THE SIGNIFICANCE OF COMMUNITY-BASED ADAPTATION STRATEGIES IN SUSTAINING CROP PRODUCTION IN FLOOD-PRONE NORTHCENTRAL BANGLADESH

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ABSTRACT

Background and Statement of the Problem: Floods are a periodic disaster in Bangladesh, severely affecting agriculture, food security, and rural livelihoods, mostly alongside rivers. The Jamalpur district is situated in north-central part of Bangladesh and next to the Brahmaputra-Jamuna basins facing repeated flooding, damaging crops; hampering farming activities. In response to this challenge, community-based adaptation strategies have emerged as an important approach to increase resilience in flood prone areas. Main objective: This research explores the importance of community-based adaptation and explores how local farmers use their traditional knowledge, ecological practices, and strategies in the face of recurring floods. It also explores how floods have taken a positive turn in agriculture despite many adversities Methods and data: Focusing on three flood prone unions in the Melandah Upazila of Jamalpur region data collection involved interviews, observation, FGDs, KIIs, case studies, pen and paper and audio-visual methods. The data are analysed in a thematic way. The sample size is about 40 out of a large population, as not all people are equally flood-affected or farmers. Purposive sampling to select experienced farmers, agricultural officers, local leaders, and nursery workers who can provide expert insights. To ensure data is gathered from relevant individuals with knowledge of adaptation strategies, judgmental sampling is also applied. Convenience sampling is used for quick, on-the-ground data collection, which helps capture immediate responses. Snowball sampling was employed to find new leaders using innovative techniques. Result: Some farmers have achieved stability in agriculture through some communal knowledge, while others, including educated and new-age farmers, are adopting new methods that are also bringing success to the community agriculture sector. The study confirms that recent adaptation is not just a survival process but a dynamic process of environmental management and social innovation. Valuing traditional knowledge, promoting equitable distribution of community-based knowledge, and institutionalizing grassroots-led initiatives will achieve local resilience in the face of climate change in other regions like Jamalpur. Concluding remarks: Farmers should be informed about modern agricultural practices and traditional adaptation techniques should be preserved. Traditional practices such as silt soil and crop rotation can be combined with modern methods. Local agricultural officials should be aware of new processes and form cooperatives for collective access to inputs and market opportunities. Increased training opportunities on flood-adaptation techniques should be provided to all farmers, including women. Encouraging women and men to engage in farming can accelerate the community-based adaptation process.

JEL Classifications: Q01, Q18, Q54
Keywords: Community Based Adaptation Strategies, Reduced Vulnerability, Sustainable Agriculture, Food Security, Sustainable Livelihood.

INTRODUCTION

Climate change is increasingly intensifying extreme weather events worldwide, with flooding emerging as one of the most destructive hazards, threatening agriculture, livelihoods, food security across numerous regions and Bangladesh is not exceptional. Most development projects in the country address reducing vulnerability to disasters or poverty including floods, costal and riverbank erosion, droughts, landslides are

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the major climate induced hazards in Bangladesh (UNDP 2023). In addition to this, Bangladesh as rated as very high risk on the 2024 index with a score of 27.73 out of 100 (The Business Standard, 9 September). Bangladesh is one of the largest deltas in the world, shaped by the confluence of numerous rivers, some key rivers of Bangladesh are Padma, Meghna, Jamuna, Brahmaputra, Sitalakhya and Karnaphuli. Because of the structure of the land, Bangladesh slopes southwards along a gentle gradient from the north, thereby enabling all these rivers tributaries and distributaries to fall into the Bay of Bengal. The whole of Bangladesh except for the hilly areas of northeast and Southeast, is an extensive flat plain formed by rivers sediments (Banglapedia). Three main river basins of the country play a big role in floods in Bangladesh. From June, the Brahmaputra-Jamuna river started growing slowly. From the Frist week of July, rapidly increased and in the First half of July the Brahmaputra – Jamuna water crossed the danger of the danger (Dhaka Times). Since Jamalpur district is geographically located along the Brahmaputra basin, Jamalpur region experiences floods every year due to the overflowing of the waters of these two rivers. According to a report by Bangla Tribune (August 2021) Rafiqul Islam, Executive Engineer of the Jamalpur Water Development, the Jamuna river was flowing 55cm above the danger level, while at Jagannathganj Ghat Point in Sarishabari, it was 94 cm above the danger level. Over 300,000 people of t0 Unions in Dewanganj, Bakshiganj, Islampur, Melandah, Madarganj and Sarishabari Upazila were marooned. Altogether 8,000 hectares of farmland went under flood while classes in 259 primary and 88 secondary schools remained suspended along with 19 community clinics.

Jamalpur is an agriculturally rich district in northcentral Bangladesh within the Mymensingh Division. Major agricultural products are rice, jute, sugarcane, mustard, ground nut and wheat. Flood also damage ceps every year in these regions. For instance, the 2021 floods affected 26 districts during the first phrase commencing from late June, thereby damaging around 76.000 hectors of crop. During the second phrase of mid-July about 83,000 hectors of land were destroyed with crop loss reaching almost 5 billion BDT. Also, around one million homes have submerged completely. Crops such aa rice, jute, sesame, peanuts and vegetables were badly damaged (Karim 2020). Such reports are common during flood season in Bangladesh. These floods disrupt agricultural activities, reduce crop yields and threaten the Sustainable livelihoods of farmers who primarily depend on agriculture for their survival. In response to these challenges, community -based adaptation strategies have emerged as an important approach to increase resilience in flood prone areas. Community- based adaptation (CBA) aims to reduce the risks of climate change to the world's poorest people by involving them in the practices and planning adaptation which adds to current approaches to adaptation by emphasizing the social, political and economic drivers of vulnerability and by highlighting needs of vulnerable people (Forsyth 2013). Such strategies involve collective action by local communities, integrating indigenous knowledge and innovative practices to mitigate the adverse effects of floods on crop production in different countries. These strategies often include measures such as flood- tolerant crop varieties raised seedbeds. Water management techniques and diversified framing aimed at maintains agricultural productivity and food security. The river island areas in Jamalpur have been suffering from flooding every year. Inhabitants of these areas are very dependent on crop cultivation for their livelihoods.

The seasonal crops ensure continuity from an assured annual income, and as this is a community susceptible to frequent flooding, the ways in which communities continue to adapt and produce crops, replanting after floods, would be interesting to learn. There have been successes in community-based adaptation processes in various districts in Bangladesh, with success exceedingly high where community-based adaptation is practiced. Despite their potential, the effectiveness of these community-based adaptation strategies in the Jamalpur district of Bangladesh remains unexplored. There is a need to assess their impact on crop production, identify barriers to their implementation and assess their role in ensuring food security and improving livelihoods. This study seeks to fill this knowledge gap by exploring the significance of community-based adaptation strategies to increase crop production in flood-prone study site, thereby contributing to policy recommendations for sustainable agricultural practices and resilient agricultural systems. The interest in understanding how flood prone slap area communities adapt to floods and sustain their livelihoods through innovative crop production strategies has inspired the selection of

research topic, “The Significance of Community Based Adaptation Strategies for Crop Production in The Flood-prone Northcentral Bangladesh”

AIM AND OBJECTIVE

The aim of this research is to investigate the significance of community-based adaptation strategies for enhancing crop production in the flood-prone areas of the Jamalpur region with a focus on identifying existing challenges and assisting strategies to ensure food security, strengthen agricultural resilience, and promote sustainable livelihoods among farmers.

Specific Objectives

- To identify prominent flood concerning challenges affecting crop production in study areas.
- To investigate and document different types of community-based adaptation strategies used in the northcentral Bangladesh flood-prone areas.
- To examine the impact of identifying adaptation strategies and their influence on crop land, productivity and livelihood condition in the region.

LITERATURE REVIEW

For this study, the author reviewed a range of journal articles, reports, and studies on community-based adaptation, flood management, and agricultural resilience. The key findings from these studies helped identify existing knowledge and informed the formulation of the present research.

TABLE 01: LITERATURE REVIEW

QUERY TITLE	LITERATURE TITLE	FINDINGS	CITATION
COMMUNITY-BASED ADAPTATION	*Community based adaptation*	Community-based adaptation (CBA) is a climate change adaptation approach that involves vulnerable people in the design and implementation of measures. It emphasizes participatory methods, longer-term development, and social empowerment to reduce vulnerability. CBA emerged in the 2000s due to intensifying climate change impacts, evolving debates on adaptation methods, and connections to Community-Based Natural Resource Management.	(Forsyth 2017)
	Operational Definition	In this study, CBA is operationalized as farmer-led practices (e.g., crop rotation, silt management, raised beds) that enhance crop production, measured by their adoption rate among 40 respondents and impacts on yield recovery post-flood (e.g., via thematic analysis of FGDs showing reduced vulnerability).	Based on study area respondents
	A Brief overview of Community-Based adaptation	Climate Change Action (CBA) aims to support adaptation needs of vulnerable people in developing countries, driven by climate change social injustices. With thousands of projects in Africa, Asia, and the Pacific Islands, CBA is a research agenda and Community of Practice,	(Kirkby 2015)

