

Unveiling the Role of Climate-Smart Cooperatives in Climate Change Adaptation and Sustainability Transitions

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Abstract

Climate change poses profound challenges for vulnerable communities in Bangladesh, exacerbating socio-economic disparities and environmental vulnerabilities. This study explores the transformative potential of climate-smart cooperatives as a community-driven model for fostering resilience and promoting sustainability transitions among climate-vulnerable women. The study identifies three primary strategies employed by cooperatives: agroforestry and diversified agriculture, water conservation and efficient irrigation, and livelihood diversification. These practices enhance food security, optimize resource use, and stabilize incomes, addressing immediate climate adaptation needs while contributing to long-term sustainability goals. Furthermore, cooperatives empower marginalized communities by fostering leadership, financial independence, and social cohesion, particularly among women, thus challenging entrenched gender inequalities. The research also highlights the dual dynamics of challenges and opportunities. Financial constraints, limited access to technology, and dependency on external support hinder cooperative scalability. However, opportunities in market expansion, technological advancements, and capacity building underscore the potential for growth and innovation. Notably, the environmental impacts of cooperative practices, such as carbon sequestration and biodiversity conservation, position them as key actors in achieving global climate objectives. By aligning the findings with theoretical frameworks on sustainability transitions and empowerment, this study contributes to a growing body of literature on cooperative-based climate resilience. The insights presented offer valuable implications for policymakers, development practitioners, and researchers, advocating for an integrated approach to scaling climate-smart cooperatives as a sustainable solution for climate adaptation and social transformation.

Keywords: Climate-smart cooperatives, resilience building, sustainability transitions, women empowerment, Bangladesh, climate change adaptation.

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Chapter 1: Introduction

1.1 Background of study

Bangladesh is among the most climate-vulnerable nations globally due to its geographical location, dense population, and reliance on climate-sensitive sectors such as agriculture and fisheries. Rising sea levels, erratic rainfall patterns, and increased frequency of extreme weather events exacerbate existing socio-economic challenges. The most vulnerable groups, including women, face intensified risks as traditional livelihoods and resources are heavily impacted (Bangladesh, 2022).

To address these challenges, innovative approaches have emerged. Climate-smart cooperatives offer a unique, community-driven platform for enhancing resilience and facilitating sustainability transitions. These cooperatives incorporate principles of self-help, democracy, and equality, empowering women and marginalized groups to collaborate on sustainable initiatives. The Local Government Initiative on Climate Change (LoGIC)¹ project, led by the United Nations Development Program (UNDP), has introduced such cooperatives in vulnerable regions of Bangladesh, showing promising results in building economic resilience and fostering adaptation strategies (UNDP Bangladesh, 2023).

This study examines the pivotal role of climate-smart cooperatives in advancing climate resilience and sustainable development, focusing on their impact on women in climate-vulnerable² communities. Through this exploration, the research sheds light on cooperative models that address socio-economic vulnerabilities and promote long-term environmental sustainability.

Climate-smart cooperatives have emerged as transformative models in community-driven climate adaptation strategies. They provide economic opportunities, build social capital, and enhance collective decision-making, particularly among women, who are disproportionately affected by climate change.

This study contributes to existing knowledge by:

- Expanding understanding of how climate smart cooperatives empower women and marginalized communities.
- Highlighting the role of cooperatives in addressing climate resilience and sustainability transitions.
- Providing insights into how cooperative structures can align with the Sustainable Development Goals (SDGs), particularly SDG 5 (Gender Equality) and SDG 13 (Climate Action) (Ishtiaque et al., 2021; Munasinghe, 2010).

The findings of this study aim to inform policymakers, practitioners, and development organizations on enhancing cooperative models to better serve climate-vulnerable communities in Bangladesh and beyond.

¹ Local Government Initiative on Climate Change (LoGIC) is a multi-donor collaborative initiative of GoB, UNDP, UNCDF, European Union (EU), Sweden and Denmark. It aims to enhance the capacity of vulnerable communities, Local Government Institutions and civil society organizations for planning and financing climate change adaptation solutions in selected climate-vulnerable areas (UNDP, 2024).

² Climate vulnerable communities are groups of people who are disproportionately affected by climate change due to social and economic factors.

1.2 Research Objectives

The primary objective of this research is to examine the role of climate-smart cooperatives in enhancing climate resilience and facilitating sustainability transitions among climate-vulnerable women in Bangladesh. Specific objectives include:

1. To analyze how climate-smart cooperatives facilitate climate change adaptation and drive sustainability transitions in climate-vulnerable regions of Bangladesh. *(Addresses Research Questions 1 and 2)*
2. To evaluate the role of climate-smart cooperatives in empowering climate-vulnerable communities, particularly in enabling participation and contributions to climate adaptation and sustainability transitions. *(Addresses Research Question 3)*

1.3 Research Questions

This research seeks to address the following key questions:

1. How do climate-smart cooperatives facilitate climate change adaptation among vulnerable communities in Bangladesh?
2. What role do climate-smart cooperatives play in driving sustainability transitions within climate-vulnerable regions of Bangladesh?
3. How do climate-smart cooperatives empower climate-vulnerable communities to participate in and contribute to climate adaptation efforts?

1.4 Scope and Limitations

This study focuses on the climate-smart cooperatives associated with the LoGIC project in Bangladesh. The analysis is limited to cooperatives operating in climate-vulnerable regions, with an emphasis on their impact on women and marginalized groups. The scope includes examining cooperative strategies, sustainability transitions, and their alignment with national and global climate policies. However, the study faces several limitations:

- Limited availability of long-term data on cooperative impacts.
- Variability in cooperative performance across different regions, which may affect generalizability.
- Challenges in isolating cooperative impacts from other external factors influencing resilience and sustainability outcomes.

Despite these limitations, the research provides valuable insights into an underexplored area, offering critical perspectives for advancing climate adaptation and sustainable development initiatives.

Chapter 2: Literature Review

2.1 Introduction

Climate-smart cooperatives are collaborative models that integrate traditional cooperative principles with climate-resilient practices, making them powerful tools for addressing the multidimensional challenges of climate change. As collective organizations, cooperatives facilitate resource pooling, knowledge sharing, and sustainable development through democratic governance, empowering communities to adapt to changing climatic conditions while fostering socio-economic resilience (Panagiota et al., 2023; Manjula, 2020).

In the context of climate change, cooperatives have proven to be effective in enhancing resilience through strategies such as agroforestry, water conservation, and diversified livelihoods. These practices not only mitigate immediate risks but also lay the groundwork for long-term sustainability transitions. By promoting collaboration, inclusivity, and adaptability, climate-smart cooperatives emerge as critical players in addressing the multidimensional challenges posed by climate change (Manjula, 2020; Hasan et al., 2019).

The importance of climate-smart cooperatives extends beyond local impacts, as they contribute to global sustainability transitions. These cooperatives foster systemic change by embedding sustainable practices in economic, environmental, and social dimensions, making them integral to achieving just and sustainable futures (Flor et al., 2024). The contributions of climate-smart cooperatives align seamlessly with global development agendas, including the Sustainable Development Goals (SDGs). Notably, these cooperatives advance:

- **SDG 5 (Gender Equality):** By fostering leadership and financial independence for women, cooperatives challenge entrenched gender norms and promote equitable participation in decision-making processes (Spitzer, 2023; Chakraborty et al., 2023).
- **SDG 13 (Climate Action):** Through sustainable farming, resource conservation, and renewable energy adoption, cooperatives actively reduce greenhouse gas emissions while building adaptive capacities (UNFCCC, 2020; Vu & Phi, 2023).

The LoGIC project in Bangladesh exemplifies how cooperative frameworks can drive progress toward these goals. By integrating local knowledge with international best practices, this initiative demonstrates the potential of climate-smart cooperatives to scale impactful solutions that are both context-specific and globally relevant (UNDP Bangladesh, 2023).

As climate challenges intensify, the alignment of cooperative strategies with global goals not only enhances their efficacy but also ensures that their contributions are recognized within broader policy and development frameworks. This dual focus on local action and global alignment underscores the transformative potential of climate-smart cooperatives in fostering resilience and sustainability.

2.2 Conceptual Framework: Climate-Smart Cooperatives

The conceptual framework of climate-smart cooperatives offers a structured understanding of their role in addressing climate challenges while fostering sustainability transitions. By integrating cooperative principles with climate adaptation strategies, these organizations function as transformative agents in achieving resilience and long-term sustainability.

2.2.1 Definition and Principles of Climate-Smart Cooperatives

Historical Evolution and Theoretical Underpinnings

Climate-smart cooperatives emerged as an innovative adaptation of traditional cooperative models, driven by the pressing need to address climate change. The historical evolution of cooperatives highlights their adaptability. Initially established to address economic inequalities, cooperatives have expanded their scope to include environmental and social objectives. Historically, cooperatives originated in the mid-19th century, emphasizing mutual aid, democratic governance, and collective action. (Waring & Lange, 2019). The emergence of climate-smart agriculture (CSA) in the early 21st century marked a significant milestone, integrating sustainable farming techniques into cooperative practices (Saptarnee et al., 2023).

