ALTERNATIVE LIVELIHOOD OPTIONS FOR CLIMATE VICTIMS: A CASE STUDY OF FARMER COMMUNITY OF MUNSHIGANJ UNION AT SATKHIRA DISTRICT

By

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A thesis submitted to the Department of Architecture in partial Fulfillment of the requirements for the degree of Master in Disaster Management

Department of Architecture
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Declaration

It is hereby declared that:

The thesis submitted is my own original work while completing degree at Brac University.
The thesis does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
The thesis does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
I have acknowledged all main sources of assistance.

I at this moment, that the thesis titled "Alternative Livelihood Options for Climate Victims: A Case Study of Farmer Community of Munshiganj Union at Satkhira District" is my original work, except where otherwise indicated. I have acknowledged all the sources of information and assistance, and i have obeyed all academic and ethical standards as required by Brac University.

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Approval

The thesis titled Alternative Livelihood Options for Climate Victims: A Case Study of Farmer Community of Munshiganj Union at Satkhira District submitted by Md. Mostafa Kamal ID: 22268001) of fall, 2022 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Master in Disaster Management on May 2025.

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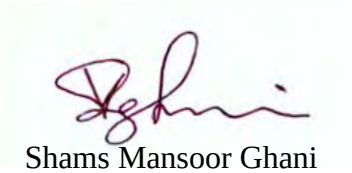

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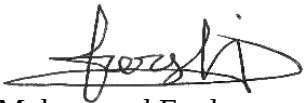

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Ethics Statement

The whole study was conducted with ethical competence and integrity in terms of conscious decision making and responsibly acting considering legal standards as well as social, economic and ecological consequences.

While conducting field surveys, at first and foremost, consent was taken from each authority to survey their facilities. All the actions such as taking photographs, talking with staff and volunteers were conducted with permission. The field survey was conducted with Beneficence-Do not harm manner. While surveying the child protection facilities, their privacy and dignity were fully respected without interrupting their regular activities like playing and learning.

One of the major ethical points followed in this study is to maintain anonymity and confidentiality in data collection procedure and analysis to respect the law and policy of Child Protection Sector. All the respondents are kept anonymous as well as samples studied in the research are presented with different identification numbers throughout the data analysis and findings. Wherever any intellectual property is used for the purpose of this study, they are given proper credits with proper citation.

The whole research is conducted with full objectivity starting from determining the research questions to research findings. The overall research design, data analysis and representation are carried out regardless of any bias and inclination.

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Abstract

Due to global warming the coastal area of Bangladesh is becoming threatened by frequent cyclones, heat wave, storm surges, tidal surges, floods and salinity intrusion. Like others coastal area of Bangladesh, Munshiganj Union in Satkhira is becoming more vulnerable particularly in agriculture-dependent populations. Climate change not only affects farmers' livelihoods, but also affects land use pattern, food security, loss of biodiversity The coastal agriculture is becoming more expensive because of require more money to buy salt-tolerant seeds, remove saline water from the land, supply fresh water and planting salt-tolerant seedlings and frequent climatic disaster. Farmers are therefore looking for alternative means of livelihood apart from agriculture due to impacts of climate change.

This study analyzes these alternative livelihood possibilities utilizing a mix of quantitative and qualitative methods to gain a thorough grasp of the problem. The study was carried out in significant parts of the Munshiganj Union, including Harinagar, Garaze Bazar, Kultoli, Jelekhali, Kodomtola, Kachukhali, and Dhankhali. A total of 104 people were polled, including farmers, local leaders, government officials, and NGO representatives. Focus group discussions (FGDs) and in-depth interviews with key informants supplemented the survey data, providing qualitative insights into the socioeconomic effects of climate change and the efficacy of adaptation methods. The study indicated that most respondents (39.4%) were between the ages of 37 and 46, with a male majority (78.8%). Income data show that 45.2% of families earn between 10,001 and 15,000 BDT per month, with only 1.0% earning more than 25,000 BDT.