		receiving increased international attention, including at the UNFCCC, COP.	
	Community-based adaptation to climate change: an overview	Community-Based Adaptation (CBA) involves vulnerable communities in climate adaptation efforts, supported by global networks. Initiatives like IIED's conferences, GICBA, we ADAPT, and CBA LinkedIn Group strengthen networks, enhance policy, and build capacity. These initiatives strengthen networks, enhance policy and planning, and build capacity for locally led climate adaptation.	(Ried 2015)
	Operational Definition	Defined as low-lying unions (e.g., Mahmudpur, Nangla, Charbani Pakuria) along the Brahmaputra-Jamuna basin, operationalized by flood frequency (1-3 times/year), duration (7 days to 3 months), and severity (e.g., crop loss >50%), assessed through field observations and informant reports.	Assessed through field observations
	Increasing Crop Productivity in Flood Prone Areas	Flooding is a prevalent issue in Asian and Pacific countries, causing significant human, crop, and animal losses. In South and Southeast Asia, 31 million hectares are flood-prone, with 13 million planted for deep-water rice. Bihar and Odisha are most susceptible, with Muzaffarpur, East Champaran, and Puri worst-hit. Floodwater stagnates for 6 to 15 days. Khari crops, especially rice, are damaged due to floodwaters.	(Mondal et.al 2020)
FLOOD PRONE AREA AND CROP PRODUCTION	*Flood vulnerability and food security in eastern India: A threat to the achievement of the Sustainable Development Goals*	India has improved food security through economic growth, agriculture, and antipoverty programs. However, floods exacerbate hunger and poverty, affecting household food security. A study found three out of four households in flood-prone rural communities are food insecure. The study recommends integrative actions against the impacts of floods and makes valuable inputs and background for the policy makers of India.	(Sam et.al 2021)
	Investigating Flood impact on Crop Production under a Comprehensive and Spatially Explicit Risk Evaluation Framework	With increasing frequency of catastrophic floods, effective agricultural flood management is especially essential in susceptible regions such as the Middle and Lower Yangtze River Basin (MLYRB). This study found flood duration to be the most accurate predictor of crop damage and has useful findings for improving flood risk governance in agricultural communities.	(Wang Liu & Chen 2022)

	Bangladesh: Impact of the floods on agricultural livelihoods and food security in the eastern part of the country – DIEM -Impact Report, September 2024	In 2024, Bangladesh experienced severe monsoon flooding, affecting over one million small farmers and causing losses exceeding USD 457 million. The August-September floods, particularly damaging Aman rice, led to increased food insecurity, malnutrition threats, and increased rice imports.	(FAO 2024)
	Use of Indigenous Knowledge in Strategies for Disaster Risk Deduction for Flood Disaster: The Study of Tharu Community of Bardiya District of Nepal	The paper explores the impact of floods on agricultural productivity in Bangladesh. Overall findings indicate that agricultural productivity is higher in flood-prone districts, and normal floods increase yields and extremely high floods decrease them.	(Dhungel 2011)
	Operational Definition	Operationalized as the use of resilient crops (e.g., flood-tolerant varieties like Binadhan-7) and techniques (e.g., mulching, diversification), measured by outcomes like stable crop yields (e.g., mustard post-flood) and reduced input costs, evaluated via case studies and productivity metrics from farmers.	Evaluated via case studies of field informants
	Integrated Flood Management Tools series -Community-based Flood Management	For over 30 years, community participation in flood management and development planning has been crucial. Prioritizing bottom-up strategies allows communities to contribute to flood resilience. Floods impact 520 million people annually and kill up to 25,000 globally. Recent floods highlight the need for community-based flood control.	(WMO 2017)
COMMUNITY-BASED ADAPTATION DURING FLOOD	*Use of Indigenous Knowledge in Strategies for Disaster Risk Deduction for Flood Disaster: The Study of Tharu Community of Bardiya District of Nepal*	The study explores the use of indigenous knowledge in Nepal's Tharu community for disaster risk reduction, highlighting their traditional methods of forecasting and river embanking, but highlighting the need for scientific remedies in response to climate change.	(Dhungel 2011)
	COMMUNITY-BASED ADAPTATION TO FLOOD: A SYSTEMIC LITERATURE REVIEW	The paper reviews 25 English-language articles on community mobilization strategies for floods, focusing on developed nations. It identifies new research areas, evolution of publications, author collaboration patterns, and future directions for CBA solutions.	(Danraka et.al 2024)
	Perceived community-based flood adaptation strategies under climate change in Nepal	Local flood coping strategies in Nepal's Terai districts involve local flood prediction, communication, relief, and safe haven creation. Post-flood operations coordinate with government departments, highlighting the importance of locally relevant adaptation methods in developing effective flood resilience strategies.	(Devkota et.al 2014)

	Operational Definition	In the study, it is operationalized as household-level food reserves (e.g., rice for 6 months from diversified crops) post-flood, measured by farmer-reported reductions in insecurity and integration of strategies like bag farming, analysed through livelihood outcomes in thematic data.	Analyzed through livelihood outcomes in thematic data.
COMMUNITY-BASED ADAPTATION IN CROP PRODUCTION DURING FLOOD	*Assessing adaptive capacity of climate vulnerable farming communities in flood prone areas: Insights from a household survey in South Punjab, Pakistan*	This paper evaluates the adaptive capacity of farmers in flood-risk districts of South Punjab, Pakistan, based on data from 448 farmers. Results show knowledge of crop markets and climate sensitivity motivates joint strategies, while experience and secondary income discourage them. The paper supports multidisciplinary adaptation methods based on social, economic, and environmental considerations.	(Aqib et.al 2024)
	Farm households' flood adaptation practices, resilience and food security in the Upper East region, Ghana	The study found that flood adaptation measures improved food security in farm households in Ghana's Upper East Region. Factors affecting adaptation included age, education, extension coverage, credit, farm size, and flood awareness. Non-farm adaptation was influenced by marital status, education, and flood awareness. Strengthening extension services, raising flood awareness, and enhancing non-farm employment could alleviate flood impacts.	(Alhassan 2022)
	Operational Definition	Operationalized as lowered crop losses (e.g., from 75% to partial via strategies) and enhanced livelihoods, measured by pre/post-flood comparisons in FGDs and KIIs, focusing on marginalized groups like women farmers.	From study area field informants
IN CONTEXT OF BANGLADESH CBA STRATEGY IN CROP PRODUCTION DURING FLOOD	*Effects of Flood on Agricultural Productivity in Bangladesh*	The study explores floods' impact on Bangladeshi agriculture, revealing both destructive and beneficial effects. It compares flood-prone and non-flood-prone districts, finding higher agricultural productivity in flood-prone areas. Normal floods, however, may increase productivity post-flood.	(Banerjee 2010)
	Vulnerability and adaptation in flood-prone ecosystems of Bangladesh: a case study of rice farming households	The study explores flood vulnerability and adaptation in Bangladesh's flood-prone ecosystems, focusing on rice farming households. Despite recurrent flooding, the country has managed to maintain a rice surplus since 2007, thanks to strategic planning, food diversification, stockpiling, and strong public distribution systems. Policy integration for flood adaptation is identified.	(Rahman et.al 2025)

	Impact of farmers' participation in community-based organizations on adaption of flood adaptation strategies: a case study in char-land area of Sirajganj district Bangladesh	The study examines the impact of community-based organizations (CBOs) on Bangladeshi farmers' flood adaptation strategies. Results show that CBO participation significantly supports farmers' adoption of flood measures, with adopters implementing 3.76 more measures than non-adopters. To implement flood adaptation measures, CBOs need to be strengthened and institutionalized.	(Faruq & Maharjan 2022)
	Floating Gardens of Bangladesh: A community Based adaptation for Combating Climate Change	Bangladesh faces severe floods affecting over one million people annually, forcing many to leave their villages. Floating gardens, a potential adaptation to climate change, are suggested but not yet proven effective in food security, disaster risk reduction, or climate change adaptation. Understanding their strengths and limitations is crucial.	(CANSA 2024)
	Crop adaptation processes to extreme floods in Bangladesh: A case study	The study uses a multi-method approach to investigate flood adaptation in Islampur, Bangladesh, focusing on the resilience of vulnerable farmers and their long-term strategies. It emphasizes community-based efforts and autonomous adaptation in policy formulation.	(Yunus 2015)
MAJOR THEORIES APPLIED AND ALIGNMENT WITH STUDY OBJECTIVES	*Sustainable Livelihood Framework (SLF)*	Groups resources into five capitals (human, natural, financial, social, physical) to analyze how households achieve positive outcomes amid vulnerabilities. In the study, it maps assets like skills (human), fertile soils (natural), and networks (social) to adaptation strategies. • (Identify flood challenges): SLF identifies vulnerabilities (e.g., degraded natural capital from siltation). • (Document CBA strategies): Highlights how capitals enable strategies (e.g., social capital for knowledge sharing). • (Examine impacts): Assesses outcomes on productivity and livelihoods (e.g., financial capital from diversified crops).	(Chambers & Conway, 1992; DFID, 1999)
	Resilience Theory	Focuses on absorptive (endure shocks), adaptive (adjust practices), and transformative (fundamental changes) capacities in socio-ecological systems. The study uses it to evaluate how strategies rearrange assets during floods. • (Identify challenges): Frames floods as shocks testing absorptive capacity (e.g., crop submergence).	(Folke, 2006; Walker et al., 2004).

	• (Document strategies): Documents adaptive moves (e.g., raised beds) and transformative innovations (e.g., cocopeat). • (Examine impacts): Measures resilience through recovery (e.g., yield stability) and transformation (e.g., reduced vulnerability).

Source: Developed by Researcher

Gaps in Existing CBA Context

- The CBA is established approach for Bangladesh (e.g., Sirajganj, Islampur, Char Land) phenomenological adversities but it has hidden in the context of study sites (Melandah, Jamalpur) though it is highly and repeatedly suffered by flooding. This became a priority to focus CBA based study in selected region.
- Jamalpur is an agriculturally sound region but suffers adverse crop losses regularly, understanding and discussing the community-based knowledge is crucial for developing effective policies to support them.

