatives. In Figure 3, the Philippines (integrated rice-duck farming, 56% rural population dependent on agriculture), India (widespread adoption of drought-resistant crops, government schemes), and Thailand (carbon farming, sustainable rice initiatives) lead in adopting resilient practices. At the same time, some States lag due to systemic barriers.

Figure 3: Adoption of Climate-Resilient Agricultural Practices (2015–2023)

Source: Author. Derives from sources like ResearchGate (Philippines case study, 2017), CIRDAP reports- Annual reports and policy documents on climate-resilient agricultural practices in CIRDAP member state (2016–2023), and World Bank CCDRs. World Bank. (n.d.). Country Climate and Development Reports (CCDRs). Washington, DC: World Bank Group. https://www.worldbank.org/en/publication/country-climate-development-reports.

- **Crop Diversification and Resilient Varieties:** Adoption of drought-tolerant, flood-resistant, and heat-tolerant crop varieties (e.g., submergence-tolerant rice in Bangladesh and Vietnam). Diversifying crops to reduce risks, such as intercropping legumes with cereals in India and Nepal to enhance soil fertility and income stability.
- **Water Management:** Rainwater harvesting and micro-irrigation systems in arid regions of Pakistan and Afghanistan to optimize water use. Alternate wetting and drying (AWD) techniques in rice paddies in Indonesia and the Philippines to save water and reduce methane emissions [World Bank, 2022]. In Pakistan, particularly in Sindh, rice cultivation contributes significantly to agricultural GHG emissions, with methane from flooded paddies accounting for approximately 7.83 Mt CO_2 equivalent annually, representing about 1.7% of the country's total agricultural emissions. The adoption of alternate wetting and drying

(AWD) in Sindh's rice paddies, as piloted with support from the Asian Development Bank, has shown potential to reduce methane emissions by 30–50% while saving 10–20% of water without compromising yields. Scaling AWD in Sindh, where rice is a major crop alongside Punjab, can address the region's high water consumption and environmental footprint, given that rice cultivation consumes the largest share of Pakistan's irrigation water. Tailored interventions, such as combining AWD with improved seed varieties and farmer training through extension services, can enhance adoption and ensure alignment with local agro-ecological conditions, supporting both climate mitigation and food security in Pakistan.

- **Soil Health Management:** Conservation agriculture practices, such as zero tillage and cover cropping, are employed in India and Sri Lanka to enhance soil structure and promote carbon sequestration. Organic farming and integrated nutrient management to reduce chemical fertilizer dependency in Laos and Thailand.
- **Agroforestry and Silvopasture:** Integrating trees into farmlands in Malaysia and Myanmar to provide shade, fodder, and carbon sinks while diversifying income through timber and fruit. Silvopasture systems in Iran and Fiji to enhance livestock resilience and reduce land degradation [UNEP, 2021].
- **Livestock and Fisheries Management:** Improved feed and breed management to reduce methane emissions from livestock in India and Mongolia. Climate-resilient aquaculture practices in coastal areas of Bangladesh and Vietnam to counter salinity intrusion.
- **Digital and Precision Agriculture:** Mobile-based weather advisories and market information systems are used in India, Bangladesh, and the Philippines to inform planting and sales decisions. Satellite-based crop monitoring and drone applications for precision input use in Thailand and Malaysia [World Bank, 2022].

CSA for Rural Development in CIRDAP Countries

CSA contributes to climate-resilient rural development in CMCs by addressing socio-economic and environmental dimensions:

- **Livelihood Security:** By stabilizing yields and diversifying income sources, CSA reduces rural poverty and migration pressures, particularly for smallholder farmers and women, who are often marginalized in countries like Nepal and Afghanistan [UNDP, 2020].
- **Food and Nutrition Security:** CSA promotes the cultivation of nutrient-rich crops and resilient food systems, addressing malnutrition prevalent in rural areas of Pakistan, India, and Indonesia.
- **Gender and Social Inclusion:** CSA interventions prioritize women and youth through training in modern farming techniques and access to resources, as seen in community-based programs in Bangladesh and Sri Lanka [UN Women, 2021].
- **Ecosystem Restoration:** Practices like agroforestry and watershed management restore degraded landscapes, benefiting biodiversity and water resources in countries like Laos and Fiji.
- **Economic Resilience:** CSA fosters market linkages and value addition (e.g., organic produce markets in Thailand), cushioning rural economies against climate-induced disruptions [ADB, 2021].

Enabling Environment for CSA Adoption:

Scaling CSA in CIRDAP countries requires a supportive ecosystem, and as explained in the following

- **Policy and Institutional Support:** Governments must integrate CSA into national agricultural and climate policies, as seen in India's National Mission for Sustainable Agriculture and Vietnam's Climate-Resilient Agriculture Strategy [Ministry of Agriculture, India, 2022; Government of Vietnam, 2022]. CIRDAP can facilitate regional knowledge exchange, leveraging platforms like the CIRDAP Technical Committee to share best practices.
- **Access to Finance:** Microcredit, insurance, and subsidies for CSA technologies (e.g., solar pumps, drought-tolerant seeds) can bridge adoption gaps for resource-poor farmers in Pakistan and Bangladesh. Public-private partnerships can mobilize investments, as demonstrated by agribusiness collaborations in Malaysia.
- **Capacity Building and Extension Services:** Training farmers in CSA practices through farmer field schools, as practiced in Indonesia and the Philippines, enhances adoption rates. Strengthening extension systems with digital tools ensures timely advisory services, particularly in remote areas of Afghanistan and Myanmar. Iran's agricultural extension services, particularly through Agricultural Extension Model Sites (AEMSs), have demonstrated significant positive impacts. Extension interventions have increased irrigated wheat yields by an average of 0.66 tons per hectare, with every dollar invested generating approximately $60 in net profit for farmers (Shokati Amghani et al., 2023). These services have improved farm management, input use efficiency, and fostered behavioral changes. While challenges remain, they are not unique to Iran but shared regionally (Mojtahedi et al., 2025)
- **Research and Innovation:** Institutions like the International Rice Research Institute (IRRI) in the Philippines must make critical investments in climate-resilient crop breeding and localized CSA models [IRRI, 2023]. Regional research networks under CIRDAP can foster innovation tailored to smallholder needs.
- **Community Engagement:** Participatory approaches, such as community-managed seed banks in Nepal and India, ensure CSA aligns with local knowledge and priorities.

Challenges in Implementing CSA Despite its potential, CSA faces hurdles in CIRDAP countries:

- **Resource Constraints:** Limited access to finance, technology, and inputs hampers adoption, especially for marginal farmers in Laos and Afghanistan [World Bank, 2023].
- **Knowledge Gaps:** In countries where there is low awareness and technical expertise among farmers and extension agents can hinder progress.
- **Policy Fragmentation:** Inconsistent policies and weak coordination between agriculture and climate ministries in some countries undermine CSA scaling [UNESCAP, 2023].
- **Land Tenure Issues:** Insecure land rights in parts of Pakistan and Indonesia discourage long-term investments in CSA practices like agroforestry.
- **Market Barriers:** Lack of premium markets for climate-smart products limits economic incentives for farmers in Sri Lanka and Fiji.

A Step Forward

To maximize CSA's impact on climate-resilient rural development, CMCs should strengthen regional collaboration to leverage CIRDAP's platform to share CSA success stories, such as Bangladesh's floating gardens or India's zero-budget natural farming, across borders [CIRDAP, 2023]. There is a need to prioritize vulnerable groups to target CSA interventions toward women, youth, and indigenous communities to ensure inclusive development [UN

Women, 2021]. Expand access to climate information services and digital marketplaces to empower farmers in remote areas and mobilize climate finance to tap into global funds like the Green Climate Fund to support CSA projects, particularly in least-developed member countries like Afghanistan and Nepal [UNFCCC, 2022]. It is important to monitor, evaluate and establish robust frameworks to track CSA outcomes, ensuring adaptive management and evidence-based scaling. By integrating productivity, adaptation, and mitigation, CSA addresses the region's unique climate challenges while advancing food security, reducing poverty, and promoting environmental sustainability. Through targeted policies, inclusive interventions, and regional cooperation facilitated by CIRDAP, CSA can transform rural landscapes, ensuring that agriculture remains a viable and resilient livelihood for millions across Asia and the Pacific. Commitment to innovation, equity, and collaboration will be key to unlocking CSA's full potential in a changing climate.

3.2 Strengthening Rural Infrastructure

CMCs, including Bangladesh, India, Indonesia, Pakistan, the Philippines, Thailand, and others, face significant climate challenges that impact rural communities. Robust infrastructure is critical for enhancing climate resilience, ensuring food security, improving livelihoods, and promoting sustainable development in rural areas. Resilient infrastructure reduces vulnerability, supports recovery, and ensures continuity of essential services during climate shocks. Rural infrastructure includes roads, bridges, irrigation systems, water supply, drainage canals, and flood protection structures. They enhance access to markets, healthcare, and education, reducing vulnerability and supporting climate-smart agriculture through improved irrigation and water management. Efficient infrastructure also mitigates disaster impacts via resilient designs (e.g., flood-resistant roads, bio-engineered embankments) and promotes sustainable livelihoods by enabling diversified economic activities.

3.2.1 Strategies for Strengthening Rural Infrastructure

A: Climate-Resilient Design and Construction

Incorporate soil-bioengineering (e.g., planting trees, grasses) to stabilize infrastructure and reduce erosion and use durable, locally sourced materials and adhere to updated building codes to withstand extreme weather. In Timor-Leste, UNDP's SSRI project designed 20 climate-resilient infrastructure projects, benefiting over 100,000 people [UNDP, 2021].

Use natural systems (e.g., wetlands, mangroves) to enhance flood protection and water retention as green infrastructure. Plant trees along infrastructure corridors to reduce soil erosion and provide shade. In Bangladesh, the Sustainable Rural Infrastructure Improvement Project emphasized green elements in design.

B. Community-Driven Planning and Implementation

Use a participatory approach to engage communities in identifying needs and implementing projects to ensure ownership and sustainability. Training local communities and administrations in climate-resilient planning and maintenance is essential. In Timor-Leste's SSRI project, communities were trained in participatory planning, enhancing local resilience.

C. Investment in Small-Scale Infrastructure and Policy Support

Focus on roads, irrigation, and water supply systems tailored to local climate risks. Provide investment grants for climate-resilient infrastructure, as seen in Timor-Leste with UNDP's LDCF funds. ADB's $6 million grant in Timor-Leste improved water access and agroforestry productivity, mainstreaming climate resilience into rural development policies, as in Timor-Leste's National Climate Change Policy.

Establish multi-stakeholder platforms for sharing climate data and best practices. The Coalition for Disaster Resilient Infrastructure (CDRI), led by India,

supported policy upgrades for resilient infrastructure [CDRI, 2023]. Using climate finance to leverage funds from Green Climate Fund, ADB, and UNDP for infrastructure projects will help to a greater extent. Promoting insurance and financial arrangements to support infrastructure recovery post-disaster is key for development. Strengthening rural infrastructure is a cornerstone of climate-resilient rural development in CMCs and requires multi-sectoral approaches, community engagement, and innovative financing. Further, by integrating climate-proof designs, ecosystem-based approaches, and robust policies, these countries can enhance resilience, reduce poverty, and promote sustainable growth [ADB, 2021]. Recent projects demonstrate progress, but scaling up investments and addressing capacity gaps are critical for long-term success. Resilient infrastructure underpins broader poverty reduction goals, food security, and gender equality. CIRDAP can drive regional cooperation to build adaptive, inclusive rural economies.

3.3 Role of Start-Up Ecosystems

START-UP ECOSYSTEMS COMPONENTS

Access to Funding: Venture capital, grants, and government subsidies.

Mentorship and Support: Incubators and accelerators providing guidance.

Infrastructure: Digital connectivity and physical facilities.

Regulatory Environment: Policies that encourage innovation.

Market Opportunities: Access to local and global markets.

A start-up ecosystem is a network of interconnected entities—entrepreneurs, investors, incubators, accelerators, universities, and governments—that support the creation, growth, and success of start-up companies. Given the increasing impact of climate change on rural areas, CIRDAP's work emphasizes resilience, as evidenced by publications like "Climate Change Vulnerability Cases from CMCs", which examines ecosystem services and livelihoods in a changing climate [CIRDAP, 2016]. Key components include:

In rural development, start-up ecosystems focus on sectors like agritech, which enhances agricultural productivity, and cleantech/greentech, which promotes environmental sustainability. Start-up ecosystems drive climate-resilient rural development in CMCs by developing digital platforms, precision farming tools, and supply chain solutions to improve agricultural resilience and food security. They also create renewable energy solutions, waste management systems, and climate-smart technologies to reduce environmental impact. They enhance digital access to expand internet connectivity and literacy, enabling rural communities to adopt modern technologies and bringing together governments, development partners, and the private sector to scale solutions [UNESCAP, 2023]. These efforts align with the global Sustainable Development Goals, particularly those related to climate action, zero hunger, and sustainable communities.

3.3.1 Case Studies from CMCs

3.3.1.1 The Philippines

The Philippines, a CIRDAP member country, has a vibrant start-up ecosystem supported by government policies and international organizations. The Asian Development Bank (ADB) highlights the ecosystem's focus on four sectors: climate change, education, agriculture, and health (ADB, Philippines Ecosystem Report, 2022). In the Philippines, start-ups like Mayani and Cropital enhance agricultural productivity and sustainability, supported by robust government policies (Philippines Ecosystem Report, 2022). Agritech and cleantech start-ups contribute to climate-resilient rural development by enabling farmers to adopt sustainable practices, reducing emissions through renewable energy, and strengthening rural economies (Climate Tech Startups, 2024).

Agritech Contributions: Agritech start-ups enhance rural livelihoods by improving farm productivity and market access. Notable examples include:

• **Mayani:** A digital platform connecting smallholder farmers to urban markets, reducing post-harvest losses and increasing income (Philippines Ecosystem Report, 2022).

• **Cropital:** Provides financing and technology solutions to farmers, enabling them to adopt climate-smart practices (Philippines Ecosystem Report, 2022). These start-ups address climate resilience by promoting sustainable farming and reducing vulnerability to climate-induced disruptions (Climate Tech Startups, 2024).

Cleantech Contributions: Cleantech start-ups focus on green technologies to mitigate climate change. Examples include initiatives for rural electrification and smart waste management, which reduce greenhouse gas emissions and improve energy access in remote areas (Climate Tech Startups, 2024).

The Philippine government supports start-ups through the Innovative Startup Act and the Philippine Innovation Act (Philippines Ecosystem Report, 2022). The PCAARRD Startup Grant Fund, provides up to ₱5 million per agritech start-up for product development and marketability, with seven grants awarded out of 20 proposals in 2021 (Philippines Ecosystem Report, 2022). Another initiative, such as Agriculture Technology Business Incubators (ATBIs), has been established since 2017, with 22 ATBIs supporting over 300 incubators through ₱230 million in funding (Philippines Ecosystem Report, 2022). Incubators like the AIM-Dado Banatao (27 graduates, including Mayani) and UPSCALE (34 graduates, including Cropital) further bolster the ecosystem (Philippines Ecosystem Report, 2022).

However, despite progress, agritech and cleantech start-ups attract minimal funding (3.1% and 0.12% of total start-up funding in 2021, respectively) (Philippines Ecosystem Report, 2022). Challenges include limited digital infrastructure in rural areas and low digital literacy among farmers (average age 57) (Philippines Ecosystem Report, 2022). Some recommendations involve improving rural internet connectivity (e.g., expanding DICT's 11,000+ free WiFi sites), enhancing digital literacy through agricultural extension services, and creating co-financing schemes to support local governments in building start-up ecosystems (Philippines Ecosystem Report, 2022).

3.3.1.2 Cambodia

Cambodia's start-up ecosystem is growing, with a focus on agriculture and climate change, supported by government strategies and development partners (ADB, Cambodia Ecosystem Report, 2022). In Cambodia, greentech initiatives like EnergyLab and agritech projects like Chamka promote clean energy and sustainable farming (Cambodia Ecosystem Report, 2022).

Greentech and agritech start-ups enhance climate resilience by promoting clean energy, improving agricultural practices, and providing rural communities with tools to adapt to climate change (Climate Tech Startups, 2024). For example, Chamka helps farmers adopt sustainable practices, while EnergyLab's initiatives reduce carbon emissions (Cambodia Ecosystem Report, 2022).

Greentech start-ups address climate resilience through EnergyLab Cambodia, which launched the Smart Energy Hackathon in 2018, supported by the British Embassy, Smart Axiata, and UNDP, to promote clean energy innovations (Cambodia Ecosystem Report, 2022). It also hosts Clean Energy Week and provides incubation services (Cambodia Ecosystem Report, 2022). Furthermore, Total Cambodia, an oil and gas company, runs Startupper Total Challenge, offering seed capital and mentoring for energy-related business ideas (Cambodia Ecosystem Report, 2022). These initiatives focus on rural electrification, clean energy for agriculture, and smart waste management, reducing reliance on fossil fuels (Climate Tech Startups, 2024).

Agritech start-ups are transforming rural agriculture, like BlocRice (Oxfam), which uses blockchain for rice traceability, ensuring sustainability and fair trade, and another RIICE that employs remote sensing for crop monitoring, helping farmers adapt to climate variability (Cambodia Ecosystem Report, 2022). The Chamka Mobile App, developed by the International Fund for Agricultural Development (IFAD) and the Ministry of Agriculture, Forestry, and Fisheries (MAFF), provides farmers with agricultural advice and market information (IFAD, Integrated Farming Strengthens Climate Resilience in Cambodia, 2021). The SAAMBAT program, supported by IFAD, includes the Khmer Agriculture Suite (KAS) platform to enhance agricultural productivity (Integrated Farming Strengthens Climate Resilience in Cambodia, 2021). Development partners like UNDP, Oxfam, and the Cambodia Climate Change Alliance support greentech and agritech initiatives (Cambodia Ecosystem Report, 2022).