Quantitative statistics show that 83.7% of respondents are pursuing alternative livelihoods, particularly shrimp farming (56.3%) and fishing (54.0%). The findings show that many farmers saw aquaculture as more resistant to environmental degradation, which 55.4% regarded as a crucial driver for this decision. Respondents also said that aquaculture provides greater economic stability, however it requires an initial investment and technical knowledge that few farmers have. Also, Water shortage was seen as a major difficulty by 67.3% of respondents and focus group discussions suggested that prolonged dry spells and saline water sources exacerbate the situation. Furthermore, soil salinity, which affects 59.6% of participants, has rendered traditional crops unsustainable, forcing communities to transition to salt-tolerant rice types. As a result, 72.1% of respondents stated that climate change has had a substantial influence on traditional occupations, prompting younger generations to seek non-agricultural employment in adjacent towns. Mulching (67.3%) and drip watering (65.4%) are popular adaptation tactics.

However, qualitative research has revealed that these approaches are resource costly and not broadly available. NGOs, particularly Shushilan (66.3%) and Care Bangladesh (55.8%), play an important role in encouraging adaptation measures by offering technical training, financial help, and community mobilization.

This study emphasizes the critical need for sustainable livelihood options and strong institutional assistance to address the socioeconomic vulnerabilities increased by climate change. The study's findings underline the necessity of community-specific difficulties being addressed through tailored interventions such as low-cost adaptive technologies and localized capacity-building programs. This study's findings serve as a platform for future initiatives aiming at increasing the resilience of farming communities in coastal Bangladesh.

Keywords: *Climate change, Coastal areas, Alternative livelihoods, Farmers, Socio-economic vulnerability, Adaptation strategies, Munshiganj union, Satkhira district.*

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List of Acronyms

ADB - Asian Development Bank

AF-Adaptation Fund

ASA - Association for Social Advancement

ASAP - Adaptation for Smallholder Agriculture Program

BBS - Bangladesh Bureau of Statistics

BCCSAP - Bangladesh Climate Change Strategy and Action Plan

BCCTF - Bangladesh Climate Change Trust Fund

BARI: Bangladesh Agricultural Research Institute

BINA: Bangladesh Institute of Nuclear Agriculture

BSMRAU: Bangabandhu Sheikh Mujibur Rahman Agricultural University

CC- Climate Change

CPP- Cyclone Preparedness Program

CIF - Climate Investment Funds

FGDs - Focus Group Discussions

GWP- Global Warming Potential

GCF - Green Climate Fund

GEF- Global Environment Facility

INM- Integrated Nutrient Management

IFAD- International Fund for Agricultural Development

IBM- International Business Machines Corporation

KIIs- Key Informant Interviews

MFIs- Microfinance Institutions

NGOs -Non-Governmental Organizations

NDC - Nationally Determined Contribution

SPSS- Statistical Package for the Social Sciences

VSLAs - Village Savings and Loan Associations

WB - World Bank

CHAPTER ONE
Introduction

1.1 Background of study

Bangladesh's geographic location and terrain make it highly vulnerable to the impacts of climate change (Rahaman et al., 2020). Between 2000 and 2019, there were 11,450 lives lost, and $3.72 billion worth of economic damage caused by climate change and 185 extreme weather events in Bangladesh, as stated by the Climate Risk Index (GCRI 2021). This country is in South Asia, occupying a low-lying delta that the Ganges and Brahmaputra rivers form (Reliefweb, 2021). The Global Climate Risk Index puts Bangladesh in the ninth place among the ten most affected countries by extreme climate events and the seventh place in the long-term risk index (Eckstein et al., 2020). Additionally, because of its distinct geographic location and the low socioeconomic standing of its most vulnerable populations, Bangladesh, a low-lying South Asian nation, is extremely exposed to the negative effects of global climate change, especially sea level rise. According to scientific predictions, sea level rise in 37 coastal stations in the Bay of Bengal in the year 2100 ranged from 0.53 to 0.97 meters, whereas the worldwide sea level rise is expected to be between 0.09 and 0.88 meters (Haque A. et al., 2019). According to a World Bank estimate, a 1 m increase in sea level will affect 1.5 to 1.54 million people by 2070, forcing 11 million people to relocate permanently (World Bank, 2015).

In the twenty-first century, climate change is one of the greatest threats to the world community; especially to the developing world. Climate change is a global, slow, long term, multidimensional phenomenon with plenty of adverse impacts on socioeconomic aspects. Particularly, the coastal area (southern and south-eastern part) of Bangladesh is more vulnerable to climate change as it locates at the tip of inverted funnel shape of Bay of Bengal (Haque, A. et al., 2019). Geographic location, low topography (dominance of flood plains and low elevation from the sea), demographic (high population density and growth rate) and poor socio-economic (high poverty level, climate dependent traditional rural agrarian economy, institutional weakness etc.) features make Bangladesh one of the most vulnerable countries in the world to climate change (Ahmed, A et al., 2018).