Knowledge Gaps in the Study

The title focuses on CBA's significance in sustaining crop production in flood-prone northcentral Bangladesh (specifically Jamalpur). Based on the paper and reviewed literature, gaps include:

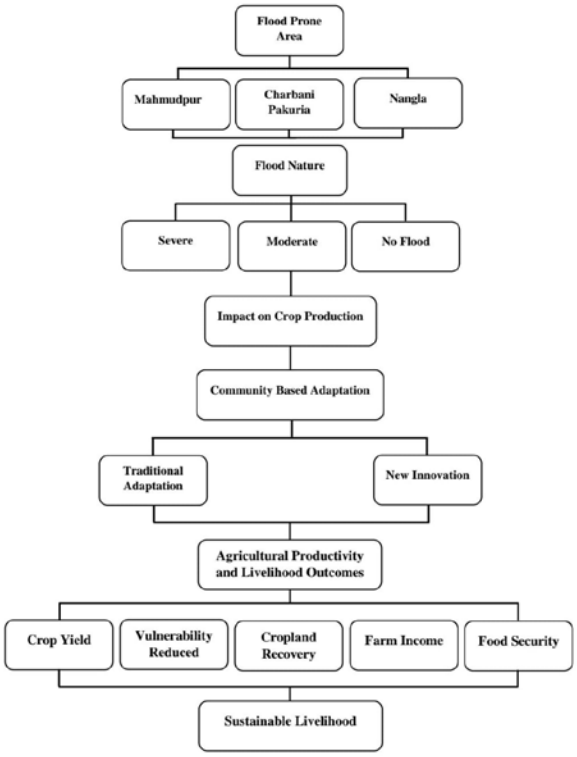
- Geographic Specificity: Limited studies on Jamalpur/Melandah (paper notes none found); most focus on coastal (e.g., southwest) or haor areas (e.g., northeast), ignoring northcentral Brahmaputra basin nuances like variable flood irregularity (e.g., recent absence causing soil decline) (gap in Banerjee, 2010; Rahman et al., 2025; expanded by search: no Jamalpur-specific CBA papers post-2024).
- Gender and Inclusivity: Minimal exploration of women's roles (e.g., bag farming by Aleja Begum in paper), despite NAP (2023) emphasis; gaps in equitable impacts and barriers for marginalized groups (e.g., landless farmers) (Khatun, 2025; Agricultural adaptation..., 2024).
- Long-Term Impacts and Scalability: Short-term productivity gains documented, but lacks longitudinal data on sustainability (e.g., 5-10 years post-adoption) or scaling via institutions (Faruq & Maharjan, 2022; Danraka et al., 2024). Economic viability (e.g., cost-benefit of cocopeat) understudied.
- Integration of Modern vs. Traditional: Gaps in hybrid models (e.g., combining silt with mulching) and their transformative resilience (Folke, 2006 alignment weak in northcentral contexts) (Community-Based Adaptation: An Analysis..., 2019).
- Climate Projections: Limited linkage to future scenarios (e.g., intensified floods per UNDP, 2023), focusing on past events; gaps in predictive modelling for CBA efficacy (Wang et al., 2022).

Addressing these could strengthen the study, e.g., via comparative analysis with coastal regions or gender-focused surveys from the above literature review in table 1, Bangladesh appears to have many adaptation strategies to face floods, even in agriculture there are many adaptation strategies in other fields. But no research was undertaken on community-based crop production adaptation strategies for flood prone areas in Jamalpur district. The researcher is unable to locate any research on community-based adaptation strategies for crop production in flood prone areas of Jamalpur district. Following this consideration, the researcher felt inclined to conduct the topic as research.

MATERIALS AND METHODOLOGY

Floods are observed every year in the research area. The pattern of floods is not the same, such as: sometimes there is no flood, sometimes there is severe flood, and sometimes there is moderate level flood. But when there is a flood, a major impact can be observed on the crop production of the research area. It is presented below.

FIGURE 01: RESEARCH DESIGN

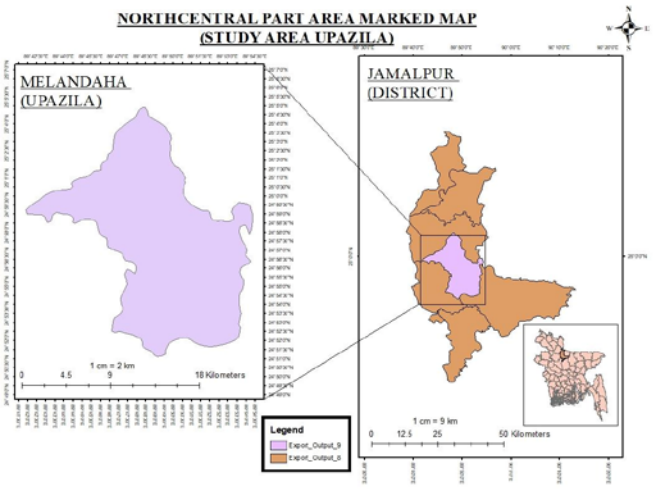


Source: Developed by Researcher

The above study plan figure 01 illustrates flood prone site at the apex of framework including flood nature. How flood affected on crop production and relevant communities make resilient by practicing CBA get top concern and showing transparently. The CBA approaches (i.e. traditional adaptation, new innovation) lead to ensure agricultural productivity and livelihood outcomes in a row displaying bottom of the framework. The circulating process is very comprehensive that push to make sure agricultural productivity; sustainable livelihood as well.

Study Location

Melandah Upazila of Jamalpur district selected on account of surveyed. Study site boundary: Melandah Upazila situated in midcentral part of Jamalpur district. Jhinai River, Old Brahmaputra River, Alai River, Madardah River flow in this district. (Banglapedia, 2023). The field conducted in some char areas of Melandah Upazila, specifically Mahmudpur Union No. 3; Nangla Union No. 4; And Charbani Pakuria 7 No. Union. Usually, Teesta barrage water floods these areas through Jamuna river. Also, the water of Brahmaputra river from the north is the cause of flooding in these areas. In map 01 Jamalpur district identified in left side and highlighted Melandah Upazila right side.

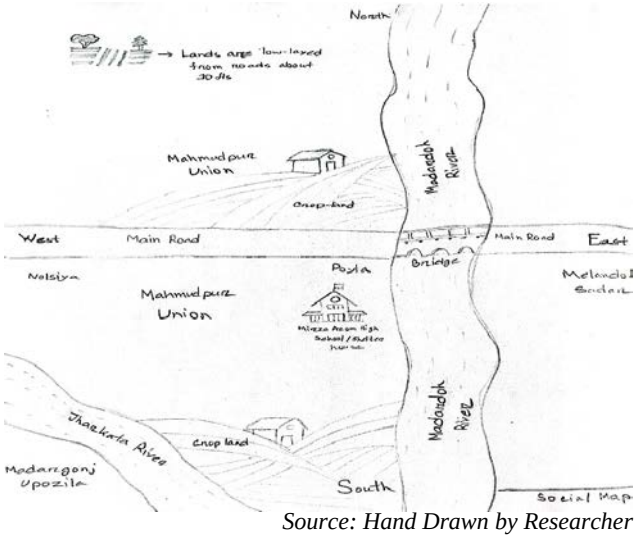


Source: Developed by Researcher with ArcGIS

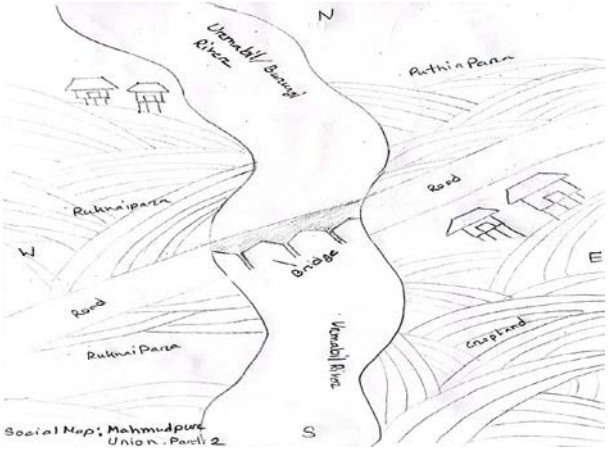
Hand Drawn Social Mapping of Study Site

Mahmudpur Union 01

The social map 01 illustrates Mahmudpur union alongside with the Madardoh river which is a branch of the Jamuna river. Madardoh River flows north to south in Mamudpur Union. A big bridge has been constructed on the way from Melandah Sadar to Poyla and Nowlshia villages. The bridge is originally built over the Madardoh River. When the water of Jamuna river increases, the water of this river increases and flooded the surrounding areas. The focus land residing approximately 10 feet below off the road which leads flooding first. Jharkata river flows towards the south side of Nalsia village i.e. towards the end of Melandah Upazila and towards the beginning of Madarganj. Through this river Nalchiya village turn flooded.