Some challenges include limited digital infrastructure (fixed broadband at 1.69% of the population in 2020) and low digital literacy (30% with basic skills) (Cambodia Ecosystem Report, 2022). Expanding digital literacy programs to rural areas, targeting women, is recommended along with establishing science and technology parks in provinces and co-investing in venture capital for agritech and greentech (Cambodia Ecosystem Report, 2022).

3.3.1.3 India

Climate change poses significant challenges to rural India, including unpredictable weather patterns, droughts, floods, and declining agricultural productivity. The Indian government, through initiatives like the National Action Plan on Climate Change (NAPCC), the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), and state-level programs, has supported startups to foster climate-resilient rural development. Government-led initiatives like MGNREGS, PM-KUSUM, and NICRA have catalyzed the growth of startups like Varaha, Thinkraw, and Plastroots, driving climate-resilient rural development in India. These startups demonstrate the power of innovation, community engagement, and public-private collaboration by addressing challenges in agriculture, energy, and waste management. Other Government-led and supported startups like Solnce Technologies, Zaara Biotech, and Oorja Development Solutions are pivotal in building climate-resilient rural India.

Key Government of India Initiatives Supporting Startups

- ***National Action Plan on Climate Change (NAPCC):*** Launched in 2008, it emphasizes sustainable agriculture and rural development through programs like the Green India Mission. It encourages startups to integrate AI and data analytics for climate-resilient farming.
- ***Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS):*** Links climate resilience with rural employment by funding projects like water conservation and sustainable agriculture, often implemented with startup innovations.
- ***Kerala Startup Mission (KSUM):*** Supports climate tech startups in Kerala, focusing on carbon capture and sustainable agriculture to address local climate challenges.
- ***Atal Incubation Centre (AIC):*** Incubates startups, such as those in Baramati, Maharashtra, to develop clean energy solutions for rural farmers.
- ***Saagu Baagu Project (Telangana):*** A government-led initiative using AI tools to assist farmers with climate-smart agriculture, demonstrating scalable models for startups.
- ***PM-KUSUM Scheme:*** Promotes solar energy access for agriculture, enabling startups to deploy solar-powered solutions in rural areas.

By addressing water scarcity, sustainable agriculture, clean energy, and waste management, these startups in India align with national and state-level climate goals. Continued government support through funding, policy, and digital tools will be crucial to scale their impact, ensuring rural communities thrive amidst climate challenges. Continued investment, policy support, and awareness campaigns are also essential to scale their impact and ensure a sustainable, climate-resilient future for rural India.

3.3.1.4 IRAN

Iran's Experiences in Enhancing Climate Resilience in the Agricultural Sector:

In Iran, solutions implemented to reduce water consumption in the agricultural sector have, in some cases, led to successes in enhancing climate resilience in the agricultural sector. Some of these solutions are mentioned below:

- **Change in Irrigation Method**

One of the fundamental solutions for reducing water consumption in the agricultural sector has been the use of modern irrigation methods. Although the use of modern irrigation methods requires significant investment, in Iran, to preserve groundwater resources, especially in some integrated lands, modern irrigation methods have been adopted: in both pressurized irrigation methods, water is pumped through pipes that extend to the base of the plant, and plants are irrigated along the pipe. In

drip irrigation, water loss is only 10%, and irrigation efficiency reaches 90%. In sprinkler irrigation, efficiency is about 70%.

- **Greenhouse Cultivation:**

Another technique for combating drought in Iranian agriculture is the expansion of greenhouse cultivation. In greenhouse cultivation, crops are protected from damaging factors such as wind, storms, cold, and frost. Products currently cultivated this way include ornamental flowers and plants, vegetables, and summer crops. A significant capability of greenhouse cultivation is the possibility of growing various products outside their natural growing season, and this production method has today become one of the most profitable sectors of agriculture. For example, using this method, products such as cucumbers, melons, watermelons, tomatoes, etc., whose growing season is in spring and summer, can be cultivated in winter. Water consumption in greenhouses is 10 times less than traditional agricultural patterns, and crop yield is 15 times higher.

- **Land Consolidation with Emphasis on Paddy Fields:**

Land consolidation of paddy fields practically means converting non-geometric paddy fields into geometric land parcels, along with improving access to road networks, irrigation, and drainage, and facilitating the use of modern agricultural machinery; in other words, one of the goals of land consolidation is to enhance water productivity and improve the irrigation system, which itself leads to improved resilience against climate disasters. In general, field evaluations have shown that after the consolidation of paddy fields, not only are water resource issues reduced, but working and production conditions, as well as the road system and farms, have improved to some extent; however, the reduction of production costs and control of production quantity according to market demand, the unification of land parcels, and overall improvement of farmers' conditions have not been fully realized. Although after the consolidation of paddy fields, production diversity has given way to monoculture rice cultivation, thereby significantly reducing the role of production diversity in improving resilience against climate disasters. However, overall, the effects of paddy field consolidation on "climate-resilient rural development" can be summarized as follows:

- ✓ Land consolidation leads to a 25% saving in water consumption, thereby increasing resilience against climate disasters.
- ✓ With improved drainage systems after land consolidation, harvesting, threshing, and transportation of products have been facilitated.
- ✓ Agricultural land consolidation, when carried out in a scientific and participatory manner, while preventing the waste of basic resources, especially water, has improved resilience against climate disasters and played an important role in rural development.

3.3.1.5 Sri Lanka

Some of the key interventions and startups in Sri Lanka are detailed below.

Govi Mithuru ("Farmer's Friend") by Dialog Axiata PLC : It is a mobile-based advisory service that provides personalized agricultural guidance to Sri Lankan farmers via simple voice messages in local languages (Sinhala and Tamil). It is a key example of how digital innovation supports climate adaptation and productivity in rural farming. Some of the key features are: It is delivered via basic mobile phones (no smartphone required) and the content is customized by crop, region, and growth stage. Other advice in this service includes climate-smart cultivation practices, pest and disease alerts, Fertilizer application timing, Weather forecasts, and harvest planning. The climate change adaptation benefits include, improved preparedness for climate variability, encourages diversification, and reduces crop loss risks. Over 600,000 users across Sri Lanka (2022) used the services. This model is scalable, inclusive, climate smart and runs on public-private partnerships

Alignment with CIRDAP's Mission

CIRDAP's mission to promote integrated rural development and poverty alleviation aligns closely with the contributions of start-up ecosystems (CIRDAP, About Page, 2023). Its publication Climate Change Vulnerability Cases from CMCs (2016) highlights the impact of climate change on rural livelihoods and ecosystems, suggesting a recognition of the need for innovative solutions (CIRDAP Vulnerability Cases, 2016). While direct CIRDAP

initiatives for start-ups are not well-documented, its focus on climate resilience and rural development implies support for approaches like agritech and cleantech (CIRDAP Vulnerability Cases, 2016). Start-up ecosystems can complement CIRDAP's efforts by scaling innovative technologies to rural areas, enhancing collaboration between governments, private sectors, and communities, and addressing climate vulnerabilities through sustainable practices.

Some of the challenges and opportunities include limited funding for agritech and cleantech start-ups, which receive a small share of investments compared to fintech and e-commerce (Climate Tech Startups, 2024). Digital infrastructure in rural areas of CIRDAP countries often lacks reliable internet and digital tools, and older farmers and rural communities may struggle to adopt new technologies (Philippines Ecosystem Report, 2022; Cambodia Ecosystem Report, 2022). Some countries lack comprehensive start-up policies tailored to climate resilience. Hence, policy support and cooperation of development partners like ADB, IFAD, and UNDP that offer funding and expertise are very much required (Philippines Ecosystem Report, 2022; Cambodia Ecosystem Report, 2022). Moreover, regional collaboration by CIRDAP can facilitate knowledge-sharing among member countries to scale successful start-up models (CIRDAP, 2023).

Recommendations for CMCs

To maximize the impact of start-up ecosystems on climate-resilient rural development, CMCs should:

- ***Develop Targeted Policies:*** Create start-up policies focused on agritech and cleantech, with incentives for climate-resilient solutions (Philippines Ecosystem Report, 2022).
- ***Enhance Digital Infrastructure:*** Invest in rural broadband and digital platforms to support start-up growth (Cambodia Ecosystem Report, 2022).
- ***Promote Digital Literacy:*** Implement training programs for farmers and rural communities to adopt new technologies (Philippines Ecosystem Report, 2022).
- ***Increase Funding Access:*** Establish venture capital funds and public-private partnerships to support agritech and cleantech start-ups (Climate Tech Startups, 2024).
- ***Leverage CIRDAP's Platform:*** Use CIRDAP's network to share best practices and scale successful start-up models across member countries.

The start-up ecosystem in CIRDAP countries catalyzes climate-resilient rural development, blending innovation with local wisdom. By addressing systemic barriers and fostering collaboration, these ecosystems empower communities to adapt to climate change while driving economic growth (Climate Tech Startups, 2024). Governments, investors, and civil society must prioritize nurturing this ecosystem through targeted policies, funding, and capacity-building to unlock its full potential. These efforts align with CIRDAP's mission to improve rural livelihoods and resilience, offering a scalable model for other member countries. CIRDAP countries can harness start-up ecosystems to build a more climate-resilient future by addressing challenges like funding and digital infrastructure (Philippines Ecosystem Report, 2022; Cambodia Ecosystem Report, 2022).

3.4 Improving Access to Climate Information and Technology

Improving access to climate information and technology is a cornerstone for climate-resilient rural development. It enables communities to adapt, enhance agricultural productivity, and secure livelihoods. To plan agricultural activities, rural communities should have access to timely climate information (e.g., early warning systems, weather forecasts). They should also support the diffusion of climate-resilient technologies (e.g., solar-powered irrigation and drought-resistant crop varieties) (Climate Tech Startups, 2024).

3.4.1 Importance of Climate Information and Technology

Climate information encompasses data on weather patterns, seasonal forecasts, and long-term climate projections, often delivered through early warning systems, digital platforms, or extension services. Climate-smart technologies include resilient crop varieties, precision agriculture tools, and water management systems (Climate Tech Startups, 2024). Together, they empower rural communities to:

Anticipate and Prepare: Early warnings for floods or droughts enable timely actions like crop diversification or evacuation.

Enhance Productivity: Technologies like drought-resistant seeds or automated irrigation boost yields under adverse conditions (Climate Tech Startups, 2024).

Reduce Vulnerability: Data-driven decisions strengthen infrastructure and livelihoods against climate shocks. The Intergovernmental Panel on Climate Change (IPCC) emphasizes that integrating climate information into development planning reduces risks and fosters resilience, particularly in agriculture-dependent regions (IPCC, 2022).

3.4.2 Strategies for Improving Access

3.4.2.1Strengthening Climate Information Systems:

Robust climate information systems require reliable data collection, analysis, and dissemination. Key approaches include digitizing historical data. Programs like the UNDP's Climate Information for Resilient Development in Africa (CIRDA) demonstrate the value of digitizing historical climate records to improve forecasting accuracy (UNDP, 2021). Similar efforts in CIRDAP countries, such as Bangladesh's meteorological upgrades, enhance early warning systems. Further, regional coordination by CIRDAP can facilitate cross-country data sharing, as seen in the Pacific Regional Strategic Program for Climate Resilience (SPCR), which scaled best practices across Pacific nations (SPCR, 2020). Tailored dissemination through SMS, radio, or mobile apps ensures rural farmers receive actionable insights. India's Agro-Advisory Services, delivering weather forecasts to millions of farmers via SMS, is a model for replication (Government of India, 2021). In Pakistan, scaling digital tools, such as weather forecasting apps for farmers, faces significant challenges in rural areas due to low internet penetration. In regions like Sindh, where only 28% of rural households have internet access, the reliance on high-tech solutions is hindered by limited connectivity, high data costs, and a lack of digital literacy. Smallholder farmers, who form the backbone of rural economies, often lack smartphones or the technical know-how to use apps effectively, further limiting adoption. Additionally, inconsistent electricity supply and the high cost of maintaining digital infrastructure in remote areas exacerbate these barriers, making it difficult to deliver real-time climate information to vulnerable communities.

To address these challenges, a dual approach combining low-tech and high-tech solutions is essential. Low-tech options, such as radio-based early warning systems, can effectively reach farmers in areas with low internet access, as radios are widely available and cost-effective. Community radio stations can broadcast weather updates, disaster alerts, and agricultural advice in local languages, ensuring accessibility. Simultaneously, high-tech innovations like SMS-based alerts or offline-capable apps can complement these efforts for farmers with basic mobile phones. Partnerships with local agricultural extension services and NGOs can further enhance outreach by training farmers to use these tools, blending traditional communication channels with scalable digital solutions to build climate resilience.

3.4.2.2 Deploying Climate-Smart Technologies

Adopting technologies suited to local agro-ecological conditions is critical (Climate Tech Startups, 2024). Precision agriculture that uses IoT-based devices, as practiced in India's CultYvate system, monitors soil health and optimizes irrigation, increasing yields by 16% and farmer incomes by ~USD 1,000 per hectare (CultYvate, 2023). Growing resilient crop varieties like in Sri Lanka, the USAID SOLID project introduced off-season chili cultivation with sprinkler irrigation, enhancing resilience to weather variability (USAID, SOLID Project, 2022). Water management in Cambodia's Integrated Water Resources Management Project promotes alternate wetting and drying (AWD) techniques, reducing emissions by 11,750 tons of CO2 equivalent while improving rice yields (IFAD, Integrated Farming Strengthens Climate Resilience in Cambodia, 2021).

3.4.2.3 Building Institutional and Community Capacity

Capacity building ensures effective use of information and technology. Using training programs' extension services in Bangladesh's Chittagong Hill Tracts, training farmers in climate-smart agriculture, boosts the adoption of resilient practices (ADB, 2023).

Farmer cooperatives in Niger's FCMN model, where farmers learn composting to improve soil fertility, can be adapted to enhance collective learning in CIRDAP countries (FAO, 2021). Climate-Smart Agriculture Investment Plans (CSAIPs), developed for countries like Bangladesh and Nepal, mainstream resilience into national policies (World Bank, 2022).

3.4.2.4 Leveraging Digital Infrastructure

Digital technologies amplify access for mobile platforms (Climate Tech Startups, 2024). In the Philippines, the Climate Change Commission's TRANSCEND Project supports MSMEs with digital tools for climate-resilient business planning (Climate Change Commission, 2022). UNDP's use of drone mapping in Timor-Leste for ridge-to-reef approaches can inform land-use planning in CIRDAP countries (UNDP, 2021). Advocating for open data sharing, as suggested by AVPN, fosters innovation and collaboration (AVPN, 2023).

3.4.2.5 Financing and Partnerships

Scaling access requires innovative financing, such as blended finance (Climate Tech Startups, 2024). As seen in APAC's climate tech ecosystem, combining public and private investments supports technology deployment (AVPN, 2023). Climate Investment Funds (CIF) have mobilized $12.5 billion for resilience projects and offer models for CIRDAP countries (CIF, 2023). Public-private partnership collaborations with telecom providers in India have expanded rural connectivity for climate apps (Government of India, 2021).

Case Studies in CMCs

In Bangladesh, under the Chittagong Hill Tracts Project, the Asian Development Bank (ADB) approved a $120 million loan to enhance climate resilience in Bangladesh's Chittagong Hill Tracts (ADB, 2023). The project improves rural roads, water supply, and watershed management while training farmers in climate-smart agriculture. Outcomes include increased crop yields and reduced disaster risks, demonstrating the impact of integrated climate information and technology (ADB, 2023). In India, under CultYvate's SMART Irrigation program, CultYvate's IoT-based irrigation system uses real-time climate data to optimize water use, achieving a 16% yield increase (CultYvate, 2023). Scaled across India, it showcases how digital tools can transform rural agriculture, a model applicable to other CIRDAP nations (Climate Tech Startups, 2024). In Sri Lanka under the USAID SOLID Project, the SOLID project introduced climate-resilient dairy and chili cultivation practices, increasing milk production by 20% for 50% of farmers (USAID, SOLID Project, 2022). By integrating weather data and irrigation technologies, it enhanced rural livelihoods.

Despite progress, several challenges persist like data gaps, infrastructure limitations, capacity gaps, and policy fragmentation. Many CIRDAP countries lack digitized historical climate data, hindering accurate forecasting. Rural areas often lack connectivity for digital tools, as seen in remote parts of Afghanistan and Myanmar. High upfront costs for technologies like IoT devices deter adoption, particularly for smallholder farmers, and limited technical skills among farmers and extension workers slow technology uptake (Climate Tech Startups, 2024). Inconsistent integration of climate resilience into national plans, as noted in IPCC reports, undermines scalability (IPCC, 2022).

It is worthwhile to have some recommendations for CMCs like the creation of a centralized platform for data sharing, modelled on CIRDAP, to enhance forecasting and resilience planning (UNDP, 2021). Expand India's SMS-based advisory model to deliver tailored climate information across member countries (Government of India, 2021). Promoting affordable technologies and subsidizing low-cost tools like drip irrigation or resilient seeds is helpful, drawing on Cambodia's AWD success (IFAD, Integrated Farming Strengthens Climate Resilience in Cambodia, 2021). There is a need to develop training modules for farmers and officials, leveraging Niger's cooperative model (FAO, 2021), and secure climate financing while tapping into CIF or Green Climate Fund resources to fund infrastructure and technology deployment (CIF, 2023). Finally, align national adaptation plans with CSAIPs to mainstream resilience, as done in Bangladesh (World Bank, 2022).

Improving access to climate information and technology is pivotal for climate-resilient rural development in CMCs. These nations can enhance agricultural resilience and safeguard rural livelihoods by strengthening data systems, deploying innovative technologies, building capacity, and securing financing (Climate Tech Startups, 2024). Case studies from Bangladesh, India, and Sri Lanka highlight practical pathways, while challenges like data gaps

and financing underscore the need for coordinated action. CIRDAP's role as a regional facilitator can drive collaboration, ensuring that climate-resilient development becomes a reality for millions of rural inhabitants (CIRDAP, 2023).