The integration of climate-smart principles into cooperative frameworks began with the advent of climate-smart agriculture (CSA) in the early 2000s, which focused on enhancing productivity, resilience, and reducing greenhouse gas emissions (Lipper & Zilberman, 2018). This evolution reflects the adaptation of cooperative principles to address modern environmental and socio-economic crises, enabling collective responses to global climate challenges (Manjula, 2020).

Key Principles

1. **Self-Help:** Members are encouraged to take the initiative in adopting climate-smart practices, fostering resilience and independence. (Hasan et al., 2019)
 - *Example:* Cooperative-led efforts in Bangladesh promote rainwater harvesting and agroforestry, empowering communities to address water scarcity and land degradation.
2. **Democracy:** Participatory decision-making ensures that all members contribute to and benefit from cooperative strategies.
 - *Example:* Women-led cooperatives in India demonstrate how inclusive governance can enhance resource management and equitable participation (Chakraborty et al., 2023).
3. **Equity:** Fair access to resources and benefits among members is a foundational principle, reducing socio-economic disparities.
 - *Example:* Cooperatives in Vietnam allocate land resources equitably for agroecological practices, ensuring inclusivity in climate adaptation efforts (Vu & Phi, 2023).
4. **Sustainability:** Long-term environmental and economic viability is prioritized, aligning cooperative activities with global sustainability goals.
 - *Example:* European energy cooperatives focus on transitioning to renewable energy sources, significantly reducing carbon emissions (Torgerson et al., 2021).

2.2.2 Sustainability Transitions and Cooperative Models

Sustainability transitions refer to systemic shifts in socio-economic, environmental, and governance systems toward sustainable practices. The **Sustainomics framework**, introduced by Munasinghe (2010), provides a transdisciplinary approach for integrating economic, social, and environmental dimensions into decision-making processes.

This framework emphasizes:

- **Economic Viability:** Sustainable practices must deliver tangible economic benefits to ensure adoption and scalability.

- **Social Equity:** Ensuring inclusivity and reducing inequalities within communities is key to successful transitions.
- **Environmental Stewardship:** Practices must minimize ecological degradation and promote biodiversity conservation.

Role of Cooperatives in Driving Sustainability Transitions

Climate-smart cooperatives act as catalysts for sustainability transitions by bridging the gap between individual action and collective goals.

1. Economic Shifts

- Cooperatives promote income diversification and market access for climate-resilient products, reducing economic vulnerabilities. In Bangladesh, cooperatives facilitate the sale of salt-tolerant rice and organic vegetables, ensuring stable incomes for members (Hasan et al., 2019).

2. Social Shifts

- By fostering gender equity and leadership opportunities, cooperatives drive social transformation within patriarchal societies. Women-led cooperatives in South Asia have significantly improved gender dynamics by empowering women through financial independence and governance roles (Spitzer, 2023).

3. Environmental Shifts

- Through practices like agroforestry, water conservation, and renewable energy adoption, cooperatives actively contribute to reducing carbon emissions and restoring degraded ecosystems. Agroforestry initiatives by cooperatives in Vietnam have enhanced biodiversity and soil health while reducing reliance on chemical inputs (Vu & Phi, 2023).

Climate-smart cooperatives are key drivers of sustainability transitions. They integrate sustainable practices into community livelihoods, enabling transitions from high-risk, unsustainable practices to adaptive and sustainable systems. Case studies in Vietnam and India illustrate how cooperatives facilitate economic, social, and environmental shifts through agroecological practices, renewable energy adoption, and collective resource management (Vu & Phi, 2023; Kumar et al., 2015).

2.3 Cooperatives and Climate Resilience

Climate-smart cooperatives are pivotal in building resilience to climate change, especially in vulnerable communities. They act as mechanisms for adaptation by integrating economic, social, and environmental strategies into their frameworks. This section explores their multifaceted role in fostering resilience, drawing from both local and global contexts.

2.3.1 Cooperatives as Tools for Adaptation

Mechanisms for Climate Adaptation

Cooperatives adopt various strategies to mitigate the impacts of climate change and enhance community resilience:

- **Agroforestry:** Combining tree planting with crop cultivation helps mitigate soil erosion, improves soil fertility, and sequesters carbon. For instance, cooperatives in coastal Bangladesh have

implemented agroforestry using salt-tolerant crops, enabling farmers to sustain agriculture in saline-prone areas (Hasan et al., 2019).

- **Water Conservation:** Techniques such as rainwater harvesting and community ponds ensure water availability during droughts, a critical adaptation measure in regions facing erratic rainfall patterns (Vu & Phi, 2023).
- **Diversified Livelihoods:** Cooperatives promote livelihood diversification, integrating aquaculture, handicrafts, and small businesses to reduce dependency on climate-sensitive sectors like agriculture (Manjula, 2020).

Comparative Analysis

Globally, cooperatives have shown adaptability in diverse climatic contexts:

- **Vietnam:** Agricultural cooperatives focus on agroecological practices, such as intercropping and natural pest control, to combat extreme weather conditions (Vu & Phi, 2023).
- **India:** Farmer cooperatives have pioneered renewable energy adoption, such as solar-powered irrigation, reducing reliance on fossil fuels while enhancing agricultural productivity (Kumar et al., 2015).
- **Bangladesh:** Cooperatives like those under the LoGIC project have excelled in integrating local knowledge with climate-smart techniques, such as using organic fertilizers and salt-tolerant seeds (UNDP Bangladesh, 2023).

These comparative insights underscore the adaptability and scalability of cooperative models in fostering resilience across varying socio-environmental contexts.

2.3.2 The Role of Social Capital in Resilience Building

Enhancing Trust, Collaboration, and Collective Decision-Making

By fostering inclusive governance, cooperatives enhance social cohesion and collective efficacy, enabling communities to address climate vulnerabilities effectively (Esther et al., 2022; Nur et al., 2022). Social capital is central to the success of cooperatives, as it fosters trust, collaboration, and participatory governance:

- **Trust:** Members trust the cooperative structure to provide fair access to resources, fostering a shared sense of security (Sabatini et al., 2014).
- **Collaboration:** Joint projects, such as community water conservation or market access initiatives, strengthen social bonds and collective efficacy (Chakraborty et al., 2023).
- **Collective Decision-Making:** Democratic governance within cooperatives ensures that all voices are heard, promoting equitable resource allocation (Waring & Lange, 2019).

Empowerment of Women and Marginalized Groups

Empowerment of women and marginalized groups through cooperative activities further amplifies resilience. Women-led cooperatives in South Asia have demonstrated improved resource management, financial independence, and social inclusion, highlighting the transformative potential of gender-inclusive

approaches (Britt et al., 2023; Chakraborty et al., 2023). Cooperatives are instrumental in empowering women and other marginalized groups, enabling their active participation in resilience-building initiatives:

- **Leadership Opportunities:** Women-led cooperatives in Bangladesh have demonstrated improved decision-making and financial management capabilities (UNDP Bangladesh, 2023).
- **Economic Independence:** Cooperative activities provide women with access to savings, loans, and income-generating opportunities, reducing dependency on patriarchal structures (Spitzer, 2023).
- **Social Inclusion:** By involving landless farmers and indigenous communities, cooperatives ensure inclusivity in adaptation measures (Hasan et al., 2019).

2.3.3 Economic Dimensions of Resilience

Cooperatives contribute significantly to economic resilience by providing income diversification, market access, and financial stability. Initiatives such as value-added agricultural products and international market linkages have enhanced the economic viability of cooperative members, particularly in Bangladesh and India (Kumar et al., 2015; UNDP Bangladesh, 2023).

Income Generation and Financial Security

Economic stability is a cornerstone of resilience, and cooperatives contribute significantly by:

- **Generating Income:** Members earn higher incomes through value-added activities like organic farming, aquaculture, and handicraft production. For example, salt-tolerant crop cultivation has increased household incomes in coastal Bangladesh (Manjula, 2020).
- **Building Financial Security:** Savings schemes and micro-loans offered by cooperatives help members prepare for climate-induced financial shocks (Kumar et al., 2015).

Market Access for Climate-Resilient Products

Cooperatives facilitate access to local, regional, and international markets, ensuring fair prices for members' products:

- **Local Markets:** In Vietnam, cooperative networks connect farmers with urban markets, boosting demand for organic produce (Vu & Phi, 2023).
- **Global Markets:** Partnerships with NGOs and development agencies help cooperatives in Bangladesh export organic and climate-resilient products, such as crab and shrimp, to international markets (UNDP Bangladesh, 2023).