Source: Hand Drawn by Researcher



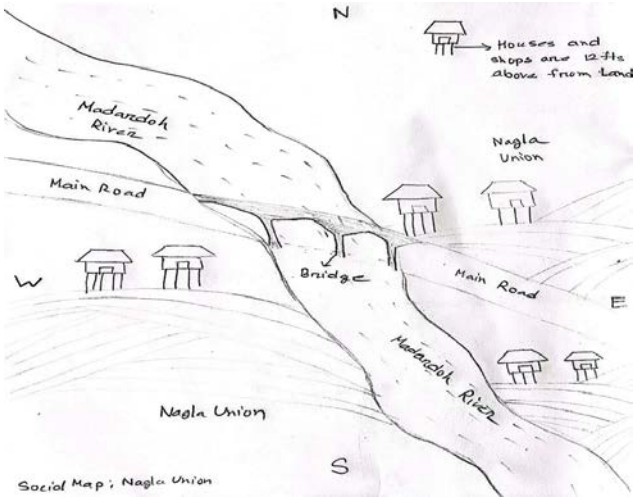
Mahmudpur Union 02

The social map 02 illustrates additional side of Mahmudpur union's Ruknaipara and Puthiyapara village where both turns divided by Urmabil river. The villages are enriched with croplands. In the way of this villages nearly three new bridges being constructed. Houses and shops are about 12 feet higher than the cropland which means the land is low-lying. In these villages, the flood water comes from the Urmabil or Burungi river. Urmabil is also the branch of the Yamuna River which ends to Sorishabari.

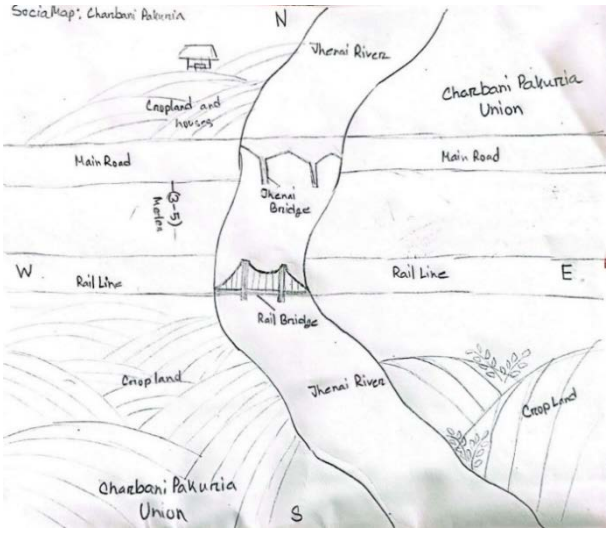
Source: Hand Drawn by Researcher

Nangla Union 03

The social map 03 has drawn about the Nangla Union. The Madardoh River is also flown to the northern side to the southeast part of this union. Most of the houses are 12 feet higher than the roads in this union. There is much land seen to be accumulated with flood water. Here most of the land harvested with paddy; few of those harvested with mustard and other lands were empty with dry soil. There were two new bridges in the way of the Nangla union which are very high from the basement. That's why the farmers are mostly affected by floods.



Source: Hand Drawn by Researcher



Source: Hand Drawn by Researcher

Charbani Pakuria Union 04

The social map 04 demonstrates Charbani Pakuria Union. Jhenai river flows through this union. There are two bridges constructed over the river where one is a railway bridge and local bridge. The Jhenai River is also a branch of the Yamuna River. The two bridges are 3 to 5 meters away from one another. The right side of railway bridge shown endless cropland where the farmers were working. Though the land is combined for many owners but all in raw genuinely unparalleled.

Research Method and Data Collection Tools

The study act in accordance with qualitative research approach that emphasizing an exploratory and thematic analysis. A semi-structured questionnaire was conducted to collect primary data which driven in line with a methodological pathway of direct participation observation, in-depth interviews, key informant interviews (KII), focus group discussion (FGD), audio-visual techniques, and pen-and-paper techniques. Harmonious and polite behaviour maintained while collecting data from the informants for ensuring credibility and ethical consideration. And secondary data from various online journals, books, previous studies, and reports that provide insights into the topic of interest. The study obtained dependent variable (DV) as agricultural productivity and livelihood outcomes (i.e. crop yield, vulnerability reduced, cropland recovery, farm income and food security) while independent variable (IV) obtained as community-based adaptation strategies (i.e. flood tolerant crop varieties, crop diversification, traditional techniques like silt soil and crop rotation as well as relevant community's everyday behaviour).

After completing a semi-structured, open-ended questionnaire, the villagers participated in two focus group discussions. The FGDs covered the study's main subjects, such as local coping mechanisms

under challenging situations. There were eight to 10 people in each focus group. The interview texts were coded using preliminary ideas, the data were grouped to determine major themes, and the results of the focus groups and interviews were examined in relation to each topic to extract important conclusions. As a result, other data collecting technologies are also employed, such the Learning Space Toolkit for focus group discussions and Google Forms for questionnaires.

Sampling criteria

Farmers, common flood-affected locals, local leaders, nursery owners, and agricultural officers were all included in this research sample, which was selected using a mixed sampling technique. The sample size is just around forty persons since not everyone is equally affected by farms or floods. To choose seasoned farmers, agricultural authorities, community leaders, and nursery staff who can provide informed viewpoints, the purposive sampling approach is employed. To ensure that information is gathered from relevant individuals who are knowledgeable about adaptation strategies, judgmental sampling is employed. Convenience sampling helps obtain rapid replies by collecting data quickly on the ground. Additionally, utilizing cutting-edge methods, snowball sampling was used to find hidden adaption leaders.

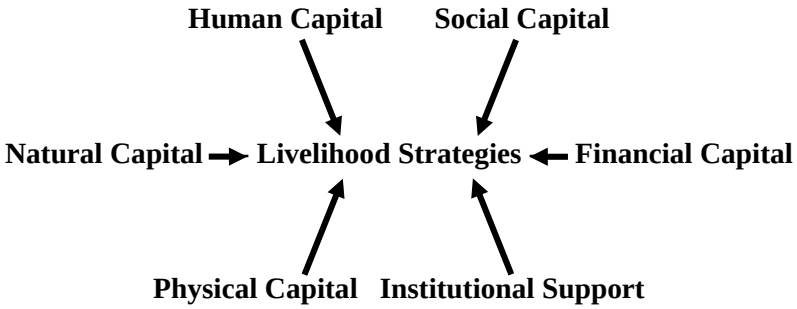
Theoretical Framework

This study draws on two complementary lenses the Sustainable Livelihood Framework (SLF) and a resilience perspective to explain how farm households in flood-prone Jamalpur keep crops in the ground despite recurrent shocks. The SLF helps map which resources people rely on, while the resilience view focuses on what people do with those resources when water rises again and again.

Sustainable Livelihood Framework (SLF)

Early SLF work (Chambers & Conway, 1992; DFID 1999) groups rural resources into five broad "capitals": human, natural, financial, social and physical. In Jamalpur, these show up in familiar ways—skills and know-how around flood timing, fertile but risk-exposed soils, alternative farming benefit, neighbourhood networks that share seed, and bits of infrastructure like raised storage. What matters is the mix: the same household rarely depends on a single capital. A practical reading for this study is that (i) strengthening people and soils widens options at cultivating time, (ii) modest finance and basic infrastructure keep production moving after losses, and (iii) cooperation turns many small assets into something more reliable.

FIGURE 02. SUSTAINABLE LIVELIHOOD FRAMEWORK



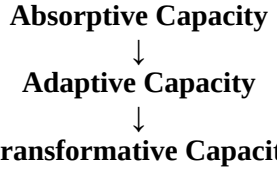
Source: Adapted from DFID, 1999

Resilience Theory

Resilience thinking (e.g., Folke; Walker and colleagues) looks at capacity rather than inputs: can a farming system absorb a hit, adjust, and if needed change shape? In this setting, absorptive capacity includes flood-

tolerant varieties and stored grain; adaptive capacity shows up as shifting calendars, raised beds, mixed cropping; transformative capacity is the bigger, slower work better drainage, seed systems that reach everyone, climate-smart tools that change the local baseline.

FIGURE 03. RESILIENCE FRAMEWORK



Source: Adapted from Folke, 2006; Walker et al., 2004

Used together, SLF tells us what is on the table; resilience tells us how it is rearranged when rivers breach their banks. For example, a neighbourhood seed or knowledge -sharing habit (social capital under SLF) becomes a rapid replanting mechanism when floods recede (an adaptive move in resilience terms). That combination—asset-based and shock-responsive—explains why community-led practices in Jamalpur can keep yields from collapsing across repeated flood seasons.

Research Ethics

Ethical considerations were strictly maintained throughout the fieldwork in Melandah Upazila to ensure the dignity and rights of the flood-affected communities. Since the respondents are from rural backgrounds, the researcher took special care to explain the study objectives in the local dialect before every Key Informant Interview (KII) and Focus Group Discussion (FGD). Verbal consent was taken from each participant, making it clear that their involvement was voluntary. To protect privacy, personal names were removed during the data analysis phase. When quoting specific stakeholders like agricultural officers or local leaders, permission was sought; otherwise, they were referred to by their roles. As the study involved close interaction with villagers, polite behaviour was maintained, and interviews were conducted at times that did not hamper their daily farming activities. All collected data, including photos and audio, were used solely for this research purpose.

Limitations of the Research

Although this study brings out important insights regarding community-based adaptation in the Jamalpur region, there are some limitations to consider. First, the sample size includes about 40 respondents. While this number was sufficient to understand the major themes and local strategies, it may not statistically represent the entire population of flood-prone areas in Bangladesh. Second, the study was geographically limited to Mahmudpur, Nangla, and Charbani Pakuria unions. Therefore, the findings might not fully capture the adaptation nuances of other areas in the Brahmaputra-Jamuna basin that face different levels of flood intensity. Third, the use of convenience and snowball sampling helped in gathering data quickly from experienced farmers, but it might have excluded some marginalized individuals in remote char areas who were harder to reach. Finally, since the data relies on the farmers' memory of past flood events and crop yields, there is a possibility of recall bias.