3.5 Capacity Building and Knowledge Sharing

CMCs face heightened vulnerability to climate change due to their reliance on climate-sensitive sectors (e.g., agriculture, fisheries) and limited adaptive capacities in rural areas. Capacity building and knowledge sharing are critical to empowering communities, institutions, and governments to implement climate-resilient strategies. In countries like Bangladesh, India, Indonesia, climate risks are high, affected by floods, droughts, and rising sea levels, which impact agriculture, livelihoods, and food security. Capacity building equips farmers, local leaders, and institutions with tools to adopt climate-smart practices, while knowledge sharing ensures scalable solutions (CIRDAP, 2023). As a regional intergovernmental organization, CIRDAP facilitates capacity building and knowledge sharing to promote integrated rural development aligned with Sustainable Development Goals (SDGs).

3.5.1 Leveraging Regional Cooperation and Technological Capacities

To effectively leverage technological capacities, the following operational steps are recommended:

- **Assess Technological Needs:** Identify and list the technological requirements of member countries.
- **Evaluate Existing Capacities:** Map current technological capabilities within member states.
- **Build Capacity for Technology Transfer:** Develop skills and infrastructure to facilitate technology sharing.
- **Establish Transfer Mechanisms:** Consider forming a dedicated committee to oversee technology transfer processes.
- **Facilitating Access to Knowledge and Technology for Final Users:** Strategies must be practical, accessible, and relevant to end-users such as farmers, rural communities, and local governments. A distinctive feature is the use of digital platforms designed for user-friendly access. These platforms should enable users to benefit from shared practical experiences across the region, raising awareness and fostering adoption of best practices.

3.5.1.1 Specific Capacity Building Initiatives taken up by CIRDAP

International Training Program on Disaster Management and Climate Change Adaptation (Pakistan, January 2025): Organized by Akhtar Hameed Khan National Centre for Rural Development (AHKNCRD) and CIRDAP, the training was held from January 12-22, 2025, in Islamabad, Pakistan (Figure 4). Ten CMCs participated: Pakistan, Bangladesh, Fiji, Myanmar, Thailand, Sri Lanka, Malaysia, Indonesia, Nepal, and Iran. The training focused on teaching participant's disaster management and climate adaptation skills through in-house sessions and field visits. The outcome was that participants gained practical knowledge on implementing climate adaptation strategies in their countries.

Figure 4. Participants of the CMCs at the International Training Program on Disaster Management and Climate Change Adaptation held in Pakistan, January 2025

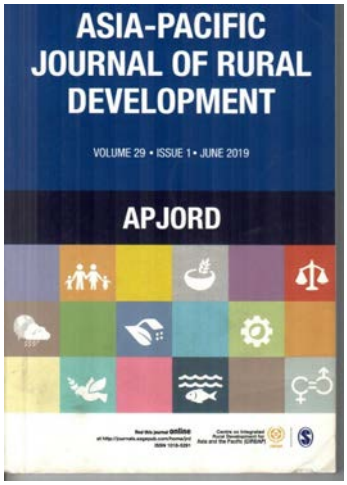
CIRDAP-BARD Regional Training Programs (Bangladesh, 2022–2023): The 1st Flagship training (November 4–25, 2022) was held with 18 participants (9 female, 9 male) representing 11 CIRDAP countries in a program on Integrated Rural Development, Governance, Trade, and Sustainable Development. Topics included climate change and natural disaster management. The 2nd Flagship Training (November 3–27, 2023) was conducted with 24 participants (11 female, 13 male) from 14 countries (Figure 5), covering similar themes on climate resilience and rural policy-making. The outcome of both trainings was enhanced knowledge in climate adaptation, policy-making, and gender-inclusive governance. Participants reported improved understanding of regional challenges and solutions.

Likewise, many capacity building activities were conducted in Southeast Asian countries involving the designated Climate-Smart Villages (CSVs). In the Philippines (2019), twenty-one Adaptation and Mitigation Initiative in Agriculture (AMIA) villages were established, integrating CSV approaches to train farmers in climate-smart agriculture (CSA) practices like drought-resistant crops and water management (CGIAR, 2019). In countries like Vietnam and Laos, Climate-Smart Agriculture trainings were conducted in CSVs particularly to enhance food security and nutrition (CGIAR, 2019). Farmers in these countries adopted resilient practices, improving yields and livelihoods. CSVs served as learning hubs for scaling CSA (CGIAR, 2019).

Figure 5. Participants of the CMCs at 2nd Flagship training program on Integrated Rural Development, Governance, Trade, and Sustainable Development held in Bangladesh, November 2023

3.5.2 Specific Knowledge Sharing Initiatives

CIRDAP's Asia-Pacific Journal of Rural Development (APJORD): A bi-annual journal published by CIRDAP since 1991, focusing on rural development issues, including climate change. This provides a platform for policymakers, academics, and NGOs to share research and case studies on climate resilience. For example, a 2016 monograph, Climate Change Vulnerability - Cases from CMCs, included studies from Bangladesh, Fiji, Iran, Nepal, and Thailand, highlighting adaptation strategies like flood-resistant farming and community-based disaster preparedness.



Roving Workshops for CSVs (2015–2018): A workshop was conducted by CGIAR's Climate Change, Agriculture and Food Security (CCAFS) program in Southeast Asia, which involved 135 participants from CIRDAP countries like Vietnam, the Philippines, and Laos (CGIAR, 2018). In the workshop, sharing practical CSA knowledge through field demonstrations and translating guides into local languages helped the participants (CGIAR, 2018). The workshop's outcome was increased adoption of CSA practices, with Vietnam integrating CSVs into national rural development plans (CGIAR, 2018).

South-South Cooperation: CIRDAP facilitates exchange visits and knowledge transfer. For example, Bangladesh's flood-resistant farming techniques were shared with Nepal and India through CIRDAP workshops. In 2023, CIRDAP collaborated with the International Centre for Integrated Mountain Development (ICIMOD) to share climate adaptation strategies for Afghanistan, Nepal, and Pakistan mountain communities.

Digital Knowledge Platforms: CIRDAP plans to develop digital repositories for climate resilience case studies and toolkits, though specific platforms are under development as of 2025. In Indonesia, the WaterIQ initiative by Yayasan Solar Chapter uses IoT and cloud computing to monitor water systems, with data shared across CIRDAP networks to promote similar innovations.

3.5.3 Building Native Capacity to Minimize Damage from Natural Disasters in CIRDAP Member Countries

A. Strengthening Early Warning Systems and Preparedness- Effective early warning systems are crucial for mitigating the impacts of sudden-onset disasters, such as flash floods, cyclones, and landslides. Community training is vital, particularly in remote areas, to ensure residents can recognize and respond to early warning signals. Regular evacuation drills and emergency response training can enhance preparedness. Additionally, developing localized warning systems that account for regional languages, cultural practices, and accessibility ensures that marginalized groups, including women and children, receive critical information promptly.

B. Promoting Nature-Based Solutions- Nature-based solutions offer sustainable and cost-effective methods for reducing disaster risks while enhancing resilience in rural areas. Restoring ecosystems, such as forests, wetlands, mangroves, and coral reefs, can mitigate the impacts of floods, landslides, and storm surges. In hilly regions, afforestation and increased vegetation cover stabilize slopes and reduce soil erosion, thereby minimizing landslide risks. Protecting wetlands helps regulate floodwaters during monsoons, while avoiding development in floodplains reduces vulnerability. In fire-prone countries, promoting fire-resistant native plant species and implementing controlled burning practices can effectively manage wildfire risks.

C. Enhancing Infrastructure Resilience- Rural infrastructure in CIRDAP countries often lacks the resilience to withstand natural disasters. Adopting climate-resilient construction techniques, such

as utilizing locally sourced and environmentally responsible materials for homes, schools, and health centers, can help mitigate damage from cyclones, floods, and earthquakes. For instance, elevated homes in flood-prone areas have proven effective in minimizing inundation losses. Retrofitting critical infrastructure, such as hospitals and schools, to meet disaster-resistant standards is another key strategy. Combining natural and engineered solutions—so-called green-gray infrastructure—offers cost-effective protection.

D. Building Community-Based Disaster Risk Management- Empowering rural communities to manage disaster risks fosters long-term resilience. Community-based disaster risk management programs, such as those supported by UNICEF, engage women, children, and adolescents in planning and response, leveraging local knowledge for effective outcomes. Training local leaders and volunteers to coordinate disaster response during Typhoons strengthens community preparedness. Additionally, promoting livelihood diversification—such as aquaculture or agroforestry—reduces dependence on climate-sensitive agriculture, particularly in drought-prone areas of some countries.

E. Strengthening Institutional Capacity- Robust institutions are essential for effective disaster management. Integrating disaster risk reduction into national and local development plans, as exemplified by India's National Disaster Management Authority, ensures alignment with climate adaptation strategies. Training local governments and disaster management agencies in risk assessment, resource allocation, and post-disaster recovery is crucial, as they have limited institutional capacity. Regional cooperation through CIRDAP can amplify these efforts by facilitating the sharing of best practices, technologies, and resources. For instance, Thailand's expertise in flood management can benefit flood-prone neighbours, fostering a collaborative approach to resilience.

F. Addressing Health and Social Impacts- Natural disasters often trigger health crises, including disease outbreaks, malnutrition, and psychological stress, particularly in rural areas. Strengthening health systems with mobile clinics and telemedicine ensures access to care during disasters, as seen in India's child-centered disaster preparedness initiatives. Providing mental health support to address disaster-induced stress and trauma is equally essential, as these issues can exacerbate chronic conditions. Stockpiling emergency food and water supplies, as well as promoting water purification systems, can prevent disease outbreaks and ensure nutritional security.

G. Enhancing Financial Resilience - Economic losses from disasters disproportionately affect rural communities, underscoring the need for adequate financial mechanisms to support their recovery. Promoting microinsurance schemes for farmers and small businesses, as seen in India's crop insurance programs, helps cover losses from floods, droughts, and cyclones. Cash assistance programs provide immediate relief to affected households. Advocating for international funding to support adaptation measures is critical, as many CIRDAP countries face fiscal constraints. The IMF estimates that adaptation costs for low-income countries amount to 1% of GDP annually, underscoring the need for global support.

H. Integrating Climate Change Adaptation- Climate change intensifies natural disasters, requiring proactive adaptation strategies. Promoting climate-resilient agriculture, such as drought-resistant crops and efficient irrigation, as practiced in Ghana's cocoa farming, can enhance food security. Implementing rainwater harvesting and watershed management addresses water scarcity and flood risks, particularly in South Asia, where monsoon variability is increasing. Planning urban expansion to avoid encroachment on rural floodplains and forests, as needed in countries like Indonesia and Sri Lanka, reduces disaster risks and preserves ecosystems.

I. Supporting Vulnerable Populations- Children, women, and displaced populations are disproportionately affected by disasters. Child-centered programs, such as UNICEF's initiatives in

certain countries, prioritize safe schools, nutrition, and protection from exploitation during times of crisis. Gender-sensitive approaches ensure that women have access to resources, training, and leadership roles in disaster management, where women utilize invasive weeds for sustainable fuel after floods. Providing climate-resilient shelters and livelihood support for refugees and internally displaced people, as practiced by UNHCR, addresses the needs of displaced populations in climate-vulnerable regions.

J. Monitoring and Evaluation- Continuous monitoring and evaluation ensure that disaster risk reduction strategies remain effective and adaptable. Utilizing GIS and remote sensing for risk mapping enhances preparedness for floods and cyclones. Regular impact assessments of interventions, such as nature-based solutions and early warning systems, enable strategic refinements. Incorporating community feedback ensures that interventions are locally relevant and sustainable, fostering ownership and long-term success.

Building native capacity to minimize damage from natural disasters in CMCs demands a holistic approach that integrates technology, nature-based solutions, community empowerment, and institutional strengthening. By investing in early warning systems, resilient infrastructure, sustainable livelihoods, and robust institutions, these countries can reduce losses and enhance recovery for rural communities. Regional cooperation through CIRDAP can amplify these efforts by sharing knowledge and resources, ensuring that even the most vulnerable populations are equipped to face the growing challenges of climate-driven disasters. Through sustained commitment and collaboration, CIRDAP member countries can build a resilient future that protects lives, property, and livelihoods.

3.6 Inclusive and Gender-Responsive Policies

Women, particularly rural women, are disproportionately affected by climate change due to limited access to resources, decision-making power, and economic opportunities. Gender-responsive policies address these inequalities to enhance resilience and ensure equitable benefits from climate adaptation and mitigation efforts. Women in rural areas of CIRDAP countries (e.g., Bangladesh, India, Nepal) often rely on climate-sensitive sectors like agriculture, making them vulnerable to climate variability. Gender inequalities exacerbate vulnerabilities, limiting women's ability to adopt climate-smart practices or access financial services. Policies must integrate gender equality into climate change adaptation and disaster risk management (CCDRM) frameworks, ensuring women's participation in decision-making. Legal reforms should promote women's rights to land, property, and resources to enhance their adaptive capacity. For example, the Asian Development Bank (ADB) emphasizes gender-responsive laws to strengthen women's resilience in Fiji, Lao PDR, and Mongolia by promoting green jobs and integrating women's rights into environmental laws (ADB, 2023). Inclusive policies ensure that marginalized groups (e.g., women, youth, Indigenous Peoples, and low-income communities) are actively involved in planning and benefiting from climate-resilient development.

3.6.1 Challenges in CIRDAP Countries:

- Socioeconomic and geopolitical barriers limit access to climate finance and adaptation resources, particularly for rural women and smallholder farmers.
- Cultural norms often restrict women's control over assets, increasing their vulnerability to climate shocks. Some strategies include strengthening local institutions (e.g., cooperatives, women's groups) to enhance agency and access to climate services. Promote participatory processes that include women, youth, and Indigenous communities in policy design and implementation. In Bangladesh, the National Workshop on Gender-Responsive and Inclusive Circular Economy (2024) highlighted the need for public-private partnerships to integrate gender

inclusivity into climate policies, aligning with Nationally Determined Contributions (NDCs) (Government of Bangladesh, 2024).

3.6.2 Key Approaches for Gender-Responsive Climate-Resilient Agriculture

Women in CIRDAP countries (e.g., India, Vietnam) are key players in subsistence agriculture but face barriers in adopting CSA due to limited access to technology and training. Policies should promote gender-responsive CSA practices, such as drought-resistant crops and water management systems tailored to women's needs, increasing women's access to land tenure, credit, and extension services to support climate-resilient livelihoods. Village Savings and Loan Associations (VSLAs) and Self-Help Groups (SHGs) have empowered women in India and other regions by providing financial inclusion. For instance, the FAO's project in Uganda (applicable to CIRDAP contexts like Nepal or Bangladesh) promotes gender-transformative climate-smart agriculture by improving women's access to productive resources and decision-making (FAO, 2021). CMCs are part of global frameworks like the Paris Agreement and Sustainable Development Goals (SDGs), which emphasize gender equality (SDG 5) and climate action (SDG 13) (UN, 2015).

The ASEAN Declaration on Gender-Responsive Implementation (2017) provides a model for CIRDAP countries, promoting gender mainstreaming in rural development and climate policies (ASEAN, 2017). Institutional capacities of governments and local organizations need to be strengthened to integrate gender into climate policies. Training programs for policymakers and climate negotiators can enhance gender mainstreaming, as seen in the Inclusive Climate Change Adaptation for a Sustainable Africa (ICCASA) program (ICCASA, 2022). The Scaling up Climate Action in Land Use and Agriculture (SCALA) program, active in countries like Vietnam, supports gender analyses and inclusive consultations to inform NDCs and National Adaptation Plans (NAPs) (FAO, 2023).

Specific Examples in CMCs

Bangladesh: The National Workshop (2024) emphasized a gender-responsive circular economy to meet NDC targets, focusing on sectors like textiles and agriculture (Government of Bangladesh, 2024). Policies advocate for women's inclusion in climate-resilient agriculture and watershed management.

India: The National Rural Livelihoods Project has organized 75.7 million rural women into SHGs, enhancing their access to finance and climate-resilient practices (Government of India, 2023). Gender-responsive policies are Sexually Transmitted Diseases (STDs) are needed to address sexually transmitted diseases (STDs), which are intensified by women's workloads due to climate variability.

Fiji: ADB's technical assistance promotes green jobs for women and gender-responsive CCDRM policies to enhance resilience (ADB, 2023).

Vietnam: The SCALA program supports gender analyses in agriculture, integrating women's needs into climate plans (FAO, 2023).

Sri Lanka: The climate-smart home gardening by women is a fine example in Moneragala, Anuradhapura, and Badulla, supported by IFAD and the Government of Sri Lanka aimed at climate resilience among rural households, particularly women-headed households and female farmers. Besides, there are several gender-responsive climate-resilient activities that were promoted in Sri Lanka.

3.6.3. Recommendations for CMCs

Policy Integration: Mainstream gender equality into national climate policies, NDCs, and NAPs, following models like the ASEAN Gender Mainstreaming Strategic Framework.

Empowerment through Education: Promote girls' education in STEM and climate-related fields to build long-term resilience.

Financial Inclusion: Expand VSLAs and SHGs to give women access to credit and climate-resilient technologies.

Participatory Governance: Ensure women's representation in climate decision-making bodies at local and national levels.

Knowledge Sharing: Leverage CIRDAP's platform to share best practices on gender-responsive policies across member countries.

3.6.4. Role of CIRDAP

CIRDAP can facilitate knowledge exchange and capacity building among member countries to promote gender-responsive rural development. Support gender analyses and evidence-based policymaking to address climate vulnerabilities. Collaborate with organizations like ADB, FAO, and UNDP to scale up gender-responsive climate initiatives.

Inclusive and gender-responsive policies are critical for climate-resilient rural development in CMCs. By addressing gender inequalities, empowering women, and ensuring inclusive participation, these policies can enhance resilience, reduce poverty, and promote sustainable development. Examples from Bangladesh, India, Fiji, and Vietnam demonstrate practical applications, while challenges like socio-cultural norms and limited finance require targeted action. CIRDAP's role as a regional coordinator can amplify these efforts through knowledge sharing and partnerships.