These economic benefits not only enhance individual resilience but also strengthen the cooperative's ability to invest in sustainable practices, creating a virtuous cycle of adaptation and growth.

2.4 Gender and Marginalized Communities in Cooperatives

Climate-smart cooperatives are transformative platforms for addressing systemic inequalities, particularly concerning gender and marginalized groups. By empowering women and integrating underrepresented communities, cooperatives foster inclusive development and resilience, especially in climate-vulnerable regions.

2.4.1 Gender Equity in Climate-Smart Cooperatives

Empowerment of Women through Leadership Roles and Financial Independence

Women's active participation in climate-smart cooperatives transforms them from passive beneficiaries to key decision-makers, breaking entrenched socio-cultural norms.

- **Leadership Roles:** Climate-smart cooperatives provide women with opportunities to assume leadership positions, enabling them to influence resource allocation, governance, and project implementation. In Bangladesh, women-led cooperatives under the LoGIC project have demonstrated improved resource management and community engagement (UNDP Bangladesh, 2023).
- **Financial Independence:** Through savings schemes, microloans, and income-generating activities, cooperatives empower women economically, reducing their dependency on male family members. Women involved in cooperatives in India report significant improvements in household financial stability due to access to credit and training in sustainable agriculture (Chakraborty et al., 2023).

Addressing Socio-Cultural Barriers in Patriarchal Societies

Cooperatives actively challenge patriarchal norms by creating safe spaces for women to voice their concerns and participate equally in decision-making processes.

- **Breaking Gender Norms:** Cooperatives normalize women's involvement in traditionally male-dominated domains, such as financial management and agriculture. Women in South Asia have increasingly engaged in collective farming and community-based water management through cooperatives (Manjula, 2020).
- **Support Networks:** Cooperatives provide platforms for mutual support and skill-sharing, helping women overcome socio-cultural restrictions.

2.4.2 Inclusion of Marginalized Groups

Strategies for Integrating Marginalized Groups

Climate-smart cooperatives prioritize inclusivity, ensuring that landless farmers, indigenous communities, and other marginalized groups benefit from resilience-building activities.

- **Access to Resources:** Cooperatives allocate resources equitably, such as community land for agroforestry or shared water systems for irrigation. Farmers in Bangladesh were granted access to cooperative-managed land for salt-tolerant rice cultivation, increasing their income and food security (Hasan et al., 2019).
- **Culturally Sensitive Approaches:** Tailoring strategies to respect indigenous knowledge and practices ensures effective integration of marginalized communities. In Vietnam, cooperatives engage indigenous groups in agroecological practices, enhancing resilience while preserving traditional farming methods (Vu & Phi, 2023).

Intersectional Analysis of Empowerment and Participation

Understanding the intersection of gender, economic status, and social identity is critical for maximizing the impact of cooperatives.

- **Intersectional Challenges:** Women from marginalized groups often face compounded barriers, such as limited mobility, lack of education, and restricted access to financial resources.
- **Targeted Interventions:** Cooperatives can address these challenges by offering targeted training programs, subsidized resources, and inclusive governance structures. In India introduction of skill-development workshops specifically for marginalized women, boosted their participation in leadership roles (Kumar et al., 2015).

2.5 Environmental Impacts of Cooperative Activities

Climate-smart cooperatives significantly contribute to environmental sustainability by promoting practices that mitigate climate change and restore ecological balance. Through agroforestry, biodiversity conservation, and water resource management, cooperatives play a dual role in enhancing environmental resilience and fostering sustainable livelihoods.

2.5.1 Agroforestry and Biodiversity Conservation

Role of Cooperatives in Carbon Sequestration and Restoration of Degraded Ecosystems

Cooperatives play a vital role in biodiversity conservation and carbon sequestration through agroforestry. Practices such as intercropping, organic farming, and reforestation enhance ecological balance while addressing climate mitigation goals (Dinesh et al., 2024; Torquebiau, 2024). Agroforestry practices adopted by cooperatives integrate trees and crops, creating a synergistic system that benefits both the environment and agricultural productivity.

- **Carbon Sequestration:** Agroforestry systems absorb atmospheric carbon dioxide, contributing to climate mitigation. Cooperative members in Bangladesh reported planting salt-tolerant mangroves and fruit-bearing trees along farmland boundaries to enhance carbon sequestration. In coastal Bangladesh, mangrove restoration initiatives led by cooperatives have not only captured carbon but also provided natural barriers against cyclones (Hasan et al., 2019).
- **Restoration of Degraded Ecosystems:** By reforesting degraded land and adopting agroforestry, cooperatives contribute to soil regeneration and habitat restoration. In Vietnam have introduced fast-growing tree species to degraded uplands, revitalizing soil fertility and supporting local wildlife (Vu & Phi, 2023).

Promoting Sustainable Agricultural Practices to Enhance Biodiversity

Sustainable practices encouraged by cooperatives minimize harmful impacts on the environment while improving biodiversity.

- **Organic Farming:** Cooperative's advocate for the use of organic fertilizers and pest control methods, reducing chemical runoff and enhancing soil health.
- **Crop Diversification:** Introducing diverse crop species fosters genetic biodiversity and resilience to pests and diseases. Cooperative farmers in India have adopted intercropping techniques, growing millet alongside legumes, to improve soil nutrient balance and support pollinators (Kumar et al., 2015).

2.5.2 Water Resource Management

Innovations in Water Conservation

Cooperatives play a crucial role in addressing water scarcity through innovative conservation techniques:

- **Rainwater Harvesting:** Cooperative-led rainwater harvesting systems provide an essential water source during dry spells, reducing dependency on groundwater. In Bangladesh, members of cooperatives under the LoGIC project constructed shared rainwater harvesting tanks, ensuring water availability for irrigation and household use (UNDP Bangladesh, 2023).
- **Community Ponds:** Shared water reservoirs managed by cooperatives prevent water wastage and ensure equitable access. In India, cooperative-managed ponds serve as a model for efficient water storage and allocation for agricultural use (Kumar et al., 2015).

Contributions to Sustainable Irrigation and Soil Erosion Prevention

Sustainable irrigation techniques and erosion control measures promoted by cooperatives improve water efficiency and land stability:

- **Drip and Sprinkler Irrigation:** Cooperatives facilitate access to modern irrigation systems that deliver water directly to plant roots, minimizing water loss.
- **Erosion Control Measures:** Tree planting and terracing initiatives reduce soil erosion, preserving farmland productivity. Agroforestry practices in Vietnam have successfully controlled erosion on sloping lands, protecting both the environment and livelihoods (Vu & Phi, 2023).

2.6 Challenges and Opportunities for Climate-Smart Cooperatives

Climate-smart cooperatives, while instrumental in building resilience and driving sustainability transitions, face several challenges in their operational and strategic goals. Simultaneously, emerging market demands and technological advancements present significant opportunities for scaling their impact and enhancing their contributions to climate resilience.

2.6.1 Financial and Resource Constraints

Barriers to Accessing Funding and Advanced Technologies

One of the critical challenges faced by climate-smart cooperatives is the difficulty in securing limited funding, high technology costs, and reliance on external aid hinder cooperative scalability (Vu & Phi, 2023; Derks et al., 2022) also accessing advanced technologies necessary for implementing large-scale sustainability initiatives:

- **Limited Financial Resources:** Many cooperatives operate on small budgets, relying on member contributions or local government grants, which are often insufficient for scaling climate-smart interventions.
- **High Costs of Technologies:** The adoption of advanced tools, such as renewable energy systems or digital platforms for farm management, remains financially out of reach for most cooperatives. The cost of implementing drip irrigation systems in India has been a significant barrier, despite their proven efficiency in water conservation (Kumar et al., 2015).

Dependence on External Support for Sustainability Initiatives

Cooperatives often depend heavily on external agencies, such as NGOs or government programs, for technical and financial assistance, creating vulnerabilities in their long-term sustainability:

- **Inconsistent External Aid:** Reliance on irregular donors or government funding can delay or disrupt cooperative activities.
- **Technical Knowledge Gaps:** Limited access to training and expertise hampers the effective implementation of climate-smart practices. cooperatives in Vietnam report challenges in adopting advanced agroecological practices due to insufficient training programs (Vu & Phi, 2023).

2.6.2 Opportunities in Market Expansion and Technological Advancements

Growing Demand for Climate-Resilient Products in Regional and International Markets

The rising global interest in sustainable and climate-resilient products offers cooperatives the opportunity to expand their economic base and build resilience:

- **Market Expansion for Organic and Climate-Resilient Crops:** Products like organic vegetables, salt-tolerant rice, and aquaculture products are increasingly sought after in local and international markets. Cooperatives in Bangladesh have started exporting organic shrimp and crabs to international buyers, significantly boosting member incomes (UNDP Bangladesh, 2023).
- **Branding and Value Addition:** With proper branding and packaging, cooperatives can market their products as premium goods, capturing niche markets. Indian cooperatives exporting organic millet have leveraged fair trade certifications to access European markets (Kumar et al., 2015).