According to the Global Climate Risk Index (2021), Bangladesh ranked as the seventh-most affected by climatic calamities across the world during the period 2000–2019 (UNDP, 2023). Climate change poses a great threat to Bangladesh's economy because of its high dependence on agriculture. Today, the agricultural sector employs about 40.6% of the country's labor force and contributes 14.10% to Bangladesh's gross domestic product. Various climatic variabilities, such as changes in precipitation, temperature, rises of sea level, salinity intrusion, and natural disasters, that is, storm surges, cyclones, flood, drought, and so on, distress the agricultural sector. These impacts ultimately affect crop production and increase food insecurity (Habiba, U. 2024).

Considering the geomorphological characteristics, the coastal areas of Bangladesh can be divided into three zones: the western, the central and the eastern. These areas are an important source of different economic activities ranging from commercial, recreational, and subsistence fisheries to other agriculture activities and forest resources collection (Uddin, M. S et al., 2020 & Haque, A. et al., 2019). Agriculture by itself, is one of the primary economic activities of Bangladesh representing 14.23% of the country's GDP and employs around 40.60% of total labor force of Bangladesh (BBS: Yearbook, 2017). This sector has been identified as one of the prime sectors for achieving the development goals of coastal areas and agriculture is the main economic activity of 40 million people living in the coastal zone (Lázár, A. N ET AL., 2015). Due to the global climate change induced Sea Level Rise, agricultural activities in the coastal areas of Bangladesh have been incurring economic loss in terms of inundation by rising water level and salinity intrusion, reduction in crop production, loses of livelihood activities and resources degradation (Brammer, H. 2014; Islam, M. A., & Paul, S. K. 2018).

Salinity intrusion is a major issue in the South-east coastal region of Bangladesh. Around 53% of the coastal region is affected by different degrees of salinity (Nur, M. N. B et al., 2024). In every three years on average, a severe tropical cyclone hits Bangladesh [4] and the fourth assessment report (AR4) of IPCC indicates that the future tropical cyclones, storm surges and its related saline water flood will be more severe in the coast of Bangladesh due to Planned Decentralization (Dasgupta, S et al., 2010). Sedimentation, rising sea levels, cyclones, storm surges and tidal surges are all natural processes that contribute to the increased salinity in this coastal region. Simultaneously, the dominance of salt in the region is also influenced by human activities like shrimp farming, inadequate infrastructure and poor maintenance, increased greenhouse gas

emissions and rising temperatures. A substantial yield loss, or an average of 20–40% in main crops, was seen in saline-prone coastal regions (Miah et al., 2020). Salinity is a serious issue that not only reduces agricultural potential but also impacts farmers' livelihood strategies and shortens the lifespan of boats, nets and houses (Rahim et al., 2018). The issue is made worse, especially during the dry season, when insufficient rainfall reduces the salinity of surface water and removes salt from the soil. Due to salt and tidal flooding, coastal agriculture suffers a yield drop or, in extreme cases, destruction (Nicholls et al., 2007).

Available data from EM-DAT for 120 years shows that cyclones and floods are the most common disasters in Bangladesh, often causing huge economic losses as well as worse events-the 1970 Bhola Cyclone claimed nearly 500,000 lives (NIRAPAD, 2021). The area affected by salinity in Bangladesh expanded from 83.3 million hectares in 1973 to 102 million hectares in 2000, reaching 105.6 million hectares by 2009 (Brammer, 2014). Because of salinity intrusion, the population of coastal Bangladesh has been forced to adapt its agricultural practices, food sources, and groundwater resources (Ashrafuzzaman et al., 2022; Hasan et al., 2020; ReliefWeb, 2019). Excessive groundwater extraction and sea-level rise have led to seawater intrusion into even the coastal aquifers in southwestern Bangladesh causing long term salinization (Salehin et al., 2018). Coastal areas stand as most vulnerable to changing climates, which result in saltwater intrusion, a primary threat to agriculture (Hasan et al., 2020).