3.7 Financial Mechanisms and Funding

Financial mechanisms and funding enable adaptive agricultural practices, resilient infrastructure, and social protection systems (World Bank, Making Climate Finance Work in Agriculture, 2022). Climate change exacerbates vulnerabilities in rural areas, where agriculture employs a significant portion of the population in CIRDAP countries (e.g., 60% in Nepal and 40% in Bangladesh). Financial mechanisms bridge the gap between adaptation needs and available resources by mobilizing public, private, and international funds (Global Landscape of Climate Finance, 2023). They address barriers such as high investment risks, limited access to credit, and inadequate institutional capacity (Evaluating institutional climate finance barriers in selected SADC countries, 2023). Effective funding ensures the adoption of climate-smart agriculture (CSA), disaster risk reduction, and ecosystem-based adaptation, aligning with the UN's Sustainable Development Goals (SDGs) and the Paris Agreement (UN, 2015).

3.7.1 Key Financial Mechanisms

Several innovative and traditional financial mechanisms support climate-resilient rural development in CIRDAP countries:

3.7.1.1. Multilateral Climate Funds

Multilateral funds under the United Nations Framework Convention on Climate Change (UNFCCC), such as the Green Climate Fund (GCF) and the Least Developed Countries Fund (LDCF), provide grants and concessional loans to support adaptation and resilience (Unlocking climate finance for social protection: an analysis of the Green Climate Fund, 2023). In CIRDAP countries like Bangladesh, the GCF-funded project (FP215) strengthened climate risk-informed social protection systems, enhancing adaptive capacity in rural areas through improved safety nets and disaster-responsive mechanisms (Unlocking climate finance for social protection, 2023). In Lao PDR, a GCF project promotes ecosystem-based adaptation in the Nam Phark and Nam Ou river basins, supporting resilient livelihoods for rural communities (Unlocking climate finance for social protection, 2023). These funds are critical for low-income countries but face challenges like complex application processes and limited local capacity to meet fiduciary standards (Evaluating institutional climate finance barriers, 2023).

3.7.1.2 Debt-for-Nature Swaps

Debt-for-nature swaps allow countries to redirect debt repayments toward conservation and resilience projects (Innovative funding tools for climate adaptation and resilience, 2023). While more common in Africa (e.g., Seychelles), their potential in CIRDAP countries is underexplored (Innovative funding tools, 2023). Like Indonesia, which has high biodiversity and debt levels, it could leverage swaps

to fund marine and forest conservation, benefiting rural coastal communities (The bioeconomy can help climate-resilient development in Africa and the world, 2024). In the Philippines, debt swaps could finance mangrove restoration, enhancing coastal resilience against typhoons (Innovative funding tools, 2023).

3.7.1.3. Microfinance and Green Inclusive Finance

Microfinance targets smallholder farmers and rural entrepreneurs, offering credit, insurance, and savings products to adopt climate-resilient practices (Financial Inclusion Overview, 2023). In Nepal, the Central American and Caribbean Microfinance Network's (REDCAMIF) model could inspire Nepal's microfinance institutions to offer green loans for drought-resistant seeds and water management (Financial Inclusion Overview, 2023). In India, the Self-Employed Women's Association (SEWA) provides microinsurance to rural women, protecting against crop losses due to floods (Financial Inclusion Overview, 2023). However, financial exclusion remains a barrier, with 96% of farmers in northern Nigeria (a comparable context) unable to access credit due to stringent requirements (Climate change and financing adaptation by farmers in northern Nigeria, 2023).

3.7.1.4.Climate-Smart Agriculture Investment Plans (CSAIPs)

CSAIPs, supported by the World Bank, prioritize investments in resilient infrastructure and capacity building in Bangladesh and Nepal (World Bank, Making Climate Finance Work in Agriculture, 2022). CSAIPs promote climate-resilient crop varieties and agroforestry, increasing productivity and reducing emissions (World Bank, Making Climate Finance Work in Agriculture, 2022). In Vietnam, water management and precision farming investments enhance resilience to salinity intrusion in the Mekong Delta (World Bank, Making Climate Finance Work in Agriculture, 2022).

3.7.1.5. Adaptation Benefits Mechanisms

Pioneered by the African Development Bank, these mechanisms provide fiscal credits for achieving adaptation outcomes and improving project bankability (Innovative flies in tea plantations, where credits could incentivize soil conservation and water harvesting to combat drought (Innovative Funding Tools water harvesting to combat drought (Innovative funding tools, 2023). In Thailand, it could support flood-resistant rice varieties in rural floodplains (Innovative funding tools, 2023).

3.7.1.6. Private Sector Engagement

Private investments are limited due to perceived risks, but blended finance (combining public and private funds) can unlock capital (Global Landscape of Climate Finance, 2023). In Malaysia, the BioCarbon Fund Initiative supports sustainable palm oil production, reducing deforestation and enhancing rural incomes (The bio-economy can help climate-resilient development, 2024). In the Philippines, public-private partnerships fund solar-powered irrigation systems, improving water access for farmers (Innovative funding tools, 2023).

3.7.1.7. National and Local Funding Mechanisms

National budgets and local funds enhance agility and community ownership (Funding Programs for Climate-Resilient Agriculture in Developing Countries, 2023). In Ethiopia's model, adaptable to some CIRDAP countries, national and international funds are combined to provide farmers with improved seeds and training (Funding Programs for Climate-Resilient Agriculture, 2023). In India, the National Adaptation Fund for Climate Change (NAFCC) finances state-level projects, such as watershed management in Rajasthan (Funding Programs for Climate-Resilient Agriculture, 2023).

Despite their potential, financial mechanisms face several barriers in CIRDAP countries, such as limited expertise in project design and fiduciary compliance, which hinders access to multilateral funds (Evaluating institutional climate finance barriers, 2023). Bureaucratic hurdles result in lengthy approval processes that can deter smallholder farmers and local organizations (Evaluating institutional climate finance barriers, 2023). High transaction costs and risk perceptions limit credit access, particularly for

women and marginalized groups (Financial Inclusion Overview, 2023). Data gaps can lead to inadequate climate risk assessments, impeding targeted investments (Evaluating institutional climate finance barriers, 2023). Global climate finance reached $89.6 billion in 2021, far below the $100 billion annual commitment, affecting resource availability for CIRDAP countries (Global Landscape of Climate Finance, 2023).

Recent studies highlight the efficacy and gaps in financial mechanisms (GCF Analysis, 2023). A study of the GCF emphasizes its role in funding social protection for rural resilience but notes limited integration with mitigation projects (Unlocking climate finance for social protection, 2023). The World Bank Report (2022), Making Climate Finance Work in Agriculture, recommends leveraging climate finance to unlock private capital and build lender-borrower capacity, which is relevant for CIRDAP's agrarian economies (World Bank, Making Climate Finance Work in Agriculture, 2022). Global Landscape of Climate Finance (2023) reports a rise in climate finance to $1.3 trillion annually (2021–2022), but adaptation finance lags at under 10%, critical for rural CIRDAP contexts (Global Landscape of Climate Finance, 2023). SEI Africa (2024) advocates bioeconomy-based financing for nature-based solutions, applicable to CIRDAP countries like Indonesia and Malaysia with rich ecosystems (The bioeconomy can help climate-resilient development, 2024).

To enhance the effectiveness of financial mechanisms, it is worthwhile to invest in training for local institutions to navigate funding processes and meet fiduciary standards (Evaluating institutional climate finance barriers, 2023). Streamline application procedures for multilateral funds and microfinance to include smallholder farmers (Financial Inclusion Overview, 2023). Promote blended finance, encouraging public-private partnerships to de-risk investments in CSA and resilient infrastructure (Global Landscape of Climate Finance, 2023). Establish community-managed funds to ensure responsiveness and ownership, drawing from Ethiopia's model (Funding Programs for Climate-Resilient Agriculture, 2023). Design financial products targeting women farmers, such as microinsurance and credit, to address gender disparities (Financial Inclusion Overview, 2023). Develop climate risk assessments to inform targeted investments, supported by regional cooperation through CIRDAP.

Financial mechanisms and funding are indispensable for climate-resilient rural development in CMCs (World Bank, Making Climate Finance Work in Agriculture, 2022). Multilateral funds, microfinance, CSAIPs, and innovative tools, such as debt-for-nature swaps, offer pathways to resilience; however, their success depends on overcoming institutional, bureaucratic, and financial barriers (Evaluating institutional climate finance barriers, 2023). By adopting tailored strategies and fostering regional collaboration, CIRDAP countries can develop sustainable rural economies that are resilient to climate change.

3.8 Simulation Modelling for Climate-Resilient Rural Development

Simulation modelling is a powerful tool for designing and testing strategies to enhance climate resilience in rural development, particularly for the member countries of the Centre on Integrated Rural Development for Asia and the Pacific (CIRDAP). These countries, spanning South and Southeast Asia, face diverse climate challenges such as floods, droughts, and rising temperatures, which impact agriculture, water resources, and livelihoods. Simulation models can predict outcomes, optimize resource allocation, and guide policy for sustainable rural development. Some of key objectives of simulation modelling is described below

- **Assess Climate Impacts:** Model the effects of climate change (e.g., temperature rise, erratic rainfall) on agriculture, water, and rural economies.
- **Test Adaptation Strategies:** Evaluate interventions like drought-resistant crops, water management systems, or diversified livelihoods.

- **Support Policy Decisions:** Provide data-driven insights for policymakers to prioritize investments and interventions.
- **Enhance Resilience:** Identify strategies to reduce vulnerability and improve adaptive capacity in rural communities.

Types of Simulation Models

1. **Crop Simulation Models:**

- Tools like DSSAT (Decision Support System for Agrotechnology Transfer) or APSIM (Agricultural Production Systems sIMulator) simulate crop growth under varying climate scenarios.
- **Applications:** Predict yields for crops like rice or wheat under drought or flood conditions in countries like Bangladesh or India.
- **Example:** Simulate the impact of heat stress on rice production in Pakistan and test heat-tolerant varieties.

2. **Hydrological Models:**

- Models like SWAT (Soil and Water Assessment Tool) analyze water availability, runoff, and soil erosion under climate change.
- **Applications:** Assess water resource management in flood-prone areas like Nepal or drought-affected regions in Sri Lanka.
- **Example:** Model watershed management in Bhutan to optimize irrigation under reduced monsoon rainfall.

3. **Economic and Social Models:**

- Agent-based models (ABMs) or system dynamics models simulate socio-economic impacts, such as income changes or migration due to climate stress.
- **Applications:** Evaluate the impact of climate-induced crop failures on rural livelihoods in Afghanistan or the Philippines.
- **Example:** Simulate the adoption of climate-smart agriculture in Vietnam and its effect on farmer incomes.

4. **Integrated Assessment Models (IAMs):**

- Combine biophysical and socio-economic factors to model complex interactions.
- **Applications:** Assess trade-offs between agricultural intensification and environmental sustainability in Indonesia or Thailand.
- **Example:** Model the impact of policy incentives for organic farming in Malaysia on both yields and soil health.

Steps in Simulation Modelling

1. **Data Collection:**

- Gather climate data (temperature, rainfall), soil data, crop data, and socio-economic data specific to CIRDAP countries.
- **Sources:** Local meteorological departments, FAO, World Bank, or regional research institutes like IRRI.

2. **Model Selection:**

- Choose appropriate models based on the problem (e.g., DSSAT for crops, SWAT for water).
- Ensure models are calibrated for local conditions (e.g., monsoon patterns in India or tropical climates in the Maldives).

3. **Scenario Development:**

- Define baseline scenarios (current climate) and future scenarios (e.g., RCP 4.5 or 8.5 for 2030, 2050).
- Include adaptation measures like improved irrigation, crop diversification, or agroforestry.

4. **Simulation and Analysis:**

- Run models to predict outcomes (e.g., crop yield changes, water availability).
- Analyze trade-offs and uncertainties (e.g., cost vs. benefit of adopting new technologies).

5. **Policy Recommendations:**

- Translate model outputs into actionable policies, such as subsidies for climate-

resilient seeds or investment in watershed management.

Opportunities

- Regional Collaboration: CIRDAP can facilitate data sharing and model development across member countries.
- Open-Source Tools: Use freely available tools like R or Python-based modelling frameworks to reduce costs.
- Capacity Building: Train local researchers and policymakers in simulation techniques through CIRDAP workshops.
- Integration with Technology: Combine models with remote sensing or IoT for real-time data inputs.

Case Study Examples

1. **Bangladesh:**

- Use DSSAT to model saline-tolerant rice varieties in coastal areas affected by sea-level rise.
- **Outcome:** Identify varieties that increase yields by 10-15% under salinity stress.

2. **India:**

- Apply SWAT to optimize water use in drought-prone Maharashtra, integrating rainwater harvesting.
- **Outcome:** Improve water availability for 20% more farmland during dry seasons.

3. **Vietnam:**

- Use ABMs to simulate the adoption of climate-smart agriculture in the Mekong Delta.
- **Outcome:** Predict a 30% increase in farmer resilience through diversified income sources.

Recommendations

- **Standardize Data Collection:** Develop a CIRDAP-wide database for climate and agricultural data.
- **Build Local Expertise:** Partner with universities and institutes to train modellers in each country.
- **Focus on Scalability:** Prioritize low-cost, scalable interventions identified through simulations.
- **Engage Communities:** Involve local farmers in scenario planning to ensure model outputs align with ground realities.

Therefore, simulation modelling offers a robust framework for designing climate-resilient rural development strategies in CMCs. By leveraging crop, hydrological, and socio-economic models, stakeholders can anticipate challenges, test solutions, and formulate policies that enhance resilience and sustainability.

3.9 Agro and Eco-Tourism for Climate Resilience

Agro-tourism and eco-tourism have emerged as innovative, climate-resilient strategies for rural development, offering sustainable economic opportunities while preserving natural and cultural resources. This essay explores how these approaches foster climate resilience and rural development in CIRDAP countries, emphasizing their environmental, economic, and social benefits.

3.9.1 Agro-Tourism: A Pathway to Sustainable Rural Economies

Agro-tourism integrates agricultural activities with tourism, allowing visitors to engage in farming, learn about local agricultural practices, and experience rural lifestyles. In CIRDAP countries, where agriculture employs a significant portion of the population, agro-tourism diversifies income sources, reducing dependence on climate-sensitive farming.

Climate Resilience through Agro-Tourism

Agro-tourism promotes climate-resilient practices by encouraging sustainable agriculture. For instance, in India, organic farming initiatives in states like Sikkim attract tourists interested in eco-friendly practices, reducing reliance on chemical inputs that degrade

soil and water resources. Similarly, in Thailand, agro-tourism farms showcase climate-smart techniques like crop diversification and water-efficient irrigation, which mitigate risks from droughts and floods. These practices enhance agricultural resilience while educating tourists, fostering a cycle of knowledge transfer and environmental stewardship.

Economic and Social Benefits

Agro-tourism generates alternative revenue streams for rural communities. In Bangladesh, rural homestays and farm tours in areas like Sylhet provide income for smallholder farmers, reducing economic vulnerability to climate-induced crop failures. In the Philippines, agro-tourism initiatives like the Bohol Bee Farm integrate beekeeping and organic farming, creating jobs and empowering local women through skill development. Socially, agro-tourism preserves cultural heritage by showcasing traditional farming methods, local cuisines, and festivals, strengthening community identity and pride.

3.9.2 Eco-Tourism: Preserving Ecosystems for Rural Prosperity

Eco-tourism focuses on sustainable travel to natural areas, emphasizing environmental conservation and community involvement. In CIRDAP countries, rich in biodiversity and natural landscapes, eco-tourism aligns with climate resilience by protecting ecosystems and promoting low-carbon tourism models.

Environmental Sustainability and Climate Resilience

Eco-tourism supports conservation efforts that enhance climate resilience. In Nepal, community-based eco-tourism in the Annapurna Conservation Area promotes reforestation and wildlife protection, which stabilizes local ecosystems against climate impacts like landslides and soil erosion. In Malaysia, eco-tourism in Taman Negara National Park generates funds for forest preservation, mitigating carbon emissions and supporting biodiversity. These initiatives reduce environmental degradation, ensuring that rural communities can rely on natural resources for livelihoods despite climate challenges.

Economic Diversification and Community Empowerment

Eco-tourism creates economic opportunities by leveraging natural attractions. In Sri Lanka, eco-lodges in Sinharaja Forest Reserve employ local guides and artisans, providing income diversification for communities affected by climate-driven agricultural losses. In Fiji, eco-tourism initiatives like coral reef restoration tours engage indigenous communities, offering sustainable livelihoods while protecting marine ecosystems. These activities empower marginalized groups, including women and youth, by providing training and employment in tourism-related services.

Synergies Between Agro-Tourism and Eco-Tourism

Agro-tourism and eco-tourism complement each other in fostering climate-resilient rural development. In Vietnam, the Mekong Delta combines agro-tourism (e.g., fruit orchard tours) with eco-tourism (e.g., wetland conservation trips), creating integrated tourism models that promote sustainable land use and biodiversity preservation. Similarly, in Indonesia, Bali's Subak system—a UNESCO-recognized traditional irrigation network—blends agro-tourism with eco-tourism by offering cultural tours that highlight sustainable farming and environmental stewardship. These synergies enhance rural resilience by diversifying economies and reducing climate vulnerabilities.

Challenges and Solutions

Despite their potential, agro-tourism and eco-tourism face challenges in CIRDAP countries. Limited infrastructure, lack of training, and inadequate marketing hinder scalability. For instance, remote areas in Laos and Myanmar struggle with accessibility, deterring tourists. Additionally, climate change itself poses risks, such as rising sea levels threatening coastal eco-tourism in the Maldives and Fiji.

To address these challenges, CIRDAP countries can adopt several strategies:

1. **Capacity Building:** Training programs for rural communities in hospitality, sustainable farming, and conservation can enhance service quality and environmental awareness. For example, India's Rural Tourism Scheme provides skill development for villagers.