Potential for Integrating Digital Tools and Renewable Energy Solutions

Technological advancements provide cooperatives with tools to enhance productivity, efficiency, and environmental sustainability:

- **Digital Platforms for Farm Management:** Mobile applications offering weather forecasts, pest management advice, and market information empower farmers with actionable data.
- **Renewable Energy Integration:** Solar-powered irrigation systems, biogas plants, and mini-grids for electrification enable cooperatives to reduce energy costs and environmental impacts. Cooperatives in India have successfully implemented solar irrigation systems, reducing water usage and dependency on fossil fuels (Kumar et al., 2015).

2.7 Policy and Institutional Support for Cooperatives

Effective policy and institutional support play a crucial role in enabling climate-smart cooperatives to achieve resilience and sustainability objectives. This section examines the influence of national and international policies on cooperative efficacy and provides actionable recommendations for scaling cooperative models in climate-vulnerable regions.

2.7.1 Role of National and International Policies in Promoting Cooperative Resilience

National and international policies establish the structural and financial foundations that cooperatives need to thrive. These frameworks shape cooperatives' capacity to adapt, innovate, and address climate vulnerabilities effectively.

- **National Policies:** Governments often provide cooperatives with financial subsidies, technical assistance, and training programs. In Bangladesh, the *National Adaptation Programme of Action (NAPA)* emphasizes community-based adaptation strategies, directly aligning with cooperative models (GOB, 2014). Land-use policies and climate-smart agricultural initiatives further enable cooperatives to adopt sustainable practices and access resources for resilience building.
- **International Policies:** The *Paris Agreement (2015)* recognizes the role of community-driven initiatives in achieving climate goals, encouraging countries to support cooperatives in implementing adaptation measures (UNFCCC, 2020). Programs like the Green Climate Fund (GCF) provide financial support to cooperatives for climate-smart interventions, such as renewable energy adoption and water resource management.

Case Studies of Policy Influence

- **Vietnam:** National agricultural policies emphasize agroecological practices, enabling cooperatives to integrate sustainable farming and increase productivity (Vu & Phi, 2023).
- **India:** The Indian government's *Kisan Credit Card Scheme* provides smallholder farmers in cooperatives with easy access to credit, empowering them to adopt climate-resilient technologies (Kumar et al., 2015).

2.7.2 Institutional Collaborations

Institutional collaborations are pivotal for the success of climate-smart cooperatives. Partnerships between cooperatives, non-governmental organizations (NGOs), and government agencies enhance technical expertise, financial support, and resource management, enabling cooperatives to implement scalable and impactful climate-resilient practices.

Partnerships between Cooperatives, NGOs, and Government Agencies

Collaborations between cooperatives and institutions provide essential support in areas such as capacity building, funding, and technology adoption:

1. **NGO Contributions:** NGOs play a vital role in providing technical expertise, training, and financial resources to cooperatives.
 - *Example:* The World Resources Institute (WRI) has partnered with cooperatives globally to implement agroecological practices and renewable energy solutions (Chakraborty et al., 2023).
 - *Bangladesh Insight:* BRAC, a leading NGO in Bangladesh, collaborates with cooperatives to develop sustainable agricultural practices and improve women's leadership skills.
2. **Government Support:** Governments create policy frameworks and offer financial incentives that enable cooperatives to thrive.
 - Subsidies for climate-smart technologies like solar irrigation.
 - Training programs focused on disaster risk reduction and climate adaptation.
3. **Public-Private Partnerships (PPPs):** PPPs foster collaborations where private sector entities invest in cooperative-led climate-smart projects.
 - *Example:* In Bangladesh, partnerships with renewable energy companies have enabled cooperatives to implement community solar grids, reducing energy costs and emissions (UNDP Bangladesh, 2023).

2.7.3 Case Studies of Successful Cooperative-Government Initiatives

LoGIC Project in Bangladesh

The *Local Government Initiative on Climate Change (LoGIC)* is a flagship project showcasing successful collaboration between cooperatives, NGOs, and government agencies.

- **Key Partners:**
 - Government of Bangladesh
 - UNDP Bangladesh
 - UNCDF
 - European Union (EU)
 - Sweden & Denmark
 - Cooperatives operating in climate-vulnerable regions.
- **Initiatives and Impact:**
 - **Capacity Building:** Training cooperative members in sustainable agricultural practices, disaster risk reduction, and resource management.
 - **Financial Support:** Providing micro-grants to cooperatives for implementing climate-smart interventions such as agroforestry and water conservation.
 - **Women Empowerment:** Promoting gender equity through leadership training and economic opportunities tailored for women.
 - **Outcome:** Cooperatives under LoGIC have reported a 30% increase in household incomes and a significant reduction in vulnerability to climate-related shocks (UNDP Bangladesh, 2023).

Renewable Energy Cooperatives in India

The Indian government's partnership with cooperatives to implement solar-powered irrigation systems highlights the potential of institutional collaboration:

- **Government Role:** Provided subsidies for solar panel installations and technical training.
- **Cooperative Role:** Facilitated adoption and maintenance of the systems within farming communities.
- **Outcome:** Reduced reliance on fossil fuels and enhanced irrigation efficiency, contributing to both economic and environmental benefits (Kumar et al., 2015).

Agroecological Cooperatives in Vietnam

In Vietnam, the government collaborates with cooperatives to implement agroecological practices:

- **Key Activities:** Intercropping, organic farming, and biodiversity conservation.
- **Partnership Support:** NGOs provide technical expertise, while government policies incentivize adoption through subsidies.
- **Outcome:** Increased productivity and ecosystem restoration in climate-vulnerable upland regions (Vu & Phi, 2023).

Chapter 3: Research Methodology

3.1 Research Design

This study adopts a qualitative research design to investigate the role of climate-smart cooperatives in fostering resilience and driving sustainability transitions among climate-vulnerable women in Bangladesh. A qualitative approach was selected for its ability to provide in-depth, context-specific insights into the lived experiences, challenges, and outcomes associated with cooperative participation. The research focuses on cooperatives operating under the Local Government Initiative on Climate Change (LoGIC) project, employing a combination of primary data from interviews and secondary sources to ensure comprehensive and robust analysis through data triangulation.

3.2 Collection Methods

3.2.1 Primary Data Collection

Primary data were collected through 25 semi-structured interviews with cooperative members, climate change adaptation experts, and staff working on the LoGIC project. This method provided flexibility, allowing respondents to share detailed accounts of their experiences while enabling the researcher to explore key topics in depth. Purposive sampling was used to select respondents with direct involvement in or knowledge of the LoGIC project and climate-smart cooperatives. This approach ensured a diverse range of perspectives, including those of women and marginalized groups.

3.2.2 Secondary Data Collection

Secondary data were drawn from project reports, government publications, academic articles, and relevant literature on climate-smart cooperatives, resilience, and sustainability transitions. These sources provided additional context and supported the triangulation of findings.

3.3 Data Analysis Framework

3.3.1 Thematic Analysis

Thematic analysis was employed to identify recurring patterns and themes in the interview data. Key themes included economic resilience, social empowerment, and sustainability practices. This method allowed for a detailed exploration of the cooperative model's contributions to resilience building.

3.3.2 Framework Analysis

The Sustainomics framework was applied to analyze the economic, social, and environmental dimensions of cooperatives' impacts. This structured approach ensured a holistic understanding of how cooperatives address climate vulnerabilities while promoting sustainable development.