The coastal area of Bangladesh is becoming threatened because of cyclones, heat wave, storm surges, tidal surges, flooding and salinity intrusion. Migrations, unemployment, damage of assets, vulnerability of the community are increasing due to intensity and frequent climatic disaster. People are losing their traditional livelihood options because of salinity intrusion. Due to unsustainable shrimp farming practices and salinity intrusion, the livelihoods and food security of many poor people has been under threat in recent years. The livelihood situation of poor people of coastal belt becoming more vulnerable day by day due to lack of proper adaptive and coping mechanism in the coastal area of Bangladesh. The impact of climatic variability has further restrained the coastal livelihoods and forced us to limit coping capacity with disasters and hazards. Climate change threatens food security and agricultural livelihoods of smallholder farmers (Ahmed et al., 2022). Hence the negative impact of climate change on agricultural productivity is evident (Mahmood et al., 2021).

Due to climate change, livelihood security is not adequately assessed because of which farming communities cannot develop sustainable agriculture (Blackmore et al., 2021). Climate change risks have challenged the lives and livelihoods of farmers in developing countries who depend on agriculture for livelihood (Das et al., 2024; Aribi and Sghaier, 2021).

Climate-related disasters such as floods, cyclones, earthquakes, storms, tsunamis etc. have made it difficult for rural people in South Asia and other countries to retain rural resources and sustain agriculture (Global Report on Internal Displacement, 2021). Climate change is a big problem for underprivileged groups around the world, notably farmers who primarily depend on agriculture for their livelihoods. Impacts include increased temperatures, altering rainfall patterns, increased frequency of extreme weather events-according to CARE (2019)-that result in negative consequences to the sustainability and productivity levels of farming activities.

Adaptation and coping mechanisms are being reviewed by the community in Munshiganj Union, Satkhira District in Bangladesh, because of the similar situation, regarding alternative livelihood activities. The coastal area of Bangladesh is increasingly threatened by frequent disasters such as heat waves, storm surge, tidal surge, and flooding, along with salinity intrusion, whereby these events have been aggravated by climate change, causing a spike in migration, unemployment, destruction of assets and community vulnerability. Of all the effects so far mentioned with respect to impact, the one that stands out most is the livelihood crisis facing Munshiganj Union, Satkhira District. The crisis is quite intense, considering its effect on the agricultural sector. Rising soil and water salinity with sea-level rise and saltwater intrusion, along with erratic weather patterns and floodings, have greatly affected traditional agricultural productivity over the past decade (Rahaman, 2024). Traditionally, farmers changed their crops, but now most of them must look for alternative means of living since they are unable to gain profit from the crops.

This research evaluated the economic viability, social acceptability and environmental sustainability of the proposed alternatives to ensure their practicality and effectiveness. Besides, this research will contribute to a more comprehensive understanding of alternative livelihood options for farming communities in Munsingh Union of Satkhira District and facilitate the development of effective strategies to enhance their resilience and adaptive capacity in the face of climate change.

This research was given a way to identify the potential alternative livelihoods options for the farmers considering the salinity intrusion, stagnation of saline water, cyclonic storms, floods and other climatic hazards at Munshiganj union of Shaymnagar upazilla at Satkhira districts in Bangladesh. To identify alternative livelihood options for the farmers following climate change objectively the study aimed at: i) analyzing the impact on livelihood of poor people in context of climate change; ii) assessing the scope of introducing sustainable and alternative livelihood options for the farmers.

1.2 Statement of the problem

In Bangladesh, Munshiganj Union would serve as a good case study of the continuing convoluted interplay between climate change and local livelihoods. In the past decade, some 30% of the arable land in the area has turned saline, as a direct impact of increasing sea levels and higher salinity intrusion (Rahman et al., 2022). About 60% of farmers have given up traditional rice farming in favor of fish farming and vegetable production due to distressing trends (Hossain & Khatun, 2021). Such changes are not often mentioned that severely affect food security, and the current trend has rendered the community even poorer, with many households saying they have seen their average income reduced by 25% since the onset of the ecological challenges (Bangladesh Bureau of Statistics, 2023).