2. **Infrastructure Development:** Investments in eco-friendly infrastructure, such as solar-powered homestays or improved rural roads, can boost accessibility while aligning with sustainability goals.

3. **Policy Support:** Governments can incentivize agro-tourism and eco-tourism through subsidies, tax breaks, and public-private partnerships. Malaysia's Homestay Programme is a successful model, supporting rural entrepreneurs.

4. **Climate Adaptation Measures:** Integrating climate-resilient practices, such as drought-resistant crops in agro-tourism or coral reef restoration in eco-tourism, ensures long-term sustainability.

Agro-tourism and eco-tourism are powerful tools for climate-resilient rural development in CIRDAP countries. By promoting sustainable agriculture, conserving ecosystems, and diversifying rural economies, these approaches mitigate the impacts of climate change while fostering inclusive growth. However, their success depends on addressing challenges through capacity building, infrastructure development, and supportive policies. By leveraging their rich natural and cultural assets, CIRDAP countries can position agro-tourism and eco-tourism as cornerstones of sustainable rural prosperity, ensuring resilience against climate uncertainties and enhancing the well-being of rural communities.

THE ROLE OF STAKEHOLDERS

4. The Role of Stakeholders

4.1 Governments

Governments play a pivotal role in fostering CRRD by formulating policies, mobilizing resources, and promoting sustainable practices to enhance rural resilience. Governments in CMCs are central to designing and implementing policies that integrate climate resilience into rural development.

4.1.1 Policy Frameworks for Climate Resilience

National adaptation plans (NAPs) and climate-focused agricultural policies are critical tools. For instance, Bangladesh's National Adaptation Programme of Action (NAPA) prioritizes climate-resilient crops and coastal embankments to protect rural communities from salinity intrusion (MoEF, Bangladesh 2005). Similarly, India's National Mission for Sustainable Agriculture promotes climate-smart farming techniques like zero-tillage and drought-resistant seeds (MoAFW, India 2023). These policies align with CIRDAP's mission to foster sustainable rural development by addressing region-specific climate risks.

Moreover, governments enforce regulations to curb unsustainable practices, such as deforestation and overexploitation of water resources, which exacerbate climate vulnerability. In Indonesia, policies restricting slash-and-burn agriculture have reduced forest degradation, preserving ecosystems critical for rural livelihoods (MoEF, Indonesia 2022). By embedding climate resilience into land-use planning and rural infrastructure development, governments ensure long-term sustainability. However, policy implementation often faces challenges like bureaucratic inefficiencies and lack of local-level coordination, which governments must address through streamlined governance.

4.1.2 Financial Mechanisms and Resource Mobilization

Funding is a cornerstone of CRRD, and governments are uniquely positioned to mobilize resources through domestic budgets and international partnerships. Many CIRDAP countries, such as Pakistan and the Philippines, have established dedicated climate funds, like Pakistan's Climate Change Fund, to finance rural adaptation projects (MoCC, Pakistan 2022). These funds support initiatives like irrigation upgrades and flood-resistant housing. Governments also leverage international climate finance from mechanisms like the Green Climate Fund (GCF), with countries like Vietnam securing grants for mangrove restoration to protect coastal rural areas (GCF, 2022).

Subsidies and incentives further encourage rural communities to adopt resilient practices. In Thailand, subsidies for organic farming and water-efficient irrigation systems have boosted agricultural resilience (MoAC, Thailand 2023). However, equitable funding distribution remains a challenge, as marginalized rural groups, including women and Indigenous communities, often receive limited support. Governments must prioritize inclusive financial mechanisms to ensure no one is left behind in the transition to climate-resilient rural economies.

4.1.3 Capacity Building and Knowledge Transfer

Building the capacity of rural communities to adapt to climate change is another critical government role. Governments equip farmers and rural stakeholders with the tools to withstand climate shocks through extension services, training programs, and technology dissemination. In Sri Lanka, the Department of Agriculture provides training on climate-smart agriculture, including rainwater harvesting and crop diversification, enhancing farmers' adaptive capacity (DoA, Sri Lanka 2023). In addition, research institutions such as the Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI) conduct research and training programs focused on climate-smart agriculture. These programs inform evidence-based policy formulation to strengthen the resilience and adaptive capacity of rural farming populations.

Similarly, Nepal's community-based disaster risk management programs empower rural households to prepare for floods and landslides.

Governments also facilitate knowledge transfer by supporting research and innovation. In India, the Indian Council of Agricultural Research (ICAR) develops climate-resilient crop varieties tailored to local conditions, which are then distributed to farmers. Governments bridge the gap between science and practice by fostering partnerships between research institutions, NGOs, and rural communities (ICAR, 2023). Yet, challenges like limited access to technology in remote areas and low literacy rates can hinder knowledge dissemination, requiring governments to invest in digital infrastructure and education.

4.1.4 Regional Collaboration and CIRDAP's Role

As CMCs face transboundary climate challenges, governments play a key role in fostering regional cooperation. CIRDAP serves as a platform for knowledge sharing and policy alignment, enabling governments to learn from each other's successes and challenges. For example, Bangladesh's expertise in community-based flood management has informed similar initiatives in Pakistan (CIRDAP, 2023). Regional programs, such as CIRDAP's Integrated Rural Development initiatives, encourage governments to collaborate on issues like water resource management and cross-border disaster preparedness.

Governments also engage in multilateral agreements to address shared climate risks. The Mekong River Commission, involving CIRDAP members like Laos and Thailand, promotes sustainable water management to mitigate flood and drought impacts on rural areas (Mekong River Commission, 2023). By aligning national policies with regional frameworks, governments amplify the impact of CRRD efforts. However, political differences and resource disparities can impede collaboration, underscoring the need for diplomatic efforts and equitable resource sharing.

4.1.5 Key tasks and opportunities

Despite their critical role, governments in CIRDAP countries face significant hurdles in advancing CRRD. Limited financial resources, particularly in low-income countries like Afghanistan and Nepal, constrain large-scale adaptation projects. Corruption and weak governance further undermine effective policy implementation, while urban bias in development planning often sidelines rural needs (Transparency International, 2023). Additionally, the lack of gender-inclusive policies limits the participation of women, who are key stakeholders in rural economies.

Governments must prioritize participatory governance to overcome these challenges, engaging rural communities in decision-making processes. Strengthening local institutions, such as village councils, can enhance policy implementation at the grassroots level. Furthermore, governments should leverage public-private partnerships to supplement funding and technical expertise. As seen in Malaysia's rural solar projects, investing in renewable energy and green infrastructure can also drive sustainable development while mitigating climate impacts (Ministry of Energy and Natural Resources, Malaysia, 2022).

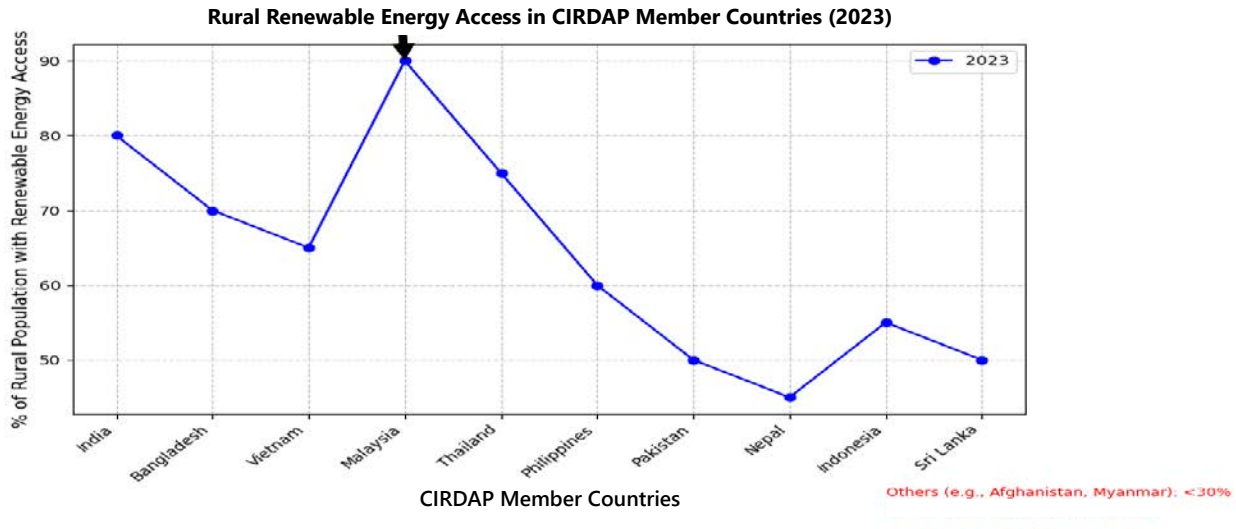


Figure 6: Rural Renewable Energy Access in CMCs (2022–2023)

Source: World Bank (2023), REN21 Renewables Report (2023), and CIRDAP webinar insights.

In Figure 6, the percentage of rural populations with access to renewable energy (e.g., solar, micro-hydro, wind) was shown in selected CMCs, highlighting efforts to enhance climate resilience through clean energy. Malaysia (advanced infrastructure, rural solar) and India (solar home systems, mini-grids) lead in rural renewable energy access, while Afghanistan and Myanmar (data gaps, conflict, or low investment) face significant gaps due to instability and limited investment.

Governments in CMCs are indispensable to climate-resilient rural development, serving as architects of policies, financiers of adaptation, educators of communities, and facilitators of regional cooperation. They can transform rural areas into resilient, sustainable hubs capable of withstanding climate change through targeted interventions. While challenges like resource constraints and governance gaps persist, the proactive engagement of governments, supported by CIRDAP's regional framework, offers a pathway to a climate-resilient future for rural communities. By prioritizing inclusivity, innovation, and collaboration, governments can ensure that rural development survives and thrives in the face of climate adversity.

4.2 International Organizations

Climate-resilient rural development is critical for nations vulnerable to climate change, particularly in the Asia-Pacific region, where rural economies often depend on climate-sensitive sectors like agriculture. CIRDAP countries face escalating threats from extreme weather, sea-level rise, and environmental degradation, exacerbating poverty and food insecurity. International organizations are pivotal in bridging resource gaps, providing technical expertise, and fostering regional collaboration to enhance climate resilience in these rural landscapes.

4.2.1 Capacity Building and Knowledge Sharing

International organizations such as the United Nations Development Programme (UNDP), the Food and Agriculture Organization (FAO), and the International Fund for Agricultural Development (IFAD) are instrumental in building the capacity of rural communities to adapt to climate change. In some CMCs like Bangladesh, India, and Vietnam, these organizations conduct training programs on climate-smart agriculture (CSA) practices, such as drought-resistant crop cultivation, water-efficient irrigation, and agroforestry. For instance, the FAO's Farmer Field Schools in Myanmar and Nepal have

empowered farmers with knowledge of sustainable land management, enabling them to mitigate soil degradation caused by climate-induced erosion (FAO, 2022).

Moreover, organizations like the Asian Development Bank (ADB) and the World Bank facilitate knowledge-sharing platforms where CMCs can exchange best practices. The ADB's Asia-Pacific Climate Finance Fund supports regional workshops that bring together policymakers, scientists, and farmers to discuss innovative solutions, such as early warning systems for floods in Pakistan and Sri Lanka (ADB, 2023). By fostering South-South cooperation, these organizations ensure that context-specific strategies are scaled across the region, enhancing rural resilience.

4.2.2 Technology Transfer and Innovation

Access to climate-resilient technologies is critical for rural development in CMCs, many of which lack the resources to develop such innovations independently. International organizations bridge this gap by facilitating technology transfer. The International Renewable Energy Agency (IRENA) promotes the adoption of solar-powered irrigation systems in countries like Afghanistan and Laos, reducing dependence on fossil fuels and enhancing water security (IRENA, 2022). Similarly, the Global Environment Facility (GEF) has supported the introduction of climate-resilient seed varieties in India and Thailand, which are better suited to withstand heat stress and flooding (GEF, 2022).

Digital technologies also play a growing role. The World Bank's Digital Agriculture initiatives in Bangladesh and Indonesia provide farmers with mobile-based weather forecasting and market information, enabling informed decision-making (World Bank, 2023). By partnering with local institutions, international organizations ensure that these technologies are tailored to the socio-economic realities of rural communities, thereby maximizing adoption and impact.

4.2.3 Financial Support and Investment

Climate-resilient rural development requires substantial financial investment, which many CMCs struggle to mobilize domestically. International organizations address this challenge by providing grants, loans, and climate finance mechanisms. For example, the Green Climate Fund (GCF) has funded projects in Vietnam and the Philippines to restore degraded ecosystems and promote sustainable aquaculture, benefiting rural livelihoods (GCF, 2023). In Bangladesh, the GCF's support for coastal afforestation has protected rural communities from cyclones while creating income opportunities through mangrove-based enterprises.

The IFAD's Adaptation for Smallholder Agriculture Programme (ASAP) is another key initiative, channelling funds to countries like Nepal and Cambodia for projects integrating climate adaptation into rural development (IFAD, 2023). These investments often prioritize marginalized groups, such as women and indigenous communities, ensuring inclusive growth. Organizations like the ADB also leverage public-private partnerships to attract private sector investment in climate-resilient infrastructure, such as flood-resistant roads in rural Thailand (ADB, 2022).

4.2.4 Policy Advocacy and Institutional Strengthening

International organizations are crucial in shaping national and regional policies to prioritize climate resilience. The United Nations Framework Convention on Climate Change (UNFCCC) supports CMCs in developing Nationally Determined Contributions (NDCs) that emphasize rural adaptation (UNFCCC, 2023). For instance, India's NDC includes targets for expanding micro-irrigation, supported by technical assistance from the UNDP. Similarly, the FAO assists countries like Sri Lanka integrate climate resilience into agricultural policies, ensuring alignment with global frameworks like the Sustainable Development Goals (SDGs) (FAO, 2022).

At the regional level, CIRDAP collaborates with organizations like the ASEAN Secretariat to advocate for policies that address transboundary climate challenges, such as water resource management in the Mekong Delta, which affects Vietnam, Laos, and Thailand (ASEAN, 2023). These organizations strengthen institutional frameworks, enabling governments to implement long-term, sustainable development strategies.

4.2.5 Tasks and Opportunities

Despite their contributions, international organizations face challenges ensuring effective climate-resilient rural development. Limited coordination among agencies can lead to duplicated efforts, while bureaucratic delays may hinder timely project implementation (UNDP, 2023). Additionally, the diverse socio-economic and environmental contexts of CMCs require highly localized solutions, which can strain the resources of international organizations.

However, these challenges also present opportunities. Greater collaboration through platforms like CIRDAP can streamline efforts and enhance impact. Leveraging emerging technologies, such as artificial intelligence for climate modelling, can improve the precision of interventions (World Bank, 2023). Furthermore, engaging local communities in project design and implementation can ensure sustainability and ownership, as seen in IFAD's participatory approaches in Nepal.

International organizations are indispensable in advancing climate-resilient rural development in CMCs. Through capacity building, technology transfer, financial support, and policy advocacy, they empower rural communities to adapt to climate change while fostering sustainable growth. While challenges remain, the collaborative efforts of organizations like the UNDP, FAO, IFAD, and GCF, in partnership with regional bodies like CIRDAP, offer a robust framework for addressing the complex interplay of climate and development. By continuing to innovate and prioritize inclusivity, these organizations can ensure that rural populations in CMCs survive and thrive in the face of climate change.

4.3 Private Sector

With its resources, innovation, and scalability, the private sector is pivotal in complementing public efforts to build resilience against climate impacts. Rural areas in CIRDAP countries, such as Bangladesh, India, and the Philippines, are often characterized by poverty, inadequate infrastructure, and dependence on climate-sensitive sectors. Climate change exacerbates these challenges, threatening food security and economic stability. For instance, prolonged droughts in Afghanistan and Pakistan devastate crops, while typhoons in the Philippines disrupt fisheries. Building resilience through diversified livelihoods, robust infrastructure, and adaptive agricultural practices is imperative to mitigate these risks.

Private Sector Contributions to Climate Resilience

4.3.1 Innovation and Technology Deployment

The private sector drives innovation by developing and disseminating climate-smart technologies tailored to rural needs. In agriculture, a cornerstone of rural economies in CIRDAP countries, companies are introducing drought-resistant seeds, precision farming tools, and efficient irrigation systems. For instance, in India, private agribusinesses like Mahyco and Bayer have developed genetically modified crops that withstand extreme weather, boosting yields by 20-30% in drought-prone areas (Mahyco, 2023; Bayer, 2023). Similarly, in Bangladesh, solar-powered irrigation pumps from companies like Rahimafrooz Renewable Energy enable farmers to access water during dry seasons, reducing reliance on erratic monsoons (Rahimafrooz Renewable Energy, 2023).

Beyond agriculture, private enterprises are advancing renewable energy solutions to enhance rural resilience. In Indonesia and the Philippines, microgrid companies like Star Energy and Meralco are electrifying remote areas with solar and wind power, ensuring stable energy for households

and small businesses during climate-induced disruptions (Star Energy, 2023; Meralco, 2023). These technologies mitigate greenhouse gas emissions and provide adaptive solutions that strengthen rural infrastructure against floods, cyclones, and heat waves prevalent in CIRDAP regions.

4.3.2 Investment and Financial Mechanisms

Private sector investment is crucial for scaling climate-resilient infrastructure and services in rural areas. Private financing fills critical gaps in CIRDAP countries, where public budgets are often constrained. For example, the Engro Corporation has invested in Pakistan's climate-resilient irrigation canals and water storage systems, benefiting over 50,000 farmers in Sindh province (Engro Corporation, 2022). Such investments enhance water security, a pressing need given the region's vulnerability to glacial melt and unpredictable rainfall.