3.4 Analytical Framework

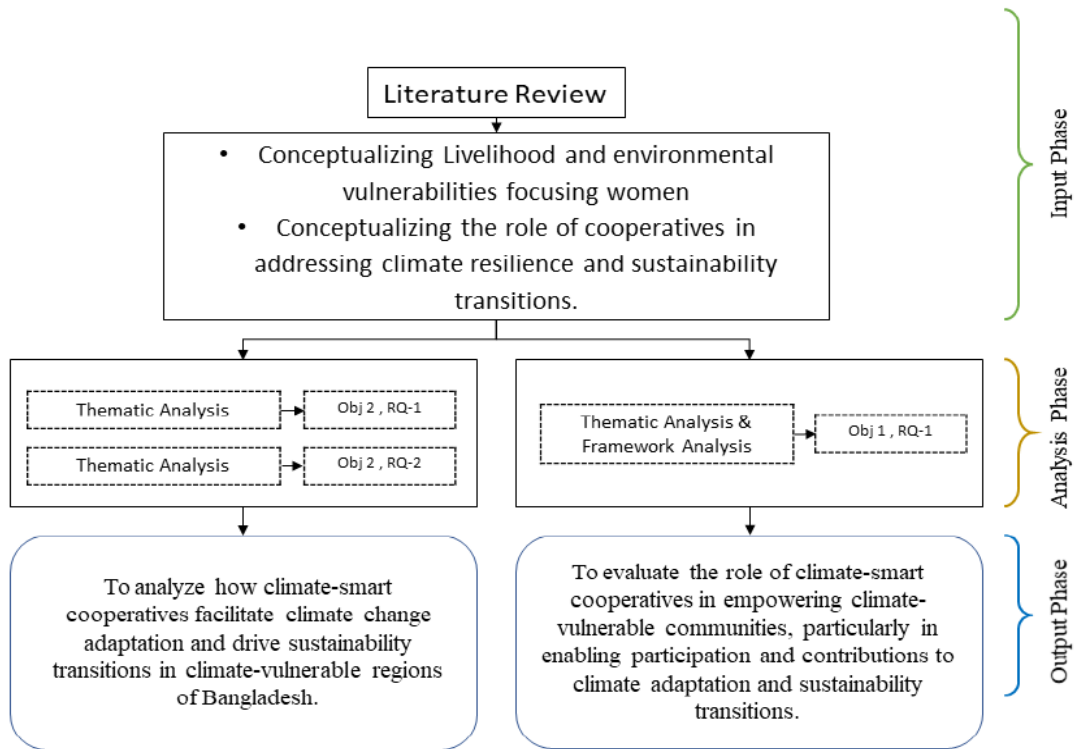


Figure 1 Analytical framework

Chapter 4: Findings and Analysis

4.1 Primary Strategies Employed by Cooperatives

The interviews highlight the diverse strategies adopted by climate-smart cooperatives to enhance resilience and foster sustainable livelihoods. Through thematic analysis and framework analysis, three primary strategies emerged: **agroforestry and diversified agriculture, water conservation and efficient irrigation**, and **diversified livelihoods**. These strategies collectively contribute to building economic resilience, promoting sustainability, and addressing the multifaceted challenges posed by climate change.

Theme	Sub-Theme	Codes
Strategies Employed by Cooperatives	Agroforestry and Diversified Agriculture	Adoption of salt-tolerant crops
		Integration of agroforestry practices
	Water Conservation and Efficient Irrigation	Crop diversification for risk mitigation
		Rainwater harvesting techniques
Social Impacts	Diversified Livelihoods	Implementation of drip and sprinkler systems
		Establishment of community ponds
	Transition to aquaculture and crab fattening	
Economic Impacts	Community Empowerment	Engagement in non-agricultural activities
		Market access through cooperative networks
	Leadership opportunities for women	
Environmental Impacts	Gender Equity	Decision-making within cooperatives
		Financial independence for women
	Challenging patriarchal norms	
Economic Impacts	Income Generation	Training programs on sustainability practices
		Knowledge sharing among members
	Increased household income	
Environmental Impacts	Market Access	Savings and financial security
		Access to local and regional markets
	Selling climate-resilient products	
Environmental Impacts	Carbon Sequestration	Agroforestry and reforestation efforts
		Reduction of soil degradation
	Biodiversity Conservation	Sustainable aquaculture practices
		Use of organic fertilizers

Theme	Sub-Theme	Codes
	Water Resource Management	Rainwater storage systems
		Soil erosion prevention through ponds
Challenges and Opportunities	Financial Barriers	Limited access to funding
		High cost of climate-resilient technologies
	Resource Limitations	Dependence on external support
		Inadequate training and technical knowledge
	Market Expansion	Increasing demand for climate-resilient goods
		Partnerships for regional and global markets
	Technological Advancements	Adoption of mobile-based advisory tools
		Renewable energy integration

Figure 2 THEME, SUB - THEME, AND CODES

4.1.1 Agroforestry and Diversified Agriculture

One of the most prominent strategies identified through the interviews is the adoption of **agroforestry** and **diversified agriculture** to mitigate climate impacts and improve productivity. Agroforestry integrates tree cultivation with crops, providing ecological and economic benefits.

Key Themes and Evidence:

1. **Cultivation of Salt-Tolerant Crops:** Many cooperatives have shifted to cultivating salt-tolerant rice and vegetables as a response to soil salinity caused by river erosion and tidal surges.
 - *“We now grow salt-tolerant rice and vegetables, which survive even in saline conditions. This has significantly increased our food security.”*
2. **Crop Diversification:** To reduce dependency on single crops, cooperatives encourage members to grow multiple types of crops, such as lentils, watermelon, and leafy greens.
 - *“Diversifying crops helps us manage risks better; if one fails, others sustain us.”*
3. **Tree Planting for Agroforestry:** Members engage in planting trees around farmlands to protect soil, increase biodiversity, and provide shade for crops.
 - *“Planting trees has made our lands more fertile and protects us from wind erosion.”*

The thematic analysis reveals that agroforestry and diversified agriculture serve not only as adaptive measures but also as tools for sustainability transitions, aligning with the principles of the **Sustainomics Framework**.

4.1.2 Water Conservation and Efficient Irrigation

Water scarcity and inefficient irrigation methods have historically constrained agricultural productivity in climate-vulnerable regions. Interviews indicate that cooperatives have introduced innovative practices to address these challenges.

Key Themes and Evidence:

1. **Rainwater Harvesting:** Some cooperatives have adopted rainwater harvesting techniques to store water during monsoons for use in dry seasons.
 - *“Rainwater harvesting has been a game-changer for us.”*
2. **Efficient Irrigation Systems:** Drip and sprinkler irrigation systems have been introduced, reducing water wastage and ensuring optimal water delivery to crops.
 - *“The cooperative helped us set up drip irrigation, which uses less water but yields better results.”*
3. **Community Ponds and Reservoirs:** Shared water storage systems are promoted to address water shortages. These reservoirs also prevent flooding during heavy rains.
 - *“With our community Tank, we now have water for daily use. It’s a lifeline for our village.”*

The **Framework Analysis** highlights that these water conservation initiatives not only improve resource efficiency but also foster social capital by promoting collective management of shared resources.

4.1.3 Diversified Livelihoods: A Pathway to Resilience

Through this qualitative analysis, it became evident that the introduction of diversified livelihoods within climate-smart cooperatives serves as a critical strategy to enhance economic resilience among vulnerable communities. Analysis of interview data and participant narratives revealed several key themes, which are synthesized below to provide a deeper understanding of the transformative role of cooperatives.

1. **Introduction of Non-Agricultural Livelihoods:** Cooperative members consistently highlighted the shift from sole reliance on agriculture to engaging in alternative income-generating activities such as poultry farming, sewing, and handicrafts. This diversification not only stabilized incomes but also reduced their dependency on climate-sensitive agricultural activities. For instance, one participant shared:
 - *“Before joining the cooperative, we depended solely on agriculture. Now, I earn from sewing and poultry farming, which supports my family year-round”*
2. **Integration of Aquaculture:** In saline-prone areas, cooperatives introduced aquaculture practices, including fish farming, crab fattening, and shrimp cultivation. These practices have become primary sources of income for many members. One respondent noted:

- *“Our cooperative provided training in crab fattening. It’s now my primary income source.”*

The shift to aquaculture represents a strategic response to the environmental challenges posed by salinity intrusion, aligning economic activities with ecological realities.

3. **Skill Development and Training:** Training and skill development emerged as critical enablers of livelihood diversification. Members said that training sessions opened avenues for small business creation and improved self-reliance. For example, a participant stated:

- *“The training sessions have opened new opportunities for us. I started a small tailoring business after learning the skills.”*

This highlights the role of cooperatives not just as economic enablers but as facilitators of personal and professional growth.

4. **Market Access and Networking:** Cooperatives played a vital role in connecting members to markets, ensuring fair prices for their products. This access to regional markets empowered members to scale their businesses and increase profitability. As one interviewee observed:

- *“The cooperative connects us to markets where we can sell our products at a fair price.”*

Key Insights: The qualitative data revealed that diversification of livelihoods significantly reduces the vulnerability of members to climate-induced shocks. This strategy addresses economic, social, and environmental dimensions of resilience:

- **Economic:** Stabilizing incomes through diversified activities.
- **Social:** Empowering marginalized groups, especially women, and fostering community participation.
- **Environmental:** Promoting practices aligned with sustainability, such as aquaculture and agroforestry.

4.2.1 Financial Barriers and Resource Limitations

The qualitative analysis also uncovered systemic challenges that hinder the scalability and long-term sustainability of climate-smart cooperatives. These challenges, rooted in financial and resource constraints, were consistently emphasized across interviews.