RESULTS

The findings are presented in line with the specific objectives of the study from qualitative data collected through interviews, FGDs, KII, observation and thematic analysis of 40 purposively selected respondents (farmers, leaders, officials, nursery workers) from three flood-prone unions (Mahmudpur, Nangla, Charbani Pakuria) of Melandah Upazila of Jamalpur district. Key themes emerged through coding and grouping of

data, with emphasis on flood patterns, community responses and livelihood outcomes. The themes include hydrological variability, agricultural resilience, socio-economic constraints, indigenous innovation and institutional gaps.

TABLE 02: FLOOD PATTERN IN STUDY AREA

UNION /VILLAGE	FREQUENCY OF FLOOD	FLOOD SOURCES	DURATION OF FLOOD	SEVERITY / NATURE OF FLOOD	SEVERITY RANKING
MAHMUDPUR (POYLA & NALCHIYA)	1-2 times/years	Water comes mainly from Yamuna river via Madardoh and sometimes from Jharkata rivers	(7-15) days to 1 month But Flood stay longer in the past	Cropland and roads submerged every year houses rarely flooded now. Boats are used for transportation. Severity lower than past (1988 was the worst)	Medium
MAHMUDPUR (PUTHIYAPARA &RUKNAIPARA)	2-3 times/years In previous about 6 months	Flood occurs from Yamuna river via Madardoh but specially from the branch Urmabil or Burungi river	15 days to 1 month	Severity depends on source of direction; variable but significant crop loss as cropland submerged every year.	High
NANGLA UNION	2-3 times/years	Water overflows from Yamuna river	(1-3) months	90% lands are low-lying shops and houses builds on raised platform. Severity moderated by bridges but still regular	High
CHARBANI PAKURIA UNION (UTTARPARA, JHENAI BRIDGE AREA)	Last 3 years faced minimal flooding Previously annual	Flood occurs mainly from Yamuna river via Jhenai river	Water used to last up to 3 months.	Earlier: severe & regular floods. In recent time irregular & less severe. Farmers concern about soil fertility decline due to irregular flood.	Low

Source: Developed by researcher

From table 2 it is clear that floods occur almost every year in these unions, but the frequency, duration and intensity of floods vary from village to village, depending on the proximity of the river, the elevation of the land and the infrastructural changes (e.g., construction of bridges and high-rise buildings). In some areas, floods last only a few weeks, while in others they can last for months. In most cases, cropland is submerged every year that means crops are affected annually.

Farmers in the study area face multiple climate-driven and structural challenges that disrupt crop production. The following table categorizes these key challenges and presents direct evidence from field interviews Table 03 is presented below-

TABLE 03: PROMINENT FLOOD CONCERNING CHALLENGES AFFECTING CROP PRODUCTION IN STUDY AREAS

Challenge Category	Specific Challenge	Detailed Description & Impact on Crop Production	Evidence from Field Study (Key Informants & Locations)
1. Hydrological & Climatic	**1.1 Predictable Annual Monsoon Flooding**	Annual inundation caused by overflow from the Yamuna and distributary rivers (Madardoh, Jharkata, Urmaburungi). Leads to damage of crops, homes, roads, and yearly loss–recovery cycles.	• *Ahad Jamal Sheikh, Mahmudpur:* "Every year their area gets flooded… we had to travel by boat." • *Roshanara Begum, Nangla:* "Every year there is a flood… due to the overflow of water from the Yamuna river."
	1.2 Variable Flood Duration & Intensity	Flood duration ranges from short (Seriban: 7–15 days) to prolonged (Buriban: 3–6 months). Longer floods destroy crops entirely and reduce options for post-flood cultivation.	• *Majnu Mia, Mahmudpur:* Water used to stay for months; now usually less than a month. • *Sulaiman, Nangla:* Classified floods as Seriban, Bauban, Buriban. • *Nurul Islam, Ruknaipara:* Water stays up to six months, 2–3 times a year.

	1.3 Multi-Source and Directional Inundation	Floodwaters enter from multiple rivers, expanding severity and complicating local mitigation. Spatial variation creates unpredictable risk.	• *Mukul & Samiul, Nalchiya:* Water from Jharkata enters houses even if one side of the road is dry.
	1.4 Recent Irregularity & Absence of Floods	Sudden decline in expected floodwater in some areas leads to soil nutrient loss, lower moisture, and chemical accumulation.	• *Md. Badsha, Charbani Pakuria:* "Earlier there were regular floods but now water is less." • *Nazrul, Charbani Pakuria:* "For the last three years, floodwater does not come."
2. Agronomic & Environmental	**2.1 Direct Crop Submergence & Loss**	Standing crops—especially Aman—are destroyed, causing large annual yield losses, reduced income, and heightened food insecurity.	• *Abbas Ali, Mahmudpur:* "50% crops are lost every year." • *Sulaiman, Nangla:* 60% of his crops destroyed.
	2.2 Post-Flood Pest & Disease Outbreaks	Stagnant water increases insect and fungal diseases, causing secondary losses for remaining or newly planted crops.	• *Ahad Jamal Sheikh:* Insect attacks increase after recession. • *Mahiron, Charbani Pakuria:* Showed infected eggplants; blamed lack of normal flooding.
	2.3 Excessive Siltation	Heavy silt deposition buries plants, alters soil structure, and increases labor for removal. Moderate silt is beneficial, but excess is destructive.	• *Md Johurul Islam, Puthiapara:* Excess silt is removed and sold. • *Roushanara, Nangla:* Community floats the silt away.
	2.4 Soil Health Degradation	Either prolonged flooding or absence of flooding decreases natural fertility, moisture, and organic replenishment. Leads to dependency on fertilizers.	• *Meghu, Charbani Pakuria:* Land fertility declining without floods. • *Nazrul:* Land "lost its moisture."
3. Socio-Economic & Institutional	**3.1 Inadequate & Unequal Access to Support**	Government/NGO aid is insufficient, politicized, or poorly distributed—marginal farmers often excluded.	• *Chaleha & Sonahar Mondol, Mahmudpur:* "NGOs list their own people… villagers are disappointed."
	3.2 High Cost of Inputs	Increased fertilizer/pesticide demand raises expenses and debt, especially in non-flood years.	• *Mahiron, Charbani Pakuria:* Fertilizer use increased by 2 kg/bigha with poor results.
	3.3 Infrastructure Damage & Isolation	Floods damage rural roads/bridges, limiting market access and emergency mobility.	• *Researcher's Observation:* Roads collapsed; boats were the only transport.
	3.4 Knowledge & Labour Gaps	Young people avoid agriculture; traditional knowledge concentrated among elderly farmers, risking future adaptation capacity.	• *Researcher's Observation:* Most farmers interviewed were elderly; very few under 30.

The table highlights how environmental stress, declining soil health, pest outbreaks, high input costs, and limited institutional support combine to weaken agricultural resilience. These pressures explain the urgency of local adaptation.

Communities respond to recurring floods through a mix of traditional knowledge, practical innovation, and modern techniques. The table below outlines the major adaptation strategies practiced across the study area. Table 04 is presented below.

TABLE 04: DIFFERENT TYPES OF COMMUNITY-BASED ADAPTATION STRATEGIES USED IN THE NORTHCENTRAL BANGLADESH FLOOD-PRONE AREAS

Adaptation Category	Specific Practice	Detailed Description & Purpose	Evidence from Field Study (Key Informants & Locations)
1. Structural & Physical Adaptations	**1.1 Housing & Shop Elevation**	Homes and shops raised 7–8 feet above ground to protect from water, allowing families and businesses to function during floods.	• *Nurul Islam & Kala Mandal, Ruknaipara:* Built high-plinth houses. • *Khobijol Rahman, Nangla:* Shops constructed on high structures.
	1.2 Strategic Road/Bridge Construction	Culverts and bridges improve connectivity during moderate flooding, though may alter water flow.	• *Kamal, Puthiapara:* Several new bridges built, reducing suffering.
2. Agricultural & Livelihood Adaptations	**2.1 Dynamic Crop Selection & Rotation**	Farmers choose crops based on flood timing and soil type. Jute favored during flood-prone months; diversified cropping for varying soils.	• *Mukul, Mahmudpur:* Jute survives floods better than paddy. • *Rasul & Kamal, Puthiapara:* Grow mustard, maize, pepper, etc., based on micro-soil differences.
	2.2 Post-Flood Catch Cropping	Quick-growing crops (mustard) planted immediately after flood recession to recover losses.	• *Kala Mandal, Ruknaipara:* Mustard planted after Roa crops die. • *Roushanara, Nangla:* Mustard preferred after severe flood damage.
	2.3 Fast-Yielding & Resilient Varieties	Quick-maturing rice like Binasadha allows harvest between flood recession and winter onset.	• *Ahad Jamal Sheikh:* Sprinkles Binasadha after floodwater recedes.
	2.4 Strategic Land Fallowing	Land left uncultivated if long floods are predicted, preventing wasted inputs.	• *Rasul & Kamal:* Some farmers avoid planting during expected long flooding.
3. Indigenous Knowledge & Forecasting	**3.1 Biometeorological Forecasting**	Observing wind direction, cloud patterns, and environmental cues to predict floods.	• *Kala Mandal, Ruknaipara:* South-to-north wind + black clouds indicate impending flood.
	3.2 Folk Flood Classification	Traditional categories (Seriban, Bauban, Buriban) help communities assess severity and plan responses collectively.	• *Sulaiman, Nangla:* Explained three flood types.
4. Modern & Innovative Techniques	**4.1 Cocopeat Nursery Technology**	Soil-less cocopeat used to produce healthy, uniform seedlings—especially effective for rapid replanting after floods.	• *Ruman & Rabiul, Mahmudpur:* Cocopeat chili seedlings yielded earlier than traditional methods.
	4.2 Sarjon (Raised Bed) Cultivation	High raised beds for vegetable and fruit cultivation in chronically waterlogged soils.	• *Dr. Ruman, Mahmudpur:* Demonstrated success growing gourds using Sarjon.
	4.3 Bag/Sack Farming & Mulching	Sack farming enables rooftop or poor-soil cultivation. Mulching regulates moisture, temperature, and reduces weeds.	• *Aleja Begum:* Sack farming on rooftop. • *Khairul Hasan:* Successful ginger/garlic in sacks; promotes poly mulching.
	4.4 Diversification into New Cash Crops	Adoption of crops like Carpus cotton that tolerate dry/clay soils where floods have decreased.	• *Khalil, Charbani Pakuria:* Carpus cotton performs well in dry soil conditions.
5. Institutional & Behavioral Adaptations	**5.1 Active Knowledge Seeking**	Younger farmers attend government trainings and learn from local innovators to adopt modern practices.	• *Rabiul:* Received modern agriculture training.
	5.2 Cultural Acceptance of Floods	Many view floods as ultimately beneficial, replenishing soil fertility—reducing stress and supporting long-term planning.	• *Abbas Ali:* Considers floods good for soil fertility. • *Nure Alam:* No special strategy needed; flood makes soil fertile.