Moreover, the private sector is pioneering innovative financial instruments like green bonds and climate insurance to support rural communities. Companies like HDFC Bank have partnered with microfinance institutions in India to offer weather-indexed insurance, protecting farmers from crop losses due to extreme weather (HDFC Bank, 2023). By 2023, over 12 million South Asian farmers had enrolled in such schemes, demonstrating the scalability of private-led financial solutions (IFC, 2023). These mechanisms not only provide immediate relief but also incentivize the adoption of resilient practices, such as crop diversification and soil conservation.

4.3.3 Capacity Building and Knowledge Transfer

The private sector makes a significant contribution to building the capacity of rural communities to adapt to climate change. Companies equip farmers and local entrepreneurs with the skills needed to implement resilient practices through training programs and extension services. In Vietnam, Nestlé's Farmer Connect program trains coffee growers in climate-smart agriculture, including shade-grown techniques that reduce heat stress on crops (Nestlé, 2023). By 2024, this initiative had reached over 20,000 farmers, improving yields and incomes while enhancing ecosystem resilience.

Additionally, private enterprises facilitate knowledge transfer by leveraging digital platforms. In Sri Lanka, Dialog Axiata's mobile-based advisory services offer real-time weather forecasts and market information to rural farmers, enabling them to make informed decisions (Dialog Axiata, 2023). These efforts empower communities to anticipate and respond to climate risks, fostering long-term resilience.

4.3.4 Partnerships and Collaborative Models

Collaboration between the private sector, governments, and civil society is essential for maximizing impact. Public-private partnerships (PPPs) in CIRDAP countries have effectively scaled climate-resilient projects. For instance, the CP Group collaborates with the government in Thailand to promote sustainable rice farming under the Thai Rice NAMA (Nationally Appropriate Mitigation Action) program, reducing methane emissions and improving water efficiency for 100,000 farmers (Ministry of Agriculture and Cooperatives, Thailand, 2023). Such partnerships combine private sector expertise and capital with public policy support, creating synergies that drive systemic change.

Furthermore, private companies engage with local communities and NGOs to ensure inclusive development. In Nepal, the Chaudhary Group works with local cooperatives to distribute climate-resilient seeds and provide training, ensuring that marginalized groups, including women and indigenous communities, benefit from these initiatives (Chaudhary Group, 2023). These collaborative models enhance social equity and ensure that resilience-building efforts are contextually relevant.

4.3.5 Tasks and Opportunities

Despite its contributions, the private sector faces challenges in scaling climate-resilient rural development. High upfront costs, limited market incentives, and regulatory barriers often deter investment in remote areas. Additionally, smallholder

farmers, who dominate CIRDAP's rural landscapes, may lack access to private sector innovations due to financial or logistical constraints. To address these issues, governments must create an enabling environment through subsidies, tax incentives, and streamlined regulations that encourage private sector participation.

Moreover, the private sector should prioritize inclusive business models that cater to low-income communities. Blended finance, combining private and public funds, can de-risk investments and expand access to climate-resilient technologies (IFC, 2023). Strengthening regional cooperation among CIRDAP countries can also facilitate knowledge sharing and attract multinational corporations to invest in cross-border resilience initiatives. The private sector is a linchpin in advancing climate-resilient rural development in CMCs. Through innovation, investment, capacity building, and partnerships, it addresses the unique challenges faced by rural communities in the face of climate change. While obstacles remain, strategic collaboration with governments and communities can unlock the private sector's full potential. By aligning profit motives with sustainable development goals, the private sector can drive transformative change, ensuring that rural populations in CIRDAP countries thrive in a climate-constrained future.

4.4 Local Communities and Farmers' Role

The Role of Cooperative Organizations in CIRDAP Member Countries

Cooperative organizations are autonomous associations of individuals who unite voluntarily to meet common economic, social, and cultural needs through jointly owned and democratically controlled enterprises. In CIRDAP member countries, cooperatives are instrumental in addressing the multifaceted challenges of rural development, particularly in the context of climate change. Their roles include:

1. **Enhancing Agricultural Productivity and Food Security:** Cooperatives in CIRDAP member countries, such as India's Primary Agricultural Credit Societies and Nepal's Cooperative Market Development, provide farmers with access to credit, inputs, and markets. By pooling resources, cooperatives enable smallholder farmers to adopt climate-resilient crop varieties, conservation agriculture techniques, and agroforestry practices, which increase productivity while reducing environmental strain. For instance, in Bangladesh, the "One House, One Farm" model leverages cooperatives to diversify agricultural production, enhancing food security and resilience to climate shocks.
2. **Promoting Climate Adaptation and Mitigation:** Cooperatives facilitate the adoption of climate-smart agricultural practices tailored to local agro-ecological conditions. In Vietnam, the Mekong Delta Integrated Climate Resilience and Sustainable Livelihood Project supports cooperatives in implementing water management strategies and resilient crop systems to combat rising sea levels and salinity intrusion. Similarly, in Iran, cooperatives contribute to sustainable water resource management in the Urmia Lake Basin, mitigating the impacts of drought and climate change.
3. **Strengthening Livelihood Resilience:** Cooperatives enhance the adaptive capacity of rural communities by diversifying income sources and improving access to resources. In the Tibetan Plateau, studies indicate that smallholder farmers participating in cooperatives are 67.9% more likely to adopt climate adaptation strategies, such as crop diversification or engaging in off-farm activities, compared to non-members. Cooperatives also provide training and credit, which are crucial for building resilience against climate-induced risks, such as droughts and floods.
4. **Fostering Social Inclusion and Gender Equity:** Cooperatives promote inclusive development by engaging marginalized groups, including

women and youth. In the Philippines, the Sustainable Livelihood Programme empowers women through cooperative enterprises, enabling them to participate in value chains and build climate-resilient livelihoods. CIRDAP's cross-cutting program on gender in integrated rural development further supports cooperatives in addressing gender disparities, ensuring equitable access to resources and decision-making.

5. **Facilitating Knowledge Sharing and Regional Cooperation:** Cooperatives serve as platforms for knowledge exchange and capacity building. CIRDAP's initiatives, such as the establishment of the CIRDAP Exhibition and Museum on Integrated Rural Development (CEMIRD), showcase best practices from member countries, such as Thailand's Sufficiency Economy Philosophy and Malaysia's Mini Rural Transformation Centres. These platforms enable cooperatives to learn from regional success stories and adapt them to local contexts, enhancing climate resilience.

6. **Supporting Policy Formulation and Advocacy:** Cooperatives act as intermediaries between rural communities and policymakers, advocating for climate-resilient policies. In Pakistan, the National Rural Support Programme collaborates with cooperatives to influence policies that promote sustainable agriculture and disaster risk reduction. CIRDAP's partnerships with contact ministries and link institutions further amplify the role of cooperatives in shaping national and regional development agendas.

Guidelines for Integrating Cooperative Organizations into Climate-Resilient Rural Development

To effectively integrate cooperative organizations into climate-resilient rural development in CIRDAP member countries, the following guidelines are proposed:

1. **Strengthen Institutional Capacity:**

Capacity Building: Provide training programs for cooperative members on climate-smart agriculture, disaster risk reduction, and sustainable resource management. For example, CIRDAP can expand its training initiatives to include modules on adaptive farming techniques and early warning systems.

Technical Support: Establish technical assistance units within cooperatives to support the adoption of climate-resilient technologies, such as drought-resistant seeds and precision farming tools.

2. **Enhance Access to Finance and Resources:**

- ***Credit Facilities:*** Develop cooperative-led microfinance schemes to provide affordable credit for climate adaptation investments, such as irrigation systems and agroforestry. In Ethiopia, similar interventions increased crop yields by up to 40% through resilient seed varieties.
- ***Resource Pooling:*** Encourage cooperatives to pool resources for collective investments in climate-resilient infrastructure, such as water harvesting systems and renewable energy solutions.

3. **Promote Gender-Inclusive and Youth-Focused Strategies:**

- ***Gender Mainstreaming:*** Integrate gender-transformative policies into cooperative operations, ensuring women have equal access to leadership roles, training, and resources. This aligns with CIRDAP's gender-focused cross-cutting program.
- ***Youth Engagement:*** Create youth-focused cooperative programs, such as the Asia-Pacific Young Farmers Camp, to foster interest in sustainable agriculture and build leadership capacity among young farmers.

4. **Foster Regional Knowledge Networks:**

- ***Knowledge Hubs:*** Establish regional knowledge hubs under CIRDAP to disseminate

best practices in climate-resilient agriculture. For instance, cooperatives can share success stories like Fiji's Markets for Change project to promote market access for climate-resilient products.

- ***South-South Cooperation:*** Leverage CIRDAP's platform to facilitate south-south cooperation, enabling cooperatives to exchange innovations and strategies across member countries.

5. **Integrate Climate-Resilient Practices into Cooperative Models:**

- ***Climate-Smart Agriculture (CSA):*** Encourage cooperatives to adopt CSA practices, such as conservation agriculture, agroforestry, and water-efficient irrigation, as outlined in World Bank CSA Country Profiles.
- ***Early Warning Systems:*** Equip cooperatives with tools to monitor environmental changes and disseminate early warnings for climate-related disasters, enhancing community preparedness.

6. **Strengthen Policy Advocacy and Partnerships:**

- ***Policy Integration:*** Support cooperatives in advocating for national policies that prioritize climate resilience, such as subsidies for sustainable farming practices. CIRDAP's collaboration with ministries can facilitate this process.
- ***Public-Private Partnerships:*** Foster partnerships between cooperatives, governments, and private sectors to fund and scale climate-resilient initiatives, as seen in China's Green Agricultural and Rural Revitalization Program.

7. **Monitor and Evaluate Impact:**

- ***Performance Metrics:*** Develop indicators to measure the impact of cooperatives on climate resilience, such as the adoption rate of CSA practices or reduction in climate-related losses. CIRDAP's common monitoring and evaluation framework can guide this process.
- ***Adaptive Management:*** Implement adaptive learning systems within cooperatives to continuously refine strategies based on climate trends and community feedback.

Hence cooperative organizations in CIRDAP member countries are vital for advancing climate-resilient rural development. By enhancing agricultural productivity, promoting climate adaptation, strengthening livelihood resilience, fostering inclusion, and facilitating knowledge exchange, cooperatives address the complex challenges posed by climate change. The proposed guidelines—strengthening institutional capacity, enhancing resource access, promoting inclusivity, fostering knowledge networks, integrating climate-smart practices, advocating for policy support, and monitoring impacts—provide a roadmap for integrating cooperatives into sustainable rural development strategies. Through CIRDAP's regional cooperation and partnerships, cooperatives can amplify their impact, ensuring prosperous and resilient rural communities in the face of climate change.

Role of Local Communities in Climate Resilience

Local communities in CIRDAP countries are deeply connected to their environments, possessing traditional knowledge that informs sustainable practices. For instance, in Bangladesh, communities in flood-prone areas have developed floating gardens, enabling crop cultivation during monsoons (FAO, 2018). Similarly, in Nepal, indigenous groups use terracing to prevent soil erosion on hilly terrains (ICIMOD, 2022). These practices demonstrate how local wisdom can address climate challenges.

Community-led initiatives, such as watershed management in India's Rajasthan, conserve water and restore degraded lands, enhancing resilience against drought (Ministry of Rural Development, India, 2023). Cooperatives in Sri Lanka and Thailand facilitate resource sharing, allowing communities to adopt climate-smart technologies like solar-

powered irrigation. By mobilizing collective action, local communities ensure equitable access to resources, strengthen social cohesion, and amplify resilience.

Moreover, participatory governance models, such as village councils in Pakistan, integrate community voices into climate adaptation plans. These councils prioritize local needs, ensuring that interventions, such as afforestation or disaster preparedness, are contextually relevant. Through knowledge sharing and collective decision-making, communities foster resilience that aligns with cultural and ecological realities.

4.4.2 Farmers as Agents of Climate-Resilient Agriculture

Farmers in CIRDAP countries are at the forefront of adapting agriculture to climate change. With agriculture employing over 50% of the workforce in countries like India and Myanmar, farmers' adoption of climate-resilient practices is critical. Techniques such as crop diversification, intercropping, and agroforestry are widely practiced. For example, in Indonesia, farmers integrate rice with fish farming, optimizing land use and reducing risks from climate variability.

Climate-smart agriculture (CSA) practices, promoted by CIRDAP, are gaining traction. In Vietnam, farmers use alternate wetting and drying (AWD) techniques in rice cultivation, reducing water use and methane emissions (IRRI, 2023). Similarly, in the Philippines, drought-resistant crop varieties, such as flood-tolerant rice, help farmers cope with extreme weather. These innovations enhance productivity while minimizing environmental impacts.

Farmers also contribute to soil health, a cornerstone of resilience. In India, zero-tillage farming conserves soil moisture and reduces erosion (ICAR, 2023). By adopting these practices, farmers mitigate climate impacts and ensure long-term agricultural sustainability.

Challenges Faced by Local Communities and Farmers

Despite their contributions, local communities and farmers face significant barriers. Limited access to resources—such as finance, technology, and training—hinders the adoption of climate-resilient practices. In Afghanistan, for instance, prolonged conflict and poverty restrict farmers' ability to invest in modern irrigation systems (FAO, 2022). Similarly, in remote areas of Laos, inadequate infrastructure limits access to markets and extension services.

Climate change exacerbates these challenges. Unpredictable weather patterns disrupt planting schedules, while rising sea levels in Bangladesh and the Maldives threaten arable land through salinization (IPCC, 2022). Smallholder farmers, who dominate CIRDAP countries, often lack the capital to absorb losses from climate-induced crop failures.

Gender disparities further complicate resilience efforts. Women, who play a significant role in agriculture in Nepal and Sri Lanka, often have less access to land ownership, credit, and training. This limits their ability to adopt adaptive practices, undermining community-wide resilience.

Strategies for Strengthening Climate-Resilient Rural Development

CMCs must prioritize integrated strategies to enhance the role of local communities and farmers. First, scaling up access to climate-smart technologies is essential. Initiatives like India's National Mission for Sustainable Agriculture provide subsidies for drip irrigation and seed banks, which can be replicated across CIRDAP nations (Ministry of Agriculture and Farmers Welfare, India, 2023). Mobile-based advisory services, as seen in Bangladesh, deliver real-time weather and market information, empowering farmers to make informed decisions. Second, capacity building through training and knowledge exchange is critical. CIRDAP's programs, such as farmer field schools in Malaysia, train farmers in sustainable practices like integrated

pest management. Regional knowledge-sharing platforms can further disseminate best practices, enabling cross-country learning. Third, inclusive policies must address gender and social inequities. In Thailand, women-led cooperatives have successfully promoted organic farming, demonstrating the value of empowering marginalized groups. Land tenure reforms, particularly in Pakistan and India, can ensure equitable access to resources, enabling more farmers to invest in resilience.

Finally, public-private partnerships can mobilize resources. In Indonesia, collaborations between governments and NGOs provide microfinance for climate-resilient infrastructure, such as rainwater harvesting systems (Ministry of Agriculture, Indonesia, 2023). Such partnerships can bridge funding gaps and scale up community-driven initiatives. Local communities and farmers in CMCs are indispensable to climate-resilient rural development. Their traditional knowledge, innovative practices, and collective action form the foundation of adaptive rural ecosystems. However, systemic challenges—resource constraints, climate impacts, and inequities—must be addressed through targeted strategies. CIRDAP countries can empower communities and farmers to lead the transition to sustainable, resilient rural development by investing in technology, capacity building, inclusive policies, and partnerships. Their role is vital and transformative, ensuring that rural areas thrive in the face of climate change.

Gelephu Mindfulness City (GMC)

Gelephu is a culturally rich, biodiverse, and strategically important town in Sarpang District, southern Bhutan, poised to transition into a futuristic economic hub with the ambitious Gelephu Mindfulness City project. Unveiled in December 2023 by KingJigme Khesar Namgyel Wangchuck, the Gelephu Special Administrative Region (GeSAR), also known as Gelephu Mindfulness City (GMC SAR), is a planned economic hub spanning 2,500 km^2. Its blend of natural beauty, spiritual heritage, and sustainable urban planning makes it a unique destination and a potential model for mindful development globally. Agriculture is central to the local economy, with rice, maize, millet, areca nut, and ginger as key crops. Livestock rearing is also significant. A biodiversity park named Royal Manas National park hotspot near Gelephu, home is to rare species like clouded leopards, Asian elephants, golden langurs, and gangetic dolphins. It connects to India's Manas Tiger Reserve. Aims to be a sustainable, mindfulness-driven urban center, integrating Bhutanese culture, Gross National Happiness (GNH) principles, and eco-friendly technologies.

Features:

Economic Clusters: Focus on spirituality, education, green energy, finance (including blockchain-backed digital currency TER), agri-tech, forestry, aviation, and logistics.

Infrastructure: Includes a new international airport (construction began July–August 2024), a 58-km Gelephu-Kokrajhar rail line to connect with India, and a dry port.

Design: Planned by architect Bjarke Ingels, featuring 11 "ribbonlike neighborhoods" designed as mandalas, with paddy fields to prevent flooding and preserve wildlife migration routes (e.g., elephants).

Sankosh Temple-Dam: A run-of-river hydropower project with an elevated temple, blending sustainability and spirituality.

Governance: Operates as an autonomous region with independent laws, adopting 18 Singaporean laws and 10 Abu Dhabi financial regulations. Led by CEO Mun Leong Liew and Governor Dasho Dr. Lotay Tshering, with the King as Chairman.

Strategic Goal: Positioned as an economic corridor connecting South Asia to Southeast Asia, attracting global investment in zero-emission industries, bioscience, data centers, and education.

Digital Assets: Plans to include Bitcoin, Ethereum, and BNB in its strategic reserves, a pioneering move for a special administrative region.