Furthermore, the socio-economic profile underlying Munshiganj is marked by at least a continued reliance on agriculture, a growing population, and limited adaptive resources intensifying the induced challenges of climate change (Islam et al., 2020). Although efforts to adopt new agricultural systems have begun, most individuals continue to depend on traditional agricultural systems, which have become increasingly less viable. Climate change impacts are gendered; many of its secondary impacts have a more disproportionate effect on women and adolescent girls in terms of adaptive capacity due to barriers in accessing productive resources and the decision-making process, adversely affecting their health, food security, and safety (Kantamaneni et al., 2018).The agricultural communities in Munshiganj Union in the district of Satkhira are undergoing deep-seated livelihood crises exacerbated by the glaring impacts of climate change.

The last decade has become a great adversity for the farmers as saline soils and water due to rising sea levels and freshwater intrusion, uncertain climatic patterns compounded by frequent floods, severely endangered agricultural production. Because of the above, many traditional farming techniques, which have underpinned the local economy for generations, are under siege. Crop failure, soil degradation, and reduced water supplies have considerably undermined agricultural productivity from previous eras, threatening food security while shaking the very underpinning of the social-economic fabric of the region. Since agriculture sustained most of these households, this community is now economically riding on one edge. They have fewer alternative revenue-generating opportunities or other resources to enable the transition of communities toward climate-resilient livelihoods. For all this to take place, the absence of institutional support, poor infrastructure, and lack of access to climate-adaptive technologies and training add to the dilemma with adaptation to change.

With ecosystem degradation ever-increasing, the socio-economic impacts are dire. Many farmers are plunged into poverty, leading urban migration in search of employment and abandonment of an already weakened rural economy. Women and children are generally the worst-hit groups with declining family incomes that limit access to education and health. Recent studies (Ahmed, 2022; Mahmood et al., 2021) accentuate the importance of saline-tolerant crop varieties and agroforestry systems as sustainable solutions for coastal communities in Bangladesh. Even though they have been successfully piloted in neighbouring areas, Munshiganj Union resists detailed investigations in this context.

The current livelihood crisis in Munshiganj Union is further compounded by limited access to alternative livelihoods, institutional support, adaptive technology and resources that ensure climate-resilient livelihoods. Disproportionate effects are seen on women and marginalized groups. Therefore, this study aims at sustainable and resilient livelihood options such as aquaculture, saline-tolerant crops, agroforestry systems and small-scale entrepreneurship, while assessing the viability of such alternatives in the context of Munshiganj Union. The study was looking at the feasibility of these alternatives, focusing on resources such as linkage with markets and the socio-cultural setting. It would also investigate the capacity of local farmers for adoption of these new practices along with support from government agencies, NGOs and other stakeholders to ensure success during application.

1.3 Research Questions

How has climate change impacted the livelihoods of farmers in Munshiganj Union?

What are the feasible and sustainable alternative livelihood options for the farmers?

1.4 Research Objectives

-to investigate the impact on livelihood of people in context of climate change.

-to assess the scope of introducing sustainable and alternative livelihood options for the farmers.

1.5 Justification of the study

The farming community of Munshiganj Union of Satkhira district is facing significant challenges due to climate change, especially sea level rise, saltwater intrusion and unpredictable weather conditions. These factors have adversely affected the agricultural productivity of farmers. In response to these challenges, it has become imperative to explore alternative livelihood options to ensure community sustainability and resilience. Climate change is contributing to reduced agricultural crop yields and farmland losing to salinity. Communities relying on agriculture are exposed to numerous risks and alternatives to sustaining agriculture such as shrimp or fish farming, small businesses, eco-tourism handicrafts and cottage industries, pottery, and traditional industries. However, to ensure minimal harm to the environment, a few among these approaches must be sustainable. Through the research findings, farmers will be able to identify alternative livelihoods.

1.6 Scope of the study

In Munshiganj Union, Satkhira District in Bangladesh, these points are elaborating on the investigation parameters and specific focus areas for the study on sustainable options for farming communities affected by climate change.

Geographic and developmental focus: It focuses on the farmer community in Munshiganj Union, Satkhira District, mainly the flooding and salinized ones, caused by climate change.

Climate Hazards: It focuses on how the specific climate hazards affect the activities of the community, i.e. cyclones, saline intrusion, and sea level rise, their effect on agricultural viability.

Current analysis of livelihoods: The study is on the present forms of livelihood and identifies the shortcomings with sustainability and resilience against climate change.