Together, these strategies demonstrate strong community resilience: farmers blend indigenous forecasting with new technologies to survive shifting flood patterns. However, modern methods remain unevenly adopted due to resource and knowledge gaps.

To understand the effectiveness of local adaptation, the following table links key strategies with their impacts on land productivity and farmers' livelihoods. Table 05 is presented below.

TABLE 05: THE IMPACT OF IDENTIFYING ADAPTATION STRATEGIES AND THEIR INFLUENCE ON CROP LAND, PRODUCTIVITY AND LIVELIHOOD CONDITION IN THE REGION

Adaptation Strategy	Description of Strategy	Impact on Farmland & Productivity	Impact on Farmers & Livelihoods
Strategic Crop Selection & Rotation	Farmers match crops to soil characteristics and flood tolerance. Jute is chosen for waterlogging tolerance; mustard for fast, post-flood recovery; wheat, maize, and certain vegetables are cultivated in sandy or mixed soils.	**Positive:** Helps maintain production even during flood years. Jute withstands seasonal floods, while mustard provides rapid post-flood yields. Soil-crop matching increases efficiency and resilience. **Negative:** Severe, long-duration floods can still destroy all crops despite careful planning.	**Positive:** Provides a steady, though sometimes reduced, income. Mustard has become a crucial cash crop allowing households to secure food reserves (e.g., "rice for six months"). **Negative:** Requires deep traditional knowledge, experience, and constant observation of changing flood patterns.
Soil Management & Silt Utilization	Farmers incorporate beneficial silt deposited by floods to restore nutrients. Excessive silt is removed. Land is classified as sandy, silt-rich, or mixed (bele doash) to guide targeted crop selection.	**Positive:** Enhances soil fertility and reduces dependency on chemical fertilizers. Floods help wash away residual pesticides and salts, rejuvenating the land. **Negative:** In years without floods, soils lose moisture and nutrients, leading to poor yields, increased fertilizer use, and pest outbreaks.	**Positive:** Reduces production costs and increases soil health. Many farmers consider moderate flooding essential for good harvests. **Negative:** Removing excess silt is labour-intensive. Absence of floods is now seen as a major threat to livelihood sustainability.
Land Elevation & Local Infrastructure Development	Farmers raise homestead land and construct houses and shops on elevated plinths (7–8 feet). Local authorities build bridges and raised roads to maintain connectivity.	**Positive:** Protects property from flood damage and prevents loss of stored crops and household assets. **Negative:** Raised structures may unintentionally redirect water flow, causing increased flooding in adjacent areas.	**Positive:** Reduces physical suffering and economic losses during floods. Better roads and bridges improve mobility and access to markets and services. **Negative:** Requires substantial financial investment, making it difficult for poorer households.
Modern Agricultural Techniques (Cocopeat, Mulching, Sarjon)	**Cocopeat:** Soil-less medium producing strong, uniform seedlings. **Mulching:** Plastic mulching conserves moisture, controls weeds, and moderates soil temperature. **Sarjon:** Raised-bed farming for crops in waterlogged areas.	**Positive:** Cocopeat ensures early post-flood planting. Mulching improves water efficiency and crop health. Sarjon makes previously uncultivable land productive. **Negative:** Knowledge-intensive methods with higher initial costs; adoption remains limited.	**Positive:** Early adopters (e.g., Rabiul, Ruman) experience higher yields, quicker returns, and more stable income. **Negative:** Large knowledge and resource gaps between progressive and traditional farmers. Limited training access inhibits widespread adoption.
Alternative Cultivation Techniques (Bag/Sack Method)	Farmers grow ginger, garlic, onions, and vegetables in soil-filled bags on rooftops or homesteads.	**Positive:** Enables cultivation independent of flood-prone fields. Offers high productivity per unit and good disease control. **Negative:** Limited scalability; primarily suited for small household-level production.	**Positive:** Provides supplementary income and strengthens household food security. Women (e.g., Aleja Begum) often adopt this technique, increasing their role in farming. **Negative:** Requires initial setup cost and ongoing labour for soil preparation and maintenance.

The table shows that while most strategies improve soil health, stability, and yields, they also introduce challenges related to cost, labour, and unequal access. The benefits are clear—but not evenly distributed.

Institutional support shapes how farmers manage floods. The table below summarizes the role, reach, and limitations of government and NGO interventions reported by the community. Table 06 is presented below-

TABLE 06: ROLE OF GOVERNMENT AND NON-GOVERNMENT ORGANIZATIONS IN LOCAL AGRICULTURE DURING FLOODS

Source	Support Received (Seeds/Inputs)	Training & Knowledge Dissemination	Overall Perception & Challenges
Local Farmers (e.g., Chaleha, Sonahar Mondol, Sulaiman)	**Limited and Unequal Support:** Farmers report receiving very little assistance. Seed distribution is scarce and symbolic ("1–3 kg" packets). NGOs mostly collect data rather than providing tangible resources.	**Restricted Access:** Training opportunities rarely reach remote villages. Many feel they are excluded due to favouritisms or geographic distance ("NGO's list only their people"). Farmers express a strong desire for practical training on flood-tolerant crops and modern methods.	**General Dissatisfaction:** Farmers feel neglected and unsupported. Assistance is inconsistent, poorly distributed, and often fails to reach the most vulnerable char and riverbank populations.
Progressive Farmer (Rabiul)	**Direct and Effective Support:** Receives high-quality seeds, fertilizers, and pesticides from government programs. Also receives financial incentives after completing trainings.	**Positive Training Experience:** Participated in multiple district-level training sessions, gaining skills in modern techniques such as cocopeat nurseries and mulching.	**Successful Engagement:** Demonstrates that government programs can be highly effective when motivated farmers receive proper support. Represents a model for how knowledge transfer could uplift others.
Government Officer (Md. Ripon Hossain, Agricultural Extension Officer)	**Structured Input Distribution:** Describes a formal rehabilitation scheme after floods, providing fertilizer, pesticides, and seeds (5 kg/bigha). Emphasizes promotion of flood-tolerant varieties such as Brie 57 and Bina 11.	**Selective Training Approach:** Confirms that training is available but limited to selected farmers. Shows partial awareness of local innovations—notes sack cultivation but not fully informed about techniques like Sarjon or Cocopeat, indicating a disconnect between policy and practice.	**Bureaucratic Implementation:** A top-down model with limited outreach capacity. Acknowledges local innovation but highlights challenges in scaling support to all farmers across remote flood-prone areas.

Overall, CBA increases absorptive (tolerant crops), adaptive (replanting) and transformative (innovation) capacity, maintaining productivity amidst floods, with 75% of respondents reporting risk reduction. However, training gaps (e.g., only selected farmers) hinder equitable impact.

DISCUSSION

The findings of this study emphasize the important role of community-based adaptation (CBA) strategies in sustaining crop production amidst recurrent floods in Melandah Upazila of Jamalpur district. By integrating traditional practices (e.g., silt management, crop rotation) with modern innovations (e.g., cocopeat seedlings, raised beds), farmers demonstrated dynamic resilience, transforming flood adversity into improved soil fertility and diversified livelihood opportunities. These findings are consistent with the Sustainable Livelihood Framework (SLF) theory, which emphasizes the five capitals (human, natural, financial, social, physical) and resilience through absorptive, adaptive, and transformative capacities. Below, the findings are compared with previous literature, highlighting the consistency, heterogeneity, and how they address identified knowledge gaps, such as the lack of Jamalpur-specific research, unexplored hybrid strategies, and limited focus on long-term scalability and gender inclusion.