Environmental and Sustainability Focus:

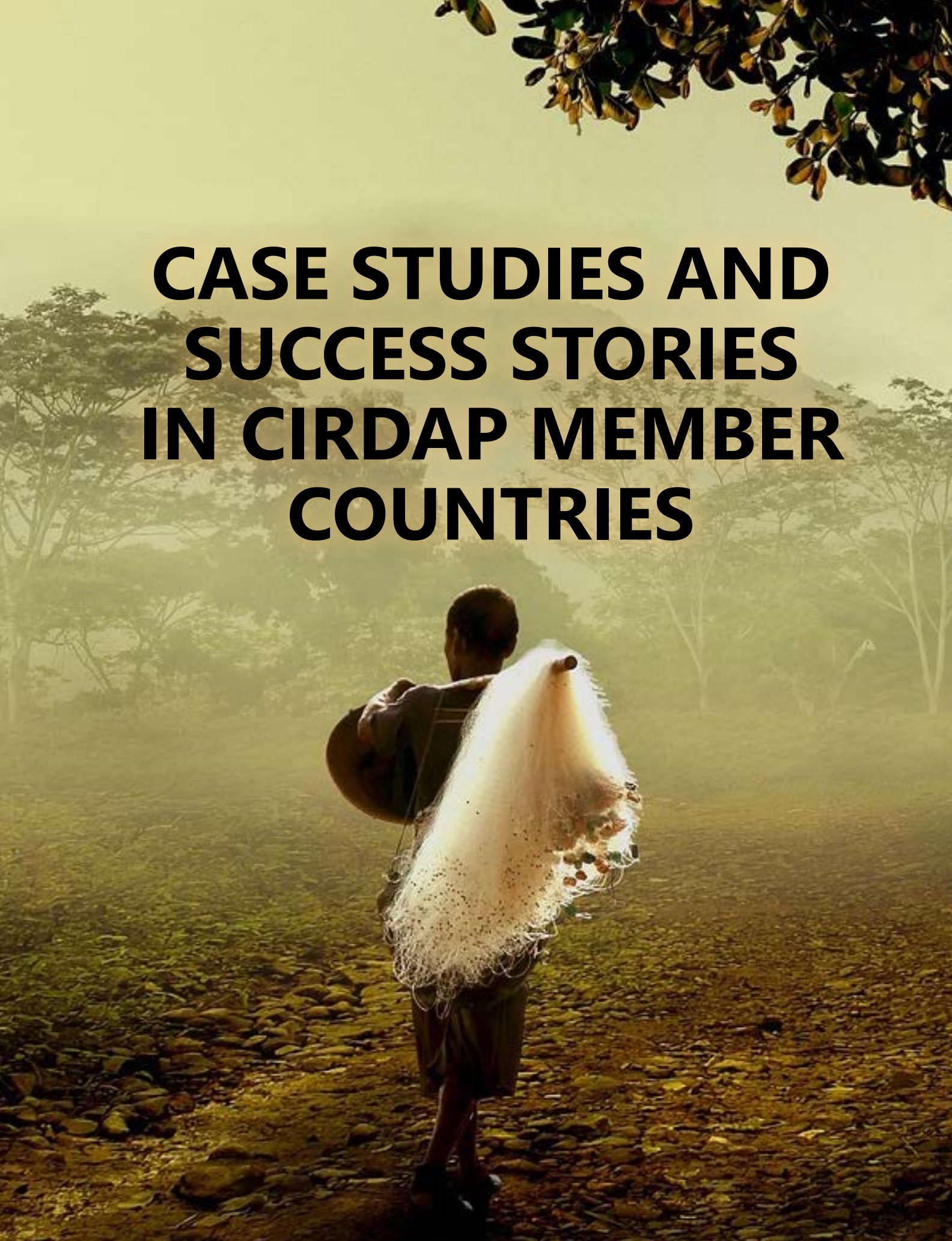
GMC emphasizes renewable energy sources (hydropower, wind, solar), plastic-free buildings constructed with local materials (wood, stone, bamboo), and biodiversity preservation. The city's design incorporates paddy fields as flood barriers and wildlife corridors, ensuring minimal ecological disruption.

Bhutan's carbon-negative status and GNH philosophy underpin GMC's vision of sustainable urban growth. Youth unemployment and urban migration are key issues GMC aims to address by creating jobs and fostering innovation.

Opportunities: GMC's strategic location and business-friendly regulations aim to attract ethical investments, positioning Bhutan as a hub for clean technology and mindful tourism.

Endorsed by global figures like Nobel laureates Joseph Stiglitz and Michael Spence, and Snap Inc. CEO Evan Spiegel at the 2024 Bhutan Innovation Forum.

CASE STUDIES AND SUCCESS STORIES IN CIRDAP MEMBER COUNTRIES



5. CASE STUDIES AND SUCCESS STORIES IN CIRDAP MEMBER COUNTRIES

Climate-resilient rural development is a critical priority for CMCs, given their vulnerability to climate change impacts such as floods, droughts, cyclones, and rising temperatures. This note explores case studies and success stories from some of the CMCs, highlighting innovative approaches, community-driven initiatives, and policy interventions that enhance climate resilience in rural areas. The examples draw from documented projects, emphasizing practical outcomes and lessons learned.

Case studies of specific CMCs:

1. BANGLADESH: Saemaul Zero Hunger Communities (SZHC) Project

In central Bangladesh, the Saemaul Zero Hunger Communities (SZHC) project (2014–2017) focused on 19 flood-prone villages to strengthen resilience to climate shocks and improve food security (UNDP, 2018). Implemented in collaboration with local communities, the project adopted a holistic approach that addressed multiple dimensions of vulnerability, including income, education, and social capital. A major flood in 2015 provided a real-world test of the project's efficacy. Key interventions included:

- **Diversified Livelihoods:** Training programs enabled households to diversify income sources, reducing dependence on flood-vulnerable agriculture.
- **Women's Empowerment:** Women's active involvement fostered ownership and sustainability, with increased community participation enhancing social cohesion.
- **Infrastructure Development:** Flood-resistant infrastructure, such as elevated community centers, supported recovery efforts.
- **Holistic Approaches Yield Broad Benefits:** Addressing income, education, and social capital simultaneously led to measurable improvements in household income, asset accumulation, child education continuity, and social networks.
- **Community-Driven Models:** Engaging local communities in project design and implementation ensured relevance and enhanced resilience, as evidenced by outcomes during the 2015 flood.

These learnings highlight the importance of integrated, inclusive, and community-focused strategies for climate adaptation and food security.

The project significantly improved food security and facilitated livelihood recovery following the flood. Propensity score matching analysis showed enhanced resilience capacities, including increased income and assets, reduced disruption in child education, and strengthened social networks. The success underscored the value of community-driven, gender-inclusive approaches in building climate resilience.

2. INDIA: Infrastructure for Climate Resilient Growth (ICRG) Program

The Infrastructure for Climate Resilient Growth (ICRG) program, a collaboration between India's Ministry of Rural Development, the UK's Foreign, Commonwealth and Development Office, and the United Nations Development Programme (UNDP), integrated climate resilience into the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) (Ministry of Rural Development, India, 2023). Launched to enhance rural infrastructure, the program focused on water conservation and disaster resilience. Key achievements included:

- **Water Conservation:** The construction of check dams, village ponds, and rainwater harvesting structures improved groundwater recharge and drought-proofing. For instance, GIS-based planning in states like Rajasthan, India has optimized water resource management.
- **Community Capacity Building:** Training programs empowered rural communities to plan and implement climate-resilient projects, fostering long-term sustainability.

- **Policy Integration:** The program embedded climate considerations into MGNREGS planning, influencing state-level policies.
- **Innovative Technology Boosts Planning Efficiency:** Tools like the Climate Resilience and Information Systems Planning (CRISP-M) tool showcased the power of technology in enhancing rural planning and decision-making for climate adaptation.
- **Documented Success Stories Inspire Replication:** The 2023 workshop, highlighting 75 success stories, underscored the program's impact on strengthening vulnerable communities against climate impacts, offering replicable models for other regions.

These learnings underscore the importance of integrating infrastructure development, community engagement, policy alignment, and technological innovation to construct climate-resilient rural communities.

3. PHILIPPINES: Climate-Resiliency Field Schools (CrFS)

Climate-Resiliency Field Schools (CrFS) have emerged as a polycentric institutional strategy to promote climate-smart agriculture (CSA) among smallholder farmers in the Mindanao region (IRRI, 2022). Supported by local NGOs and government agencies, CrFS provides a platform for farmers to access climate information and adopt resilient practices. Notable interventions include:

- **Climate-Smart Practices:** Farmers adopted soil conservation, agroforestry, and reforestation to maintain carbon stocks while boosting crop yields. For example, agroforestry practices increased productivity by integrating trees with crops.
- **Knowledge Sharing:** CrFS facilitated participatory processes, enabling farmers to make informed decisions on crop selection and planting schedules based on climate forecasts.
- **Institutional Support:** Polycentric governance models reduced transaction costs by improving market access and cooperative agreements.

The program's location-specific and knowledge-intensive approach enhanced farmers' adaptive capacity. Scalable models now inform similar initiatives in other CIRDAP countries. This success highlights the importance of local institutional structures in reducing climate risks.

4. NEPAL: Climate-Smart Village (CSV) Approach

The Climate-Smart Village (CSV) approach, supported by the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), has been scaled up by the Nepal government to promote climate-resilient agriculture (CCAFS, 2017). Implemented in rural districts, CSVs integrate adaptation, mitigation, and sustainable development. Key features include:

- **Portfolio of Practices:** Farmers adopted drought-resistant crop varieties, precision irrigation, and organic composting to enhance productivity and resilience.
- **Gender Mainstreaming:** Policies prioritized women farmers, improving their access to training and resources and increasing household resilience.
- **Policy Uptake:** The CSV model influenced Nepal's national agricultural policies, promoting climate-resilient practices nationwide.

The approach's success lies in its participatory nature, allowing farmers to co-design solutions tailored to local conditions. By 2017, the model had been adopted across multiple states, demonstrating scalability and replicability.

5 SRI LANKA: USAID Supporting Opportunities in Livelihoods Development (SOLID) Project

The USAID-funded SOLID project targeted rural communities in Sri Lanka's Northern, North Central,

and Eastern Provinces, with a focus on vulnerable groups, including women and youth (USAID, 2022). The project aimed to shift subsistence agriculture to small-scale commercial production, enhancing resilience to weather variability. Key interventions included:

- **Dairy Sector Improvements:** Introduction of silage production ensured year-round livestock feed, with 75% of farmers reporting increased milk production (50% saw a 20% or higher increase).
- **Chilli Cultivation:** Off-season chilli farming using poly bags and sprinkler irrigation reduced disease and improved yields, stabilizing incomes.
- **Technology Adoption:** Access to modern irrigation systems enhanced water efficiency, mitigating drought risks.

The project's focus on market-oriented practices and technology adoption strengthened rural livelihoods, making them more resilient to climate shocks.

6. **PAKISTAN: Climate Change Impact on Smallholder Farmers in Rajanpur**

A study in Rajanpur district, Pakistan, highlighted the socio-economic impacts of climate change on smallholder farmers and their adaptive responses (Hussain & Mudasser, 2019). In 2018, the research surveyed 280 farmers in the flood- and drought-prone tehsil of Jampur. Findings included:

- **Economic Impacts:** All respondents reported reduced agricultural yields and income due to climate variability, with annual income dropping significantly (from PKR 2,930,832 to PKR 2,684,400).
- **Adaptive Measures:** Farmers adopted water-saving techniques, such as drip irrigation, and diversified crops to include drought-resistant varieties.
- **Community Resilience:** Local cooperatives facilitated access to climate-resilient seeds and training, enhancing collective adaptive capacity.

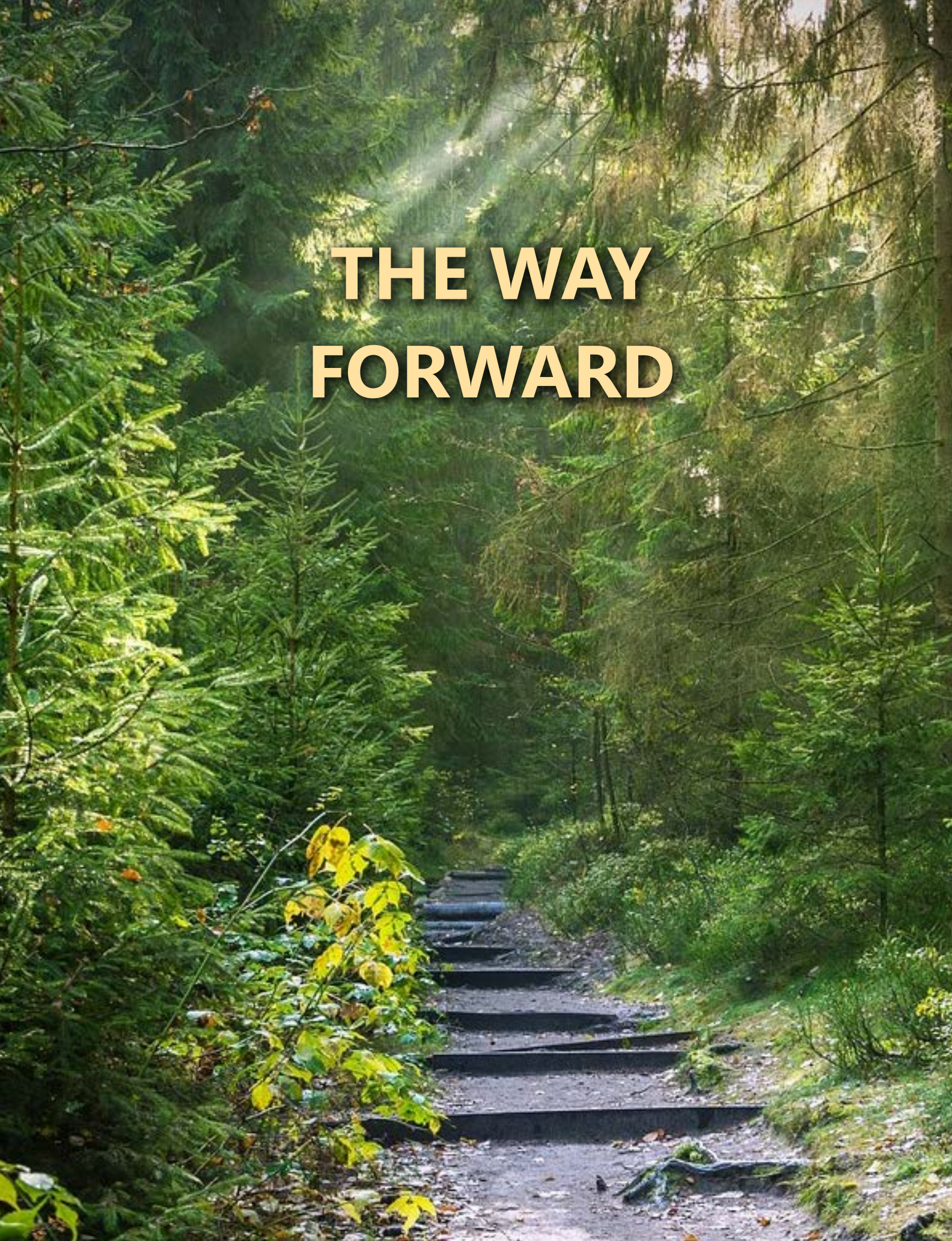
The study emphasized the need for government support in scaling up adaptive technologies and improving rural farmers' access to climate information.

Lessons Learned and Broader Implications

These case studies reveal common themes and strategies that contribute to successful climate-resilient rural development in CMCs:

- **Community Participation:** Engaging local communities, especially women and marginalized groups, fosters ownership and sustainability. Projects like SZHC and ICRG demonstrate the power of participatory approaches.
- **Technology and Innovation:** Tools like GIS, climate forecasting, and precision agriculture (e.g., CrFS, CSV) enhance decision-making and resource efficiency.
- **Policy Integration:** Embedding climate resilience into national programs, as seen in India and Nepal, ensures scalability and long-term impact.
- **Holistic Approaches:** Addressing multiple dimensions of vulnerability—economic, social, and environmental—yields comprehensive resilience, as evidenced by SZHC and SOLID.
- **Knowledge Sharing:** Platforms like CrFS and CIRDAP's webinar series facilitate cross-country learning and amplify best practices (CIRDAP, 2023).

CMCs have made significant strides in climate-resilient rural development through innovative projects and community-driven initiatives. From Bangladesh's flood-resilient villages to Nepal's climate-smart villages, these success stories offer valuable lessons for scaling up resilience across the Asia-Pacific. By prioritizing participatory approaches, technological innovation, and policy integration, CIRDAP countries can continue to build sustainable, climate-resilient rural futures. Ongoing collaboration through CIRDAP's platforms will be crucial in disseminating these best practices and addressing shared challenges.


THE WAY
FORWARD

6.1 Regional collaboration and the role of CIRDAP in the promotion of CRRD Strategies

The Imperative for Regional Collaboration

Climate change poses a transboundary threat that no single nation can address in isolation. In CMCs, rural populations, often dependent on agriculture and natural resources, are disproportionately vulnerable. For instance, Assam, India, faces rising temperatures and frequent floods, threatening 86% of its agriculture-dependent rural population. Similarly, Bangladesh, a climate change hotspot, grapples with salinization and cyclones that disrupt rural livelihoods. Regional collaboration offers a pathway to pool resources, share expertise, and develop scalable solutions. As the United Nations Economic and Social Commission for Western Asia highlights, collaborative action enhances food and water security through shared knowledge and joint policy platforms. CIRDAP's mandate to promote regional cooperation aligns perfectly with this need, making it a vital platform for driving climate-resilient rural development.

The fundamental philosophy behind regional organizations like CIRDAP is to harness member countries' capacities to address bilateral and multilateral issues, especially among geographically proximate or bordering nations. CIRDAP provides a platform for collaborative resolution of challenges related to water and agriculture, exemplified by disputes between Iran and Afghanistan or India and Pakistan. During droughts, transboundary water conflicts exacerbate the vulnerabilities of farmers in border regions. For example transboundary water disputes, such as the Helmand River conflict between Iran and Afghanistan. These disputes have direct impacts on rural livelihoods, food security, and regional stability. Addressing such issues is essential for comprehensive and actionable rural development policies.