1. **Limited Access to Capital:** Participants frequently cited funding as a significant barrier to expanding cooperative operations and adopting innovative practices. For instance, Anita Roy, a cooperative member, explained:

- *“Our cooperative struggles to raise funds for advanced projects. We rely heavily on external loans, which are not always available.”*

2. **High Costs of Climate-Resilient Infrastructure:** The financial burden of implementing advanced infrastructure, such as solar irrigation systems or drip irrigation, limits the cooperatives' capacity to adopt resource-efficient technologies. Kobita Banerjee highlighted this constraint:
 - *“While we want to install solar irrigation pumps, the cost is beyond what our cooperative can afford.”*
3. **Inadequate Training and Capacity Building:** A recurrent theme in the interviews was the lack of training opportunities in financial management and strategic planning, which restricts the cooperatives' ability to expand. As noted by Pritilata Biswas:
 - *“Many members lack the skills to prepare accounts or business plans, which restricts our ability to expand.”*
4. **Dependence on External Support:** The reliance on government or NGO assistance for resources such as seeds and fertilizers emerged as another challenge. Members reported that inconsistent support disrupted cooperative operations, as expressed by Mariam Khatun:
 - *“We rely on the Union Parishad for supplies, but the support isn't consistent.”*

Key Insights: The analysis highlights financial and resource barriers as systemic obstacles that limit the impact and scalability of climate-smart cooperatives. These findings underscore the need for targeted interventions:

- Improved access to funding mechanisms, such as microfinance or low-interest loans tailored to cooperatives.
- Enhanced training programs to build capacity in financial and operational management.
- Consistent policy supports ensuring reliable resource availability and reducing external dependencies.

Despite the challenges faced by climate-smart cooperatives, this analysis highlights significant opportunities that can enhance their impact and scalability. Through in-depth interviews, key themes emerged that underscore how evolving markets, technological innovations, and collaborative efforts are empowering cooperatives and their members.

1. Growing Demand for Climate-Resilient Products

Global and regional markets are increasingly valuing climate-resilient agricultural products, providing a unique advantage for cooperative members. Many participants emphasized that salt-tolerant rice and vegetables, grown under adverse conditions, are perceived as high-quality and resilient, commanding better prices in the market. For example:

- *“Our salt-tolerant rice and vegetables now fetch higher prices because of their quality and resilience.”*

This demand highlights the economic potential of sustainable farming practices, positioning cooperatives as key players in emerging green economies.

2. Technological Innovations in Agriculture

Technological advancements are playing a transformative role in enhancing productivity and efficiency. Cooperatives adopting mobile-based farming advisory services and renewable energy systems have reported improved outcomes. For instance:

- *“Our cooperative recently started using a mobile app to monitor crop health, and it has improved our yields.”*

This indicates that integrating technology into agricultural practices not only boosts yields but also strengthens members’ resilience against climate uncertainties.

3. Access to Regional and International Markets

Through strategic networking and partnerships, cooperatives are gaining access to larger markets. These connections facilitate the sale of climate-resilient products in urban centers and even internationally. A member shared:

- *“With the help of the LoGIC project, we’ve been able to sell our organic products in Dhaka, increasing our income.”*

Expanding market access not only increases income but also ensures recognition of the value of climate-smart agricultural products.

4. Skill Development and Capacity Building

Training initiatives by NGOs and government bodies have significantly enhanced members’ abilities to manage finances, market products, and adopt sustainable practices. Participants frequently emphasized the benefits of workshops and skill development programs. For instance:

- *“We recently participated in a workshop that taught us how to package and brand our products for better market access.”*

This underscores the importance of capacity-building efforts in equipping cooperative members with the tools they need to succeed in competitive markets.

5. Collaborative Opportunities

Collaborations with government agencies, NGOs, and private organizations are opening new avenues for funding, technical support, and knowledge-sharing. These partnerships have helped cooperatives adopt better farming practices and reduce costs. A participant noted:

“The Agricultural Department helped us implement better farming practices, which have reduced our costs and improved productivity.”

Such collaborations highlight the critical role of institutional support in enabling cooperatives to overcome challenges and seize new opportunities.

Key Insights

The qualitative data reveals that market expansion and technological advancements are creating pathways for cooperatives to enhance their economic viability and resilience. Key takeaways include:

- **Economic Opportunities:** Climate-resilient products and access to larger markets offer significant income-generation potential.
- **Technological Benefits:** Integrating advanced tools and techniques boosts productivity and enables efficient resource management.
- **Capacity Building:** Training programs enhance the skills necessary for marketing, branding, and sustainable practices.
- **Collaborative Potential:** Partnerships with government and private entities bring essential funding and technical expertise.

Summary of Challenges and Opportunities

Challenges

- Limited financial resources and access to capital.
- High costs associated with adopting climate-resilient technologies.
- Inconsistent support from external stakeholders.
- Gaps in technical and financial management skills.

Opportunities

- Expanding markets for climate-resilient and organic products.
- Access to advanced agricultural technologies.
- Growing partnerships with government and non-governmental organizations.
- Skill-building initiatives that empower members to take leadership roles and expand operations.

4.3 Social, Economic, and Environmental Impacts

The activities of climate-smart cooperatives yield significant impacts across social, economic, and environmental dimensions. These impacts are deeply intertwined, fostering resilience while promoting sustainable development in climate-vulnerable regions.

4.3.1 Social Impacts: Community Empowerment and Gender Equity

Climate-smart cooperatives play a crucial role in empowering communities, particularly women and marginalized groups, by fostering leadership, collaboration, and equitable participation.

Key Themes and Evidence:

1. **Community Cohesion and Collective Decision-Making** Cooperatives serve as platforms for collective action, enabling members to work together on shared goals.

“The cooperative has brought us together; we now discuss and decide on issues affecting the community.”

2. **Leadership and Capacity Building** Many members reported enhanced leadership skills and active participation in decision-making.

“I’ve learned to take leadership roles, which has increased my confidence in managing both household and cooperative activities.”

“Through training programs, I’ve developed the skills to lead group discussions and influence decisions.”

3. **Gender Equity** The cooperatives promote gender inclusivity, empowering women through active involvement in financial transactions and cooperative management.

“Before joining the cooperative, women rarely left their homes. Now, we handle bank transactions and lead projects.”

“The cooperative has made me financially independent, giving me the confidence to contribute to my family’s income”

4.3.2 Economic Impacts: Income Generation and Market Access

The economic benefits of cooperative activities are evident in increased incomes, improved access to markets, and greater financial stability for members.

Key Themes and Evidence:

1. **Income Generation** Members have reported significant improvements in their livelihoods through cooperative-led income-generating activities.

“With the cooperative’s help, I started a fish farming business, which now supports my family.”

“The cooperative provided a loan to start a tailoring business, and my income has doubled since then.”

2. **Savings and Financial Independence** Cooperatives encourage savings habits, enabling members to build financial resilience.

“The savings schemes have given us a sense of security. I’ve saved enough to invest in a new business.”

3. **Market Access** Facilitated by cooperative networks, members gain access to local and regional markets for their products.

“We now sell our salt-tolerant vegetables in the city, fetching better prices than before.”

“Through cooperative connections, we’ve started selling crabs to exporters, which has significantly increased our income.”

4.3.3 Environmental Impacts: Carbon Sequestration and Biodiversity Conservation

The environmental initiatives of cooperatives align with sustainable practices, emphasizing resource conservation, carbon sequestration, and biodiversity restoration.

Key Themes and Evidence:

1. **Tree Planting and Carbon Sequestration** Agroforestry practices promoted by cooperatives contribute to carbon sequestration and soil health improvement.

“We’ve planted trees around our farmlands, which not only reduce heat but also protect the soil.”

“Tree planting has helped restore the ecological balance in our village.”

2. **Promotion of Climate-Resilient Crops** Cooperatives encourage the cultivation of salt-tolerant and drought-resistant crops, reducing environmental degradation.

“We grow salt-tolerant rice and vegetables, which require less water and thrive in saline soils.”

3. **Biodiversity Conservation through Sustainable Practices** The integration of aquaculture and organic farming enhances biodiversity while reducing reliance on harmful agricultural inputs.

“Fish farming has become a sustainable income source while preserving aquatic biodiversity.”

“The cooperative trains us to use organic fertilizers, which have improved crop health and reduced pollution.”

4. **Water Conservation and Management** Efforts such as rainwater harvesting and community ponds address water scarcity while preventing soil erosion.

“Our community pond has become a lifeline, providing water for farming and daily use.”

4.4 Expert Opinion on Climate Smart Cooperatives

This section synthesizes findings from four qualitative interviews with key stakeholders involved in climate-smart cooperatives. These interviews explore the contributions of cooperatives across economic, social, and environmental dimensions, highlighting challenges and opportunities for enhancing climate adaptation efforts.

Economic Dimension

Livelihood and Income Security:

- Cooperatives promote sustainable livelihoods through green enterprises like integrated farming, coconut oil mills, rope making, and bio-floc fish culture.