Alternative Forms of Livelihood: The study identifies and assesses practical alternatives to agriculture as livelihoods available to affected farmers, including non-agricultural pursuits, crab farming, and saline-dependent aquaculture.

Barriers for Adoption: Sociocultural, financial and technology barriers such as gender and equity issues are to be discussed in the study for preventing people from adopting alternative livelihoods.

External Support Contribution: The study assesses the impact of institutional, NGO, and local government efforts on these people's access to alternative livelihood options, training, and policy frameworks.

Economic Feasibility: The study contributes to further research into the sustainability and profitability of the proposed alternative livelihoods, as well as market access and environmental concerns.

Policy Recommendations: The study findings make practical recommendations to development organizations and politicians for creating climate-resilient, sustainable living for coastal communities.

1.7 Conceptual Framework

Component	Description	Activities	Expected Outcome
Introduction/ Background	Introduce the study's purpose and objectives. Discuss the context of climate change and its impact on farmers.	Literature review, data collection from Munshiganj Union.	Clear understanding of research objectives, rationale, and context of the study.
Literature Review	Review existing literature on climate change, alternative livelihoods, and farmer adaptation strategies.	Secondary data collection, analysis of relevant studies on climate victims and livelihood transitions.	Comprehensive understanding of the impact of climate change on farmers and potential livelihood options.
Research Questions	Formulate key research questions to guide the study and identify gaps in current knowledge.	Expert consultation, further literature review, community input from Munshiganj.	Clear and focused research questions that drive the inquiry.
Methodology and Research Design	Outline the research design, approach, and methods for gathering and analyzing data.	Mixed-methods approach: surveys, FGDs, KIIs, descriptive and analytical frameworks.	Well-defined research design and methodology appropriate for the study.
Data Collection	Collect primary and secondary data through surveys, FGDs, KIIs, and document analysis.	Surveys, interviews with local farmers, focus group discussions, review of existing data sources.	Rich dataset reflecting farmers' challenges, alternative livelihood practices, and climate impacts.
Data Analysis	Analyze collected data using qualitative and quantitative methods to explore patterns and trends.	Thematic analysis for qualitative data; statistical analysis for quantitative data (livelihood changes, income levels).	Insightful analysis provides a clear understanding of the alternative livelihood options and their effectiveness.
Case Studies	Analyze specific case studies to explore alternative livelihoods in Munshiganj Union, focusing on climate victims.	Detailed case study analysis, interviews with affected farmers, document community experiences and challenges.	In-depth case studies illustrating the adaptation strategies and livelihood outcomes of local farmers.
Discussion	Discuss findings in relation to research questions and existing literature on alternative livelihoods.	Comparative analysis, synthesis of collected data with previous research on climate adaptation.	Identification of successful adaptation strategies, barriers, and opportunities for livelihood shifts.
Conclusion	Summarize key findings, addressing the research objectives and questions.	Synthesis of key insights from the analysis.	Clear summary of the study's findings with implications for future research and policy development.
Recommendations	Propose strategies to enhance alternative livelihood options for climate victims in Munshiganj Union.	Policy analysis, community feedback, expert consultation.	Practical and actionable recommendations for local government, NGOs, and farmers to strengthen resilience.

1.8 Limitations of the study

The study was successfully completed without any limitations. There are some possible limitations of this research work which were obstacles in exploring alternative livelihood options for the farming community of Munshiganj Union of Satkhira District such as: sample size of farmers, time constraints, cultural barriers and understanding considering the scope, timeframe, and logistical feasibility of the research based on the climate change and their impacts.

CHAPTER TWO

Literature Review

Bangladesh has won worldwide recognition for being one of the countries that are most vulnerable to climate change (Climate Change Cell, 2007). The Global Climate Risk Index 2020 raised it to the 7th position among the nations most affected by climate change between 1999 and 2018 (Eckstein et al., 2019). The impacts of climate change are already evident in Bangladesh, which has longer flood seasons, more frequent cyclones, droughts, and earthquakes, that damage the country crops, land, and water, and people are losing ecosystems and changing their livelihoods. This has led to the destruction of houses and means of living, the displacement of thousands of people and the ruin of agricultural land (Ashrafuzzaman; 2024, Batungwanayo et al; 2020).