Key Strategies for Collaboration

1. Strengthening Knowledge Exchange and Research

Knowledge sharing is the cornerstone of effective regional collaboration. CIRDAP can leverage its network of contact ministries and link institutions to establish a robust regional knowledge base on climate-resilient practices. The ASEAN Climate Resilience Network (ASEAN-CRN) provides a model, having advanced climate-smart agriculture through information exchange and national studies. CIRDAP could facilitate similar initiatives, such as:

Regional Research Hubs: Create centers to study climate impacts on crops, water resources, and livelihoods, tailoring solutions to local contexts.

Best Practice Dissemination: Publish and translate case studies, like Assam's community-led flood resilience efforts, for broader adoption.

Data Banks: Develop a centralized repository for climate data, accessible to all member countries, to inform evidence-based policymaking.

These efforts would empower rural communities with actionable insights, reducing vulnerability to climate shocks.

2. Innovative Financing for Resilience

Financing climate-resilient rural development requires innovative mechanisms to overcome resource constraints. CIRDAP can advocate for and facilitate access to climate funds, drawing inspiration from initiatives like the African Cities Water Adaptation Fund and the ASEAN-CRN's project proposals for scaling climate-smart agriculture. Potential approaches include:

Microfinance for Ecosystem-Based Adaptation: Programs like those in Benin and Senegal, which provide rural producers with financial tools for sustainable practices, could be scaled across CIRDAP countries.

Regional Climate Funds: Establish a CIRDAP-led fund to support smallholder farmers and rural cooperatives, ensuring equitable access to resources.

Public-Private Partnerships: Engage private sectors in member countries to invest in green technologies, such as renewable energy for rural areas. By mobilizing diverse funding streams, CIRDAP can ensure sustained investment in resilience-building projects.

3. **Capacity Building and Training**

Empowering rural communities and policymakers through capacity building is critical. CIRDAP's existing training programs for government officials and development practitioners can be expanded to focus on climate resilience. Key initiatives could include:

Climate-Smart Agriculture Training: Equip farmers with skills in drought-resistant crops, water harvesting, and soil conservation, building on ASEAN-CRN's success.

Youth Engagement: Programs like the Asia-Pacific Young Farmers Camp, which trained 130 young farmers in climate resilience, could be replicated to attract youth to sustainable agriculture.

Exposure Visits: Organize cross-country visits to showcase successful interventions, such as Bangladesh's climate-resilient land-use practices. These efforts would enhance local expertise and foster a culture of innovation in rural areas.

6.2 Long term policy vision

Policy Alignment and Regional Frameworks

Harmonizing policies across CMCs is essential to scale resilience efforts. The Rural Development Forum 2019 emphasized the need for a regional climate-resilient framework for livelihoods and land-use practices. CIRDAP can lead by developing regional guidelines, which are modelled on ASEAN's Regional Guidelines for Climate-Smart Agriculture. These could standardize best practices for resilience. However, the development of guidelines with the direct consultation and inputs received from designated representatives of the Member Countries will address the actual needs of different regions/countries. Addressing and advocating at global forums and platforms like the UNFCCC for rural adaptation projects can strengthen the goals and alignment of policies framed for the regions. With COVID-19 and economic shifts driving reverse migration to rural areas, CIRDAP can coordinate policies to mitigate pressures on resources and enhance rural economies. Such frameworks would ensure cohesive action and amplify the impact of national efforts.

FRAMEWORK FOR PROMOTING REGIONAL COOPERATION TO ALLEVIATE DAMAGE FROM ABERRANT WEATHER EVENTS IN CIRDAP MEMBER COUNTRIES

The CIRDAP Member Countries are facing increasing challenges from aberrant weather events and natural calamities, such as floods, droughts, cyclones, and heatwaves. These events disproportionately impact rural communities, threatening livelihoods, food security, and sustainable development. A robust framework for regional cooperation, emphasizing the pooling of expertise and funding, is crucial for mitigating and alleviating the damage caused by these events.

Some of the objectives are:

1. Enhance the resilience of rural communities against aberrant weather events and natural calamities.
2. Facilitate the pooling of technical expertise, knowledge, and financial resources to support disaster preparedness, response, and recovery.
3 Promote sustainable rural development through regional cooperation and shared strategies.
4 Strengthen institutional mechanisms for coordinated action across CIRDAP member countries.

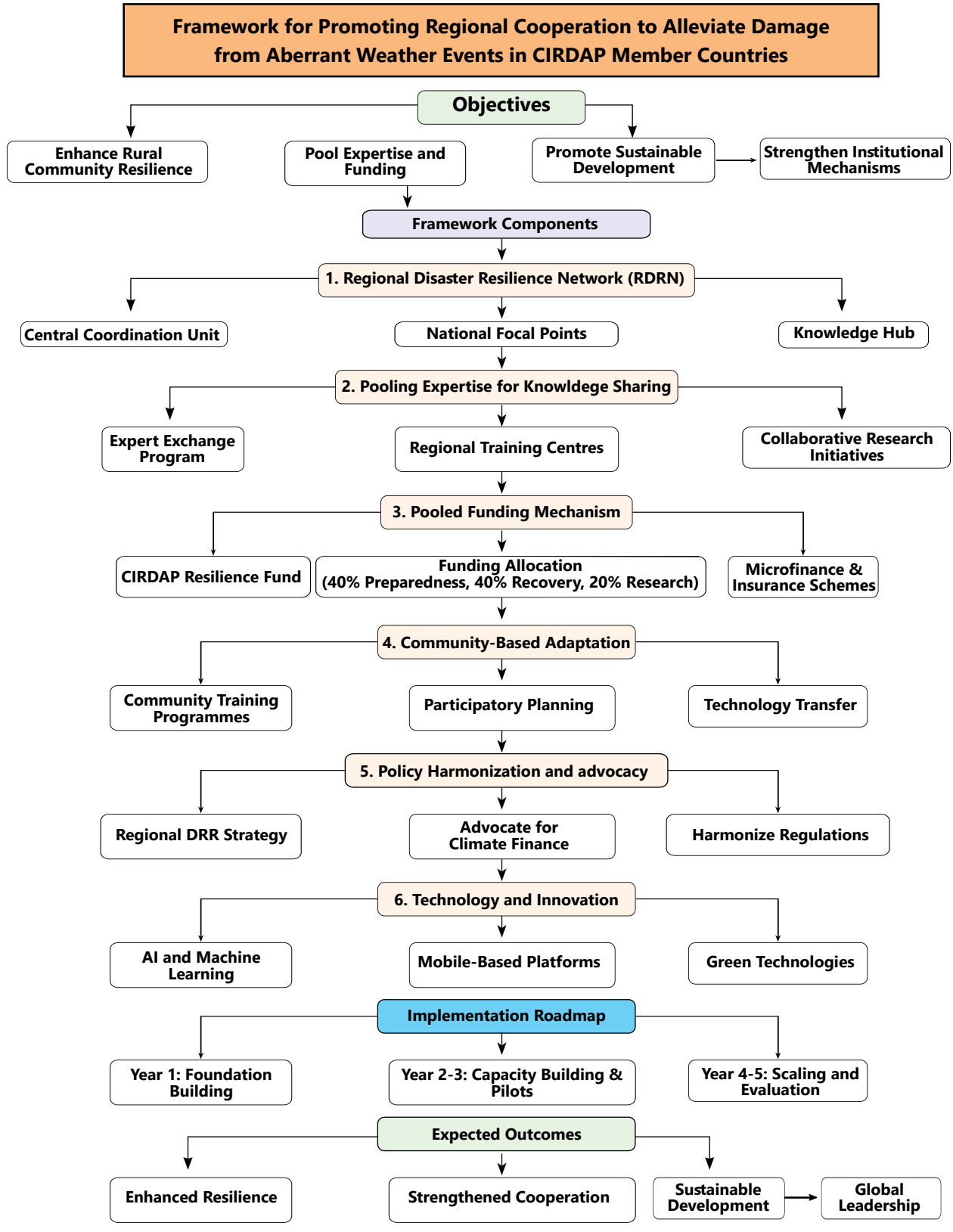


Figure 7 : Framework for promoting regional cooperation to alleviate damage from aberrant weather events in CMCs

The proposed framework for regional cooperation under CIRDAP offers a transformative approach to addressing the challenges posed by aberrant weather events in rural communities. By pooling expertise, funding, and innovative solutions, member countries can build resilient rural ecosystems that withstand and recover from natural calamities. This collaborative effort will not only safeguard livelihoods but also position CIRDAP as a model for regional cooperation in climate resilience globally.

Challenges and Mitigation

Despite its potential, regional collaboration faces challenges, including differing national priorities, resource disparities, and bureaucratic hurdles. To address these, inclusive dialogue by CIRDAP that hosts regular ministerial retreats, like the 2010 Dhaka meeting, to align priorities, and to build equitable resource allocation will prioritize least-developed member countries, in funding and training programs. A streamlined coordination using digital platforms could help to enhance communication among contact ministries, reducing bureaucratic delays. By proactively tackling these issues, CIRDAP can ensure effective collaboration.

The Role of Partnerships

CIRDAP's openness to partnerships with national, regional, and international organizations is a strength. Collaborating with entities like the FAO, UNEP, and the Asian Development Bank can enhance technical support and funding. For example, UNEP's projects in Nepal and Cambodia on ecosystem-based adaptation could be adapted for CIRDAP countries. Engaging youth and farmers' organizations, as seen in the Asian Farmers Association's initiatives, can also drive grassroots resilience.

The way forward for regional collaboration on climate-resilient rural development in CMCs lies in leveraging shared knowledge, innovative financing, capacity building, and policy alignment. By fostering a collaborative ecosystem, CIRDAP can empower rural communities to withstand climate challenges while promoting sustainable livelihoods. As climate impacts intensify, the collective action of CIRDAP's 15 member countries, supported by strategic partnerships and a commitment to equity, will be crucial in building a resilient rural future. The time to act is now, and CIRDAP stands poised to lead this transformative journey.

6.3 Monitoring and evaluation: A pathway to climate-resilient rural development in CMCs

Monitoring and Evaluation (M&E) systems offer a structured approach to assess, adapt, and enhance climate-resilient rural development initiatives. By systematically tracking progress, identifying gaps, and fostering evidence-based decision-making, M&E serves as a cornerstone for sustainable rural development in CMCs.

The Role of M&E in Climate-Resilient Rural Development

1. Assessing Vulnerability and Resilience

M&E frameworks enable CMCs to evaluate the vulnerability of rural communities to climate impacts. By collecting data on local climate risks—such as drought frequency in Bangladesh or flooding in Vietnam—M&E systems identify high-risk areas and populations. This informs targeted interventions, such as introducing drought-resistant crops or improving irrigation systems. Regular evaluations ensure these interventions enhance resilience, adjusting strategies as climate patterns evolve.

2. Tracking Adaptation Measures

Climate-resilient rural development relies on adaptive measures like sustainable agriculture, water management, and disaster preparedness. M&E tracks the implementation and effectiveness of these measures. For instance, in India, M&E systems monitor watershed management programs, assessing their impact on groundwater levels and crop yields. In Pakistan, evaluations of early warning systems for floods help refine response mechanisms, ensuring timely evacuations and reduced losses.

3. Ensuring Resource Efficiency

CMCs often face resource constraints, making efficient allocation critical. M&E provides data on resource utilization, highlighting areas of waste or underperformance. For example, in Nepal, M&E has revealed gaps in the distribution of climate-resilient seeds, prompting better supply chain management. By optimizing resources, M&E ensures that limited funds deliver maximum impact for rural communities.

4. Promoting Community Participation

Effective M&E incorporates community feedback, ensuring that climate resilience strategies align with local needs. In the Philippines, participatory M&E has empowered farmers to report on the suitability of new crop varieties, leading to more tailored agricultural policies. This inclusivity fosters ownership, increases adoption of resilience measures, and builds trust between governments and rural populations.

Some of the challenges are despite its potential, M&E faces challenges in CMCs. Limited technical capacity, especially in countries like Afghanistan or Lao PDR, hinders data collection and analysis. Inconsistent funding often disrupts long-term monitoring, while fragmented governance structures, as seen in some South Asian nations, complicate coordination. Additionally, varying climate impacts across diverse geographies—from coastal Bangladesh to mountainous Bhutan—demand context-specific M&E frameworks, which can be resource-intensive to develop.

Strategies to Strengthen M&E for Climate Resilience

1. Building Technical Capacity

Training programs for local officials and communities can enhance M&E capabilities. CIRDAP can facilitate regional knowledge-sharing, as seen in its workshops on integrated rural development. For example, Sri Lanka's success in using GIS-based M&E for coastal adaptation can be replicated in Maldives or Indonesia.

2. Leveraging Technology

Digital tools, such as mobile apps for real-time data collection or satellite imagery for crop monitoring, can streamline M&E. In Thailand, remote sensing has improved the monitoring of deforestation, aiding climate-resilient land-use planning. CIRDAP can support member countries in adopting cost-effective technologies tailored to rural contexts.

3. Leveraging Indigenous knowledge

Indigenous communities possess invaluable insights into local ecosystems, climate patterns, and sustainable agricultural practices that have been honed over generations. By incorporating this knowledge into M&E frameworks, policymakers can develop more context-specific and culturally relevant indicators that reflect the unique challenges and adaptive capacities of local populations. Moreover, engaging indigenous communities in the M&E process fosters ownership and empowers them to actively participate in resilience-building initiatives. This collaborative approach not only enhances the effectiveness of climate resilience strategies but also ensures that they are grounded in the realities of those most affected by climate change, ultimately leading to more sustainable outcomes.

4. Securing Sustainable Funding

Partnerships with international organizations like the Asian Development Bank or the Global Environment Facility can ensure consistent funding for M&E. Pilot projects in Malaysia and Iran have demonstrated how blended financing models sustain long-term monitoring of climate adaptation programs.

5. Harmonizing Regional Frameworks

CIRDAP can lead the development of standardized monitoring and evaluation (M&E) indicators for climate-resilient rural development. By aligning metrics across member countries, such as soil health or water availability, CIRDAP fosters comparability and collective learning. This approach has worked

in ASEAN's climate resilience frameworks, which CIRDAP could adapt.

Specific case studies

Bangladesh: Community-Based M&E

In Bangladesh, M&E systems monitor community-led mangrove restoration projects along coastal areas. These systems have quantified resilience benefits by tracking mangrove coverage and storm surge protection, securing further investment. Community input ensures projects address local priorities, such as protecting fisheries.

Vietnam: Evaluating Agroforestry

Vietnam's M&E frameworks assess agroforestry programs in the Central Highlands, measuring soil erosion reduction and income diversification. Evaluations have led to policy adjustments, promoting native tree species that better withstand climate variability.

Monitoring and Evaluation is a vital tool for advancing climate-resilient rural development in CMCs. By assessing vulnerabilities, tracking adaptation, optimizing resources, and engaging communities, M&E ensures that development initiatives are effective and sustainable. Despite challenges like limited capacity and funding, strategic investments in technology, training, and regional collaboration can overcome these barriers. As climate change intensifies, robust M&E systems will be indispensable for building resilient rural futures across CIRDAP's diverse Member Countries.

CONCLUSION

7.0 Conclusion

7.1 Summary of Key Points

The Asia-Pacific region, particularly the rural areas within CMCs, faces severe climate change impacts, including frequent natural disasters, rising temperatures, and sea-level rise, which threaten agriculture, livelihoods, and food security. Climate-resilient rural development (CRRD) is crucial for mitigating these vulnerabilities, addressing challenges such as agricultural dependency, limited infrastructure, governance gaps, financial constraints, and socio-cultural barriers. Key approaches like climate-smart agriculture, strengthened infrastructure, innovative start-up ecosystems, enhanced access to climate information, and inclusive policies empower rural communities to adapt and thrive. Stakeholders—governments, international organizations, the private sector, and local communities—play complementary roles in driving resilience through policy, funding, technology, and grassroots innovation. Sensitising all stakeholders across countries to mainstream climate change aspects and its impact on livelihoods, among all departments and the information dissemination by these departments to the public and relevant stakeholders regarding the climate change effects needs to be a continuous process. Success stories from Bangladesh, India, the Philippines, Nepal, and Sri Lanka highlight the potential of integrated, community-driven solutions. In Paksitan, strengthening local capacity, by introducing "floating gardens" model (like in Bangladesh) in flood-prone regions like Sindh would be beneficial. Training of extension workers on CSA techniques (e.g., drip irrigation in arid zones like Thar, Pakistan), developing district-level climate vulnerability indices (similar to ND-GAIN) could guide resource allocation, in addition to leveraging Pakistan's Space and Upper Atmosphere Research Commission (SUPARCO) for satellite-based agricultural monitoring. In Pakistan, addressing cultural barriers that limit women's access to climate information/credit, drawing lessons from India's Self-Help Group model could help women in development perspective. Moving forward, regional collaboration, facilitated by CIRDAP, alongside long-term policy vision and robust monitoring, will be critical to scaling these efforts.

7.2 Call to Action

CMCs must act urgently to integrate climate resilience into rural development strategies, prioritizing inclusive and sustainable approaches. Governments should align policies with global frameworks like the Paris Agreement, invest in resilient infrastructure, and foster public-private partnerships to mobilize resources. Re-orienting current infrastructure and increased investments, policies, programs, and information dissemination need to be prioritised, keeping in view the climate change vulnerability across the Asia-Pacific region. Green Business opportunities like solar energy-based farming, installing sensors for identifying the required inputs in agriculture, and eco-friendly income-generating opportunities need to be encouraged by the respective governments in the countries. International organizations and the private sector must enhance technology transfer and financial support, while local communities and farmers should be empowered through capacity building and equitable access to resources. CIRDAP's role as a regional coordinator is pivotal in facilitating knowledge exchange, securing climate finance, and promoting gender-responsive policies. By leveraging collective action, innovative financing, and evidence-based monitoring, the Asia-Pacific can build resilient rural economies that withstand climate challenges, ensuring sustainable livelihoods and food security for future generations.

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