TABLE 07: COMMUNITY-BASED ADAPTATION STRATEGIES AND THEIR AGRICULTURAL & LIVELIHOOD OUTCOMES IN FLOOD-PRONE AREAS OF MELANDAH, JAMALPUR

Community-Based Adaptation Strategy (IV)	Mechanism / How it Works	Observed Agricultural & Livelihood Outcomes (DV)	Field Evidence / Case Insight
Binadhan-7 (Binashad rice seeds)	Short-duration Aman rice, high yielding, resistant to lodging; harvests in 110–120 days, allows quick transition to Rabi crops	↑ Crop yield, ↑ Farm income, ↑ Cropland recovery, ↑ Food security	Farmers reported sowing Binadhan-7 immediately post-flood to ensure early harvest and maintain seasonal crop cycles
Mustard (Sorisha)	Fast-maturing (≈3 months), thrives in silt-sandy soils; cash crop with high market demand	↑ Farm income, ↓ Vulnerability, ↑ Food security	Farmers shifted to mustard when ≥75% of paddy lost; mustard oil extraction now mechanised, with by-products used as fuel
Lentil, wheat, potato & Rabi crops	Cultivated after rice harvest or flood failure; adapted to sandy loam soils	↑ Crop yield, ↑ Farm income, ↑ Food security	Farmers replant Rabi crops immediately after rice loss to reduce livelihood shocks
Crop rotation	Alternating crops maintains soil fertility, reduces pest/disease risk	↑ Crop yield stability, ↓ Vulnerability, ↑ Long-term sustainability	Generational practice in some households; adapted according to soil and flood changes
Jute	Flood-tolerant, withstands 7–15 days submersion; uses floodwater for retting	↑ Cropland use, ↑ Farm income, ↓ Vulnerability	Farmers in fertile alluvial areas cultivate jute as a resilient crop
Soil-based strategies (Bali, Poli, Bele-Doash)	Matching crops with soil type: sandy soils → sesame, wheat, potato, corn, tishi; alluvial soils → jute, chili, vegetables; mixed soils → rice + mustard	↑ Cropland recovery, ↑ Crop yield, ↑ Food security	Farmers cultivate based on post-flood soil deposits; sandy soils still utilised for specific crops rather than left fallow
Sarjon (raised beds)	Raised soil beds prevent submersion; suitable for vegetables in low-lying flood-prone land	↑ Crop yield, ↑ Cropland recovery, ↓ Vulnerability	Billal successfully grew gourds on sarjon beds where rice/jute had failed
Bag farming	Crops grown in sacks with soil + organic fertilizer; usable on rooftops or elevated spaces	↑ Crop yield, ↑ Farm income, ↑ Food security, ↓ Flood damage	Practised in Mahmudpur & Charbani Pakuria; farmers grew onions, garlic, and ginger; profitable and resilient
Cocopeat media seedlings	Coconut husk-based medium, retains 9× water, zero mortality of seedlings, faster growth	↑ Crop yield, ↑ Farm income, ↑ Cropland recovery	Entrepreneur Ruman marketed cocopeat seedlings; Robiul harvested peppers faster with higher productivity
Mulching (including poly-mulching)	Conserves soil moisture, regulates temperature, reduces erosion and pests	↑ Crop yield, ↑ Food security, ↑ Resilience	Khairul Hasan's team grew papaya and watermelon with mulching; effective against moisture loss and seasonal stress

Source: Developed by Researcher

Table 5, indicates community-based adaptation as independent variable (IV) and agricultural and livelihood outcomes like crop yield, farm income, food security etc. as dependent variable (DV). Traditional methods or techniques include cultivating mustard, although rice is very suitable for this region, but since the last 15 years, it has been seen that farmers are cultivating mustard as an alternative to rice due to floods, which they use to get faster yields. There are also some techniques such as mixing silt to increase soil fertility and eliminating excess silt. Growing crops through crop rotation, cultivating by understanding the soil condition, not leaving the land unnecessarily, and cultivating according to the soil of the land so that the crop will grow well. It is seen that the people of this region mainly cultivate crops depending on the type of flood, sometimes more silt comes with the flood and changes the type of land, and sometimes the amount of sand becomes excessive in the areas near the riverbanks, so they cultivate suitable crops periodically based on this periodic change of land. Again, some modern methods such as using seedlings of coco peat media are also being used by some new-age farmers or entrepreneurs. Using seedlings of coco peat media reduces the mortality rate of seedlings to zero. That's all strategies also indicate absorptive, adaptive and transformative capitals to ensure resilience. Case perceptions ensures these methods generate higher yields, faster returns, and more resilient income streams.

IMAGE 01: CIRCULATING PRCCESS OF COCOPEAT MEDIA SEEDLING

Source: Captured by Researcher at the time of primary data collection in research area

The image displays frequency of cocopeat media found at study site need to be shared.

1. Cocodust ↓
2. Mixture of cocopeat media ↓
3. Seedling of cocopeat media ↓
4. A tray view of cocopeat seedling.

Robert Chambers first share the idea of sustainable livelihood framework. Sustainable livelihood framework is a unique approach which tries to capture factors (e.g. food security, economic issue, sustainable nature…) to understand the fundamental causes of poverty. The approach is grounded on a belief that people require a range of assets to achieve positive livelihood outcomes (Majale 2002). Community based adaptation in study area ensures sustainable farming practices along with maintaining sustainable livelihood framework that make sure resilience. The way in which community-based adaptation in the research area shares the discourse of the region is indicated below and presented through their statements.

Crop Yield and Productivity

Crop yield is readily formed by flood intensity, soil fertility, and farmers' adaptive strategies. Though productivity of paddy ranges depending on flood duration it remains the prime crop, Short duration flooding 7to 15 days reduces yield but prolonged flood can cause losses of up to 75%. Farmers widely adopt short-duration and quick-harvesting rice varieties to mitigate this, such as Binadhan-7.

> *The seeds called Binashad are sprinkled soon after the flood water has receded so as to get a quick yield. (Sheikh, 18 December 2024)*

This practice allows households to recover staple food supplies and maintain seasonal cropping cycles. Farmers shift towards fast-growing alternatives in cases of severe crop loss, mustard and other short-cycle crops.

> *If the paddy is more than 70 percent damaged or completely damaged, we prepared the land for green chilies. And if there is up to 50 percent of the crop, then that is taken care of and made into a crop. (Ali, December 2024)*

Such diversification ensures partial yield recovery and cushions household food security. Rabi crops such as vegetables, green chilies, potato, wheat, peanuts, peas, corn and sesame are dominant to yield and income source in the post-flood period. Innovative practices significantly influenced crop yield. The use of cocopeat seedlings, Sarjon (raised beds), and bag farming has enabled early and more reliable vegetable yields in flood-prone conditions.

> *I have also sold pepper once, using seedlings of coco peat media… two months earlier yield is possible by using seedlings of cocopeat media. (Rabiul, 24 December 2024)*

Nursery owners like Dr. Ruman also promote raised-bed methods to delay water contact with plant roots, thereby safeguarding yields. Certain crop like jute, demonstrate natural flood resilience and provide stable yields despite flood.

> *We give more importance to the cultivation of jute than paddy during the flood season because even the jute plant can survive the flood and easy to clean the jute in the flood water. (Mukul, 24 December 2024)*

In this case, it appears that floods have a dual impact on crops, as confirmed by farmers' experiences; although floods cause immediate crop damage, they also increase soil fertility and wash away toxic substances from the soil, which contributes to increased productivity in the following season.

Vulnerability Reduction and Risk Management

Vulnerability in the study area is largely defined by exposure to recurrent floods, crop losses, seedling mortality rates, and livelihood shocks. Farmers repeatedly emphasized that adaptation strategies are not only for improving yields but also for reducing risks associated with unexpected floods. Therefore, reducing vulnerability emerges as a central outcome of community-based adaptation (CBA) practices. A major strategy is the cultivation of short-duration and flood-tolerant crops, such as Binadhan-7 rice and mustard, which reduce the risk of total crop failure.

> *We plant mustard when paddy is destroyed by flood and mustard seeds yield within few days. If the crops of Roa season are not damaged much, then mustard is not planted and rice left in the field. (Kala, 18 December 2025)*

In flood-prone areas, farmers no longer depend on a single crop. Instead, they try out different crops at different times so that if one fails, another can still give food or income. To deal with the low-lying land, many have started using raised beds for sowing and even simple bag cultivation. According to them, these methods keep plants above water level and help prevent the worst damage when floods arrive.

> *Since the basement of the soil is very high in the sarjon technique, when the flood water comes, it takes much time to reach the roots of the trees, so this method is very useful in floods. (Billal, 30 December 2024)*

Similarly, bag farming allows for cultivation in a safe location, such as a rooftop or a homestead, which protects production from river flooding. These methods provide farmers with a reliable fall back system in case their field crops are destroyed. Mortality rate of seedlings is another area of vulnerability. Traditional soil-based seedlings are often destroyed during floods, delaying replanting but the introduction of cocopeat medium has been transformative.

> *With cocopeat seedlings, not a single seedling dies in flood. The specialty of this sapling is the roots of the plants don't affect when planting so the sapling grows without any infection in the root. (Ruman, 18 December 2024)*

The above strategies are playing an important role in reducing the risk of farmers cultivating crops, preserving soil fertility and actually restoring the land in the fastest possible time. All these methods transform the agricultural system from high risk and frequent losses to flexibility, security and resilience.

Cropland Recovery and Soil Fertility

Cropland recovery refers to how quickly and effectively agricultural land is brought back into production after seasonal floods. Recovery depends on both the physical condition of the soil after the flood recession and the adaptive strategies that farmers adopt to restore cultivation. Farmers have consistently emphasized that the ability to bring their land back into production "without delay".

> *Silt that come with flood water mixed with normal soil and it increases the soil fertility. If any land seems to be poor condition they mixed the silt with their land soil while ploughing (Sulaiman, 18 December 2025)*

Another driver of recovery is the efficient use of post-flood soil deposits. Floods deposit layers of silt, sand, and clay (locally termed balu, poli, bele-doyash), which farmers skilfully match with suitable crops.

> *We grow crops according to land soil. After severe flood sandy fields are used for potato or wheat; we never keep land empty. (Khatun, personal commutation, 1 January 2025)*

This soil-based adaptation enables faster recovery by preventing land from lying fallow. Crop rotation is a unique technique for land recovery.