- They enhance income security by supporting crop diversification, agroforestry, and adaptive farming practices.
- Seasonal migration has reduced as cooperatives provide alternative income sources.

Economic Resilience:

- Profit-driven, sustainable enterprises build financial resilience in climate-vulnerable communities.
- Members benefit from pooled resources, financial support, and reinvestment opportunities, fostering economic stability.
- Improved food security and higher enrollment in educational institutions reflect enhanced living standards.

Social Dimension

Empowerment of Marginalized Groups:

- Women and marginalized groups gain leadership roles, training, and decision-making opportunities through cooperative structures.
- Capacity-building programs enhance their ability to manage climate risks and contribute to adaptation strategies.

Active Participation:

- Monthly meetings and democratic processes ensure inclusivity in decision-making.
- Cooperatives foster social inclusion and a sense of community, particularly benefiting vulnerable populations.
- Enhanced mobility and improved social status are direct outcomes of cooperative participation.

Environmental Dimension

Climate Adaptation Initiatives:

- Drought- and flood-resistant crops, solar-powered irrigation, and disaster preparedness are key interventions.
- Environmental protection is prioritized, with all initiatives designed to minimize harm to ecosystems.

Sustainability Practices:

- Renewable energy adoption, like solar irrigation and bio-floc systems, supports eco-friendly development.
- Cooperatives lead ecosystem restoration efforts, including reforestation and water conservation.

Long-Term Sustainability:

- Community-led recycling and sustainable businesses aim for zero carbon emissions, contributing to environmental resilience.

Challenges and Recommendations

Challenges Identified:

- Literacy barriers among members limit the full potential of cooperative programs.
- Limited financial and technical resources hinder scalability.
- Some regions lack emphasis on water conservation measures.

Recommendations:

1. **Capacity Building:** Increase training opportunities, particularly for illiterate members, on climate-smart practices and cooperative management.
2. **Financial Support:** Provide access to low-interest credit lines and subsidies for sustainable technologies.
3. **Policy and Advocacy:** Develop supportive legal frameworks to strengthen cooperatives' roles in climate adaptation.
4. **Digital Tools:** Leverage mobile apps for weather forecasting and resource planning to empower cooperative members.
5. **Cross-Learning Opportunities:** Facilitate exposure visits for experience sharing among cooperatives.

Chapter 5: Discussion

5.1 Interpretation of Findings

In the context of accelerating climate change and its profound impacts on vulnerable communities, innovative and inclusive approaches are essential to enhance resilience and promote sustainable development. Climate-smart cooperatives have emerged as a transformative model, blending collective action with locally adaptive strategies to address the multifaceted challenges posed by environmental and socioeconomic vulnerabilities. This chapter delves into the critical role of climate-smart cooperatives in facilitating climate change adaptation, driving sustainability transitions, and empowering climate-vulnerable communities.

The cooperative model is inherently participatory, fostering collaboration, resource pooling, and shared decision-making among its members. These characteristics make it particularly effective in addressing climate-induced challenges such as salinity intrusion, erratic rainfall, and dwindling livelihoods. By adopting innovative practices such as agroforestry, water management, and diversified income generation, cooperatives not only mitigate immediate vulnerabilities but also pave the way for long-term resilience and sustainability.

This chapter is structured around three core objectives: understanding how cooperatives facilitate climate change adaptation, exploring their role in advancing sustainability transitions, and evaluating their impact on empowering communities. Drawing from qualitative insights and real-world examples, it highlights the transformative potential of cooperatives in creating climate-resilient communities, promoting equitable development, and fostering sustainable livelihoods.

Through this exploration, the chapter aims to provide a comprehensive understanding of how climate-smart cooperatives contribute to resilience-building and sustainable development in climate-vulnerable regions of Bangladesh, offering valuable lessons for broader applications in similar contexts.

Facilitating Climate Change Adaptation (RQ1)

The findings highlight the significant role of climate-smart cooperatives in implementing adaptive strategies tailored to local climate vulnerabilities.

1. Promoting Agroforestry and Diversified Agriculture

- Cooperatives champion agroforestry practices, integrating salt-tolerant rice cultivation and tree planting to combat salinity and soil degradation.
- These practices not only enhance food security but also mark a shift from reactive to proactive resilience-building strategies, aligning with sustainable adaptation frameworks.

2. Efficient Water Management

- Techniques such as rainwater harvesting and drip irrigation enable communities to optimize water resources, crucial in the face of erratic rainfall and droughts.
- These measures underscore cooperatives' role in operationalizing adaptation mechanisms to withstand climatic shocks.

3. Strengthening Livelihood Resilience

- By diversifying income sources through initiatives like aquaculture and non-agricultural activities, cooperatives reduce dependency on climate-vulnerable agriculture.
- This strategic diversification stabilizes livelihoods, reaffirming cooperatives as catalysts for resilience in uncertain climatic conditions.

Driving Sustainability Transitions (RQ2)

The second research question addressed **the role of cooperatives in driving sustainability transitions**. The findings indicate that cooperatives serve as engines of transformation, fostering shifts towards sustainable practices across economic, social, and environmental dimensions:

1. Adoption of Sustainable Practices

- Cooperatives encourage members to adopt environmentally sustainable techniques, such as organic farming and renewable energy utilization. These practices reduce environmental degradation while promoting long-term sustainability.
- This aligns with the objective of driving sustainability transitions by embedding climate-smart principles into cooperative activities.

2. Market Access and Economic Viability

- By facilitating access to regional and international markets for climate-resilient products, cooperatives bridge the gap between local initiatives and broader economic opportunities.
- This economic integration ensures that sustainability transitions are not only environmentally beneficial but also financially viable for cooperative members.

3. Community-Centered Development

- The participatory nature of cooperatives fosters a sense of ownership and collective responsibility among members. By prioritizing shared goals and local contexts, cooperatives ensure that sustainability transitions are inclusive and equitable.

Empowering Climate-Vulnerable Communities (RQ3)

The third research question explored **how cooperatives empower communities to participate in and contribute to adaptation and sustainability efforts**. The findings underscore the cooperative model's transformative impact on social empowerment:

1. Leadership and Gender Equity

- Cooperative frameworks empower women by providing leadership opportunities and promoting financial independence. Women are now active decision-makers and leaders, challenging traditional gender roles in patriarchal societies.
- This directly supports the objective of evaluating empowerment, as cooperatives enable marginalized groups to play central roles in resilience-building efforts.

2. Capacity Building and Knowledge Sharing

- Training sessions and capacity-building programs enhance members’ knowledge of climate adaptation strategies, financial management, and sustainable practices. These initiatives increase community preparedness and participation in resilience efforts.
- By fostering a learning environment, cooperatives equip members with the tools needed to implement and sustain adaptive practices, fulfilling the empowerment objective.

3. Collective Action and Social Cohesion

- The participatory structure of cooperatives strengthens community cohesion, enabling members to pool resources and collectively address shared challenges.
- This collaborative approach amplifies community agency, ensuring that resilience-building efforts are both inclusive and effective.

Table 1: Contributions of Climate-Smart Cooperatives in Addressing Climate Challenges

Focus area	Actions by Cooperatives	Impact	Significance
Climate Adpatation	- Promoting salt-tolerant crops and agroforestry practices. -Implementing efficient water management techniques (e.g., rainwater harvesting).	- Improved food security and soil health. - Enhanced water availability in drought-prone areas.	- Proactive resilience against salinity and degradation. - Mitigates risks of erratic rainfall and water scarcity.
Sustainability Transitions	-Adopting sustainable practices like organic farming and renewable energy systems. - Facilitating access to regional and international markets for climate-resilient products.	- Reduced environmental degradation and long-term sustainability. - Optimized resource use and enhanced productivity.	- Embeds climate-smart principles into rural economies. - Bridges local initiatives with global opportunities.
Community Empowerment	- Providing leadership opportunities for women and marginalized groups. - Organizing capacity-building workshops and knowledge-sharing sessions	- Improved gender equity and financial independence. - Strengthened social cohesion and community agency.	- Challenges traditional social structures and norms. - Builds local expertise for sustainable development.

Connecting Findings to Research Objectives

The findings validate the research objectives by demonstrating that climate-smart cooperatives:

- **Facilitate Adaptation and Sustainability Transitions:** Cooperatives integrate adaptive strategies with sustainable practices, addressing both short-term vulnerabilities and long-term developmental goals. This dual focus aligns with the first objective, showing how cooperatives operationalize climate resilience and sustainability principles.
- **Empower Communities for Active Participation:** By fostering leadership, skill development, and social inclusion, cooperatives empower members to actively contribute to resilience and

sustainability efforts. This supports the second objective, emphasizing the cooperative model's role as a vehicle for social transformation and community empowerment.