Bangladesh will suffer environmental degradation, a cut down of land area and a reduction in its food production of 17% and 30% respectively by 2050, poverty will increase, and the mangrove forest will be more vulnerable to the sea-level rise (Islam et al., 2022). The impacts of climate change are exacerbated across different sectors, mainly in fisheries, which falls among the sectors that are most affected. Weather-related disasters such as cyclones are great risks to the economy, people's lives, and the environment of coastal fisheries (Ahsan & Brandt, 2015). Some of the potential activities which supplement conventional farming are agro forestry, aquaculture, and non-farm activities (Rahman and Biswas, 2018). In fact, farmers may also opt for dairy farming, fish farming, and vegetable gardening as the substitute of traditional agriculture to generate incomes (Khan et al., 2018). Some of the adaptive livelihoods such as micro businesses, poultry farming, and beekeeping are practiced by the farmers in Munshiganj Union who have been affected by climate change (Ahmed and Hossain, 2019). Furthermore, solar energy entrepreneurship also plays the role as an alternative source of income for people affected by climate change in Satkhira District (Mondal et al., 2021).

According to the research of Rahman, M. and Rahman, A. (2022), entire local populations can apply various measures to reduce erosion and benefit the coast. Freshwater is the main source of water supply for people in coastal regions, and they practice seasonal water storage (31%), desalination (30%), and rainwater harvesting (26%) methods for water provisioning. in 30% of the time, farmers preferred to diversify crops, use salt-resistant seedlings, and in some cases replace rice with other plants. About 32% have also adopted saline-resistant crops. In the livestock sector,

39% of farmers adopted improved management practices while 20% switched to other businesses completely. Most adaptation in fisheries is switching of freshwater fish to marine, such as crab and prawn farming (38%). There is a major long-term resilience source identified in the communities concerning salinity-related disasters: safe water, 93 percent; quality seeds, 57 percent; livestock disease control, 47 percent; and access to quality hatchlings (Rahman, M. and Rahman, A. 2022).

Different research has shown impacts on farmers because climate changes in Satkhira district and the coastal area of Bangladesh. But still several more gaps in research remain yet to be bridged. As shown in recent studies (Begum, M. E. A, 2024) salinity-tolerant crop varieties and agroforestry are increasingly emerging as sustainable alternatives for coastal communities in Bangladesh. These innovations have been piloted elsewhere with reasonable success, but Munshiganj Union begs much more consideration in this context. Most of the literature on alternative livelihood options for climate victims can broadly be classified into categories, without mentioning Munshiganj Union, Satkhira District. There really is much more research to do, considering the context-specific characteristics, challenges and opportunities of farmer communities, in particular regions. Most literature overviews the impact of climate variability on the farming community; however, it does not speak authoritatively on several aspects of the specific vulnerability and losses suffered by farmers. A comprehensive understanding of the specific climate-related challenges faced by farmers is essential to identify sustainable and alternative livelihood options for the farmers and examine the implication of gender dimension in alternative livelihood options.

2.1. Impact of Climate Change on Agriculture

2.1.1 Damage and Losses

Climate change is contributing to significant loss and damage in Satkhira, Bangladesh, affecting various aspects of the region's infrastructure, economy, environment and overall well-being (Naz et al., 2024). Most households take autonomous adaptations of their own to climatic stressors, but most interventions on the impact of extreme events and adaptation to climate change are inadequate in preventing loss and damages to household economies, livelihoods, health and cultural resources.

Satkhira, Bangladesh has excellent examples of countries where measures, however, seem inadequate in adapting to slow-start processes when inadequate conditions exist to avoid damage

from an extreme weather event. Satkhira is a coastal district with an increase in sea levels and cyclones, both of which are associated with saltwater intrusion affecting rice cultivation, the mainstay of the local economy and most diets of the population. Salinity levels increased sharply, whereby 81 percent of soils saw increases in salinity, compared to the previous 20 years at the level of only 2 percent.

According to the secondary data sources based on Bangladesh Meteorological Department (BMD), a study conducted by Rabbani et al., (2021 & 2018) time series data (1981-2015) shows the variation in temperature and rainfall, cyclonic events, salinity intrusion and sea level rise that are affecting the Southwest coast, especially Satkhira district of Bangladesh. This scientific data relevant with this study finding indicates that cyclone and storm surge, salinity intrusion and SLR are the key climate induced secondary hazards or disaster that are affecting the coastal communities as well their livelihood.