> *I cultivate different types of crop in my land. If I grow paddy the following season I grow robi crops or lentils. Next year I try to cultivate jute. I can assure you my land fertility is better than others. (Alam, 24 December 2024).*

Moderate flooding naturally increases the fertility of cropland. And if excessive flooding occurs, crop production according to the land concept, mixing silt with the soil, and crop rotation have been documented as important ways to recover cropland. Thus, cropland restoration is not a passive activity; it demonstrates both resilience and adaptive capacity, a deliberate and efficient response to the challenges of floodplains.

Farm Income and Economic Resilience

In Melandah, people don't think of farm income only as money—it is also a way of measuring whether a family can survive the flood season without falling into crisis. Every flood takes something away. Sometimes the rice fields go under overnight, and suddenly there is no cash to buy food. What farmers told me is that they have learned to spread their chances. Mustard has turned into one of the most reliable fall backs. It grows on sandy patches, and there is always demand for oil and seeds.

> *"When our paddy is destroyed mustard saves us. We press the seeds, sell the oil, and even the oilcake we use as fuel—nothing is wasted." (Begum, 2024)*

Other practices are less traditional but have caught on quickly. Sarjon (raised beds) let people grow gourds when rice has failed. Billal, a 45-year-old farmer, laughed as he told me he had vegetables to sell in the market every week, while others were waiting for their fields to dry. In Mahmudpur and Charbani Pakuria, women used bags to grow onion, garlic, and ginger for quick cash. Cocopeat seedlings are another change.

> *"We earn more because our seedlings don't die. They grow faster, so we sell earlier." (Ruman, 18 December 2024)*

That one small difference seedlings not dying means the whole income cycle speeds up. Mulching has also been picked up. Khairul Hasan's group showed me papaya and watermelon fields that needed less water and fertilizer, yet gave bigger and better fruit. They sold fast in the market and at a better price. Income, in other words, comes from many small doors, not just from rice. That is how families rebuild so quickly after the water goes down.

Food Security and Livelihood Sustainability

In the same villages, food security is not just "having rice." It is about making sure the household has something to eat every week of the year, even when the floodwater stays long. After harvesting Aman rice, farmers rush to plant mustard, lentil, potato, and wheat. These crops not only sell but also add to the plate—oil, protein, and vegetables.

> *"Though flood is a regular phenomenon, we don't depend on rice alone. Mustard oil, lentil curry, potato—all come from our fields. The children never go hungry." (Sonahar, 18 December 2024)*

People told over and over that they never leave land empty, even if the soil has changed.

> *"Each type of soil gives us some food. We cannot afford to leave land empty." (Nasima, 20 December 2024)*

Sarjon and bag farming are central here too. Small things like that kept diets balanced when others struggled. Such practices directly protect household nutrition.

> *When neighbours had no green vegetables, our sarjon gave us gourds every week. (Billal, 1 January 2025)*

Mulching practices also improve the stability of food supply. Two types of mulching are seen: silt mulching and organic mulching. The mulching process prevents insects from damaging the crop, provides adequate heat and nutrients, and provides adequate water through drip irrigation systems, which preserves the nutritional value of the crop and increases its quantity. These techniques show that farmers are active agents who are constantly making efforts to protect their families from hunger and malnutrition rather than passive victims of floods.

Synthesis: Building Resilience through the Sustainable Livelihood Framework

Through SLF, findings show strengthened capitals (e.g., social for sharing, natural via silt) enabling livelihood outcomes, extending Chambers and Conway (1992) to flood contexts. Resilience Theory (Folke, 2006; Walker et al., 2004) is evident in tiered capacities, with hybrids fostering transformation beyond absorptive survival in Dhungel (2011). Overall, this study fulfils the gaps by providing Jamalpur-centric data, emphasising hybrid strategies' scalability, and highlighting gender/inclusivity, thus informing policies for equitable, resilient agriculture in similar underserved regions.

- Starting with the land itself what they call natural capital. These guys rotate their crops, deal with the silt that piles up, and really nurse the soil back after a flood hit. It stops the ground from getting worn out, even with all the yearly battering, and keeps it churning out good stuff season after season.

- Then there's the gear and setups, or physical capital. Things like those sarjon beds, farming in bags, and using cocopeat mean they can keep veggies growing even when everything's swamped. It's clever, keeps disasters from wiping out everything by shifting to higher ground or whatever. Plus, little machines like oil extractors help them get more out of what they pull in.
- Skills-wise, human capitals on the up. People are learning hands-on stuff: how to pile up those raised beds, mix cocopeat just right, or throw down mulch to guard the plants. Nothing fancy, but it gives them a real boost in confidence and a bunch more options when things go sideways.
- Money side of things, financial capital, is looking better too. By mixing it up with mustard, fast-growing veggies, and quick crops, they've got multiple ways to bring in cash. If a flood trashes one, chances are another's okay, which cuts down on the panic and lets them sock away a little extra.
- And social capital? That's probably the quiet powerhouse. Farmers chat all the time, sharing tricks and showing each other how it's done like that guy Ruman, who's not just raising seedlings but coaching others too. These ties help ideas catch on quick and give everyone a safety net when the going gets tough.
- It all feeds into each other: better dirt leads to fatter harvests, which means more money; that buys better tools; tools spark new tweaks; and swapping know-how pushes the group ahead. So, the toughness in Melandah comes from beefing up the whole way they live and farm, not some one-off change.
- Sure, it's not all smooth. Getting into cocopeat or plastic mulching takes some cash up front and a bit of learning, which might leave the really broke folks out. And going all-in on cash crops like mustard could mess with how food flows locally in ways no one saw coming. That's why we need smarter rules may be cheaper access to supplies or more training to level the playing field.

At last but not the least, these local fixes in Melandah's flood-heavy spots hit the main problems square on: pumping up production, bouncing back faster, dialling down risks, spreading out earnings, and nailing down food for the table. They're baked right into daily life, showing that community-driven stuff is crucial for keeping farming going strong in Bangladesh's roughest areas.

CONCLUSION AND POLICY IMPLICATIONS

This research monograph explores the significance of community-based adaptation processes in agriculture in coping with floods in the Jamalpur region of Bangladesh. The research was completed through a survey of three unions in Melandah Upazila of Jamalpur district, where it was recorded how local farmers use their traditional knowledge, ecological practices and strategies in the face of recurring floods. The research project explores that although floods are temporary, in the study area, people have taken a positive turn in agriculture due to floods, despite many adversities. Just as some farmers have achieved stability in agriculture through some communal knowledge, some educated and new-age farmers, agricultural entrepreneurs are adopting new methods that are also bringing success to the community agriculture sector. If their new technologies can be combined with the traditional adaptation strategies of the community, floods and other natural disasters will not be able to cause massive damage to the agricultural sector. Some women in the study area have also advanced in agriculture, including them will ensure social stability. Cultivating flood-tolerant crops, growing crops based on soil, and cultivating through silt management all highlight the deep-rooted concept of local ecosystems. Collectively sharing knowledge, agricultural activities through flood adaptation strategies maintain social stability, while alternative farming management of farmers during floods enhances their economic stability. Flooded agricultural practices in flood-risk regions are insured and shunned through community-based adjustment mechanisms. Minimal institutional support and uneven training administration that dissuades community farm activities necessitates unprecedented intervention by local farm businesspeople. Finally, the study confirms that contemporary adaptation is not merely a coping mechanism but a dynamic environmental administration and social invention process. Valuing indigenous knowledge, promoting equitable sharing of community-based knowledge, and mainstreaming people-initiated programs will achieve livelihood resilience to climate change in other regions like Jamalpur.

- Integrate the use of traditional silt in cultivation and mulching for bag cultivation to maintain soil fertility with crop rotation (aligned with NAP 2023-2050 Target 2 on Nature-based Solutions). Target smallholder farmers and women in flood zones; Implement through MoA/DAE workshops and CCTF-funded demo plots with BRAC, with a target of 50% adoption within 2-3 years through Upazila tracking.
- Equip officials to scale up innovations like cocopeat and form cooperatives for inputs, training and markets (aligned with BCCSAP 2009 Capacity Building and BDP2100 Cooperatives). Target entrepreneurs in Jamalpur; Implement through DAE/BARI under PPCR with CCTF subsidy, quarterly inspections and digital app for 70% union coverage in 5 years.
- Provide village-based training on mulching, cocopeat and bagging methods to all farmers, with a focus on women (aligned with NAPA inclusion and NAP 2023-2050 gender focus). Target women, youth and marginalized pastoral areas; Implement through CDMP/MoDMR with UNDP mobile units and LDCF/GEF funding, train 10,000 people annually through survey evaluation.
- Promote women's agricultural participation (e.g., bagging methods) for economic empowerment (aligned with NAP 2023-2050 Goal 5 and BCCSAP Social Protection). Target female heads of households; Implement through MoA/MoWCA through BRAC microfinance and outreach, increase cooperative engagement by 40% in 3 years through gender-disaggregated information.
- Support educated farmers in community-wide knowledge sharing for multi-hazard resilience (aligned with NAP 2023-2050 Goal 6 Innovation and BDP2100 Network). Target progressive trainers; Implement DAE "farmer-to-farmer" model with CCTF hub and subsidy, reaching 5,000 people annually through feedback monitoring.
- Document and institutionalize national CBA strategies for large-scale disaster application (aligned with NAP 2023-2050 Goal 6 and NAPA Indigenous Practices). Target policymakers and BARI/MoEF; Implement MoEF/UNDP GEF-funded database with survey and BCCSAP integration, covering 20 strategies in 20 districts over 5 years with annual reporting.

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Conflict of Interest
No conflict of interests has been declared by the authors.

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