Synthesis and Implications

The findings underscore that climate-smart cooperatives are not merely economic entities but holistic platforms for climate resilience and sustainability. They bridge the gap between individual and collective action, enabling communities to transition from vulnerability to agency. Furthermore, the cooperative model demonstrates scalability and replicability, offering a blueprint for addressing climate challenges in similar contexts worldwide.

This interpretation integrates the research questions and objectives with thematic and framework analysis, providing a cohesive narrative that highlights the transformative potential of climate-smart cooperatives. The insights presented here establish a robust foundation for advancing policies and practices that prioritize community-driven approaches to resilience and sustainability.

5.2 Comparison with Existing Research

The findings of this study align with and extend existing research on the role of cooperatives in climate resilience and sustainability. This section provides a comparative analysis to position the study within broader literature.

Alignment with Existing Research

1. Community-Driven Resilience

Existing studies highlight the importance of community-driven approaches in fostering climate resilience. For example, Vu et al. (2023) emphasize that cooperatives in Vietnam enhance resilience through agroecological practices, a finding mirrored in this study's documentation of agroforestry and crop diversification strategies in Bangladesh. While the Vietnamese model is rooted in agroecological practices, this study underscores the additional emphasis on salt-tolerant crops and water conservation in Bangladesh, reflecting localized responses to climate challenges.

2. Empowerment through Gender Inclusion

Sabatini et al. (2014) and Kumar et al. (2015) demonstrate how cooperatives empower women by integrating them into decision-making and economic activities. This research similarly identifies increased leadership roles and financial independence among women cooperative members in Bangladesh. This study further elaborates on how these empowerment strategies address gender inequities in patriarchal contexts, a nuance less emphasized in previous research.

3. Economic Viability and Market Access

Studies on Indian cooperatives highlight their success in connecting members to markets for climate-resilient products (Torgerson et al., 2021). Similarly, this study documents how cooperatives in Bangladesh enable market access for products like salt-tolerant rice and organic vegetables, thus stabilizing incomes. While existing research focuses on market access, this study also emphasizes the role of cooperatives in fostering economic diversification to reduce climate-related income vulnerabilities.

Extension of Existing Research

1. **Integration of Technological Innovations**

Unlike many studies that focus on traditional practices, this research highlights the integration of mobile farming advisories and renewable energy technologies by Bangladeshi cooperatives. This finding extends the literature by illustrating how technological advancements are increasingly becoming integral to cooperative strategies.

2. **Biodiversity Conservation as a Core Outcome**

Previous research has often emphasized economic and social outcomes. This study provides a nuanced understanding of environmental impacts, such as carbon sequestration and biodiversity conservation through agroforestry and aquaculture. These positions cooperatives not just as socio-economic entities but also as stewards of environmental sustainability.

5.3 Knowledge Gaps and Future Research Directions

While this study makes significant contributions, several gaps in knowledge remain, paving the way for future research.

Knowledge Gaps

1. **Long-Term Impacts of Cooperative Practices:** While this study examines current strategies and impacts, the long-term sustainability of these practices remains unclear. Research is needed to evaluate how cooperatives evolve over time and whether their adaptation strategies remain effective under worsening climate scenarios.
2. **Scalability and Replicability of the Model:** Although the cooperative model proves effective in Bangladesh, its scalability and applicability to other climate-vulnerable regions, particularly those with different socio-economic contexts, require further exploration.
3. **Intersectional Analysis of Empowerment:** While this study focuses on gender empowerment, the intersectional experiences of other marginalized groups (e.g., indigenous communities or persons with disabilities) within cooperatives remain underexplored.
4. **Role of Policy Frameworks:** This research highlights cooperative-government collaborations but does not deeply analyze how national and international policies influence cooperative efficacy. Future research could investigate how policy reforms could better support climate-smart cooperatives.

Future Research Directions

1. **Longitudinal Studies:** Conducting longitudinal studies to monitor the long-term impacts of cooperative activities on resilience, economic stability, and environmental conservation can provide valuable insights.
2. **Cross-Regional Comparative Analysis:** Comparative studies across different countries or regions could identify universal strategies and context-specific adaptations, offering a global perspective on the cooperative model.

3. **Integration of Advanced Technologies:** Future research should examine how emerging technologies, such as AI-powered precision farming or blockchain for cooperative supply chains, could further enhance cooperative operations.
4. **Policy Integration and Governance Models:** Investigating how policies at local, national, and international levels can synergize with cooperative frameworks to scale their impact and ensure long-term sustainability would be valuable.
5. **Social Innovations for Inclusion:** Exploring innovative approaches to include more diverse groups in cooperative activities, particularly focusing on intersectionality, can strengthen the model's inclusivity.

Conclusion

Climate-smart cooperatives represent a transformative approach to addressing the multifaceted challenges of climate change, particularly in vulnerable regions like Bangladesh. This study has explored their potential in fostering resilience, driving sustainability transitions, and empowering marginalized communities, especially women, to play an active role in climate adaptation and mitigation efforts. The findings highlight that these cooperatives are not merely economic entities but integral components of a community-based response to climate change, offering solutions that are socially inclusive, environmentally sustainable, and economically viable.

The analysis of cooperative strategies reveals their effectiveness in deploying practices such as agroforestry, water conservation, and livelihood diversification. These approaches not only mitigate the immediate impacts of climate change, such as flooding and salinity intrusion but also create pathways for long-term resilience by enhancing food security, preserving biodiversity, and stabilizing community livelihoods. The role of cooperatives in promoting sustainable agricultural practices and integrating innovative technologies underscores their relevance in a rapidly changing climate landscape. Furthermore, their alignment with global goals, such as the Sustainable Development Goals (SDGs), strengthens their significance as vehicles for achieving broader sustainability objectives, particularly SDG 5 (Gender Equality) and SDG 13 (Climate Action). One of the most compelling aspects of climate-smart cooperatives is their ability to foster social capital and build collective resilience. By providing platforms for democratic governance, cooperatives empower their members, especially women, to take on leadership roles and participate in decision-making processes. This shift in traditional power dynamics has far-reaching implications for gender equity, financial independence, and social cohesion. Women's involvement in cooperatives not only enhances the inclusivity of climate adaptation strategies but also ensures that the unique challenges faced by women in patriarchal societies are addressed. The empowerment of women through cooperatives is a testament to their potential to serve as agents of transformative social change, breaking down entrenched barriers and fostering a more equitable society.

Despite these successes, the challenges faced by climate-smart cooperatives cannot be overlooked. Financial constraints, resource limitations, and a heavy dependence on external support continue to hinder their scalability and long-term sustainability. The lack of consistent funding and technical training restricts the ability of cooperatives to adopt advanced climate-smart technologies, such as renewable energy systems

and digital platforms for resource management. Additionally, external funding mechanisms, though valuable, often create dependencies that may jeopardize the autonomy and resilience of cooperatives. Addressing these challenges requires a concerted effort from policymakers, development organizations, and the private sector to provide sustained financial and technical support while fostering an enabling environment for cooperative growth. Institutional collaborations have emerged as a crucial factor in overcoming these barriers and scaling the impact of climate-smart cooperatives. Partnerships between cooperatives, government agencies, NGOs, and private sector entities have facilitated access to funding, training, and markets. The LoGIC project in Bangladesh exemplifies how multi-stakeholder collaborations can amplify the impact of cooperative-led initiatives, integrating local knowledge with global expertise to drive sustainable development. These partnerships must be institutionalized and scaled to ensure the long-term success of cooperative models, enabling them to adapt to evolving challenges and opportunities in a changing climate. The environmental contributions of climate-smart cooperatives are equally significant. Through agroforestry, biodiversity conservation, and sustainable water resource management, cooperatives contribute to reducing carbon emissions, restoring degraded ecosystems, and enhancing the adaptive capacity of vulnerable regions. These efforts highlight the dual role of cooperatives as both mitigators of climate change and protectors of ecological integrity. By aligning their activities with national and international climate policies, cooperatives serve as vital players in achieving climate resilience at the grassroots level.

In conclusion, climate-smart cooperatives embody a holistic approach to climate adaptation and sustainability transitions, integrating economic, social, and environmental dimensions into their operations. Their ability to empower communities, foster resilience, and contribute to global climate goals underscores their transformative potential. However, realizing this potential requires addressing the structural challenges they face, enhancing institutional support, and scaling successful models through collaborative efforts. By investing in climate-smart cooperatives, policymakers and development practitioners can unlock their full potential as agents of resilience and sustainability, paving the way for a more equitable and climate-resilient future. This research contributes to the growing body of literature on cooperative-based climate resilience by providing evidence-based insights into their strategies, challenges, and opportunities. It also offers practical recommendations for enhancing the scalability and efficacy of cooperative models, emphasizing the need for integrated approaches that combine local action with global vision. The findings underscore the critical role of climate-smart cooperatives as engines of transformation in the face of one of humanity's greatest challenges—climate change.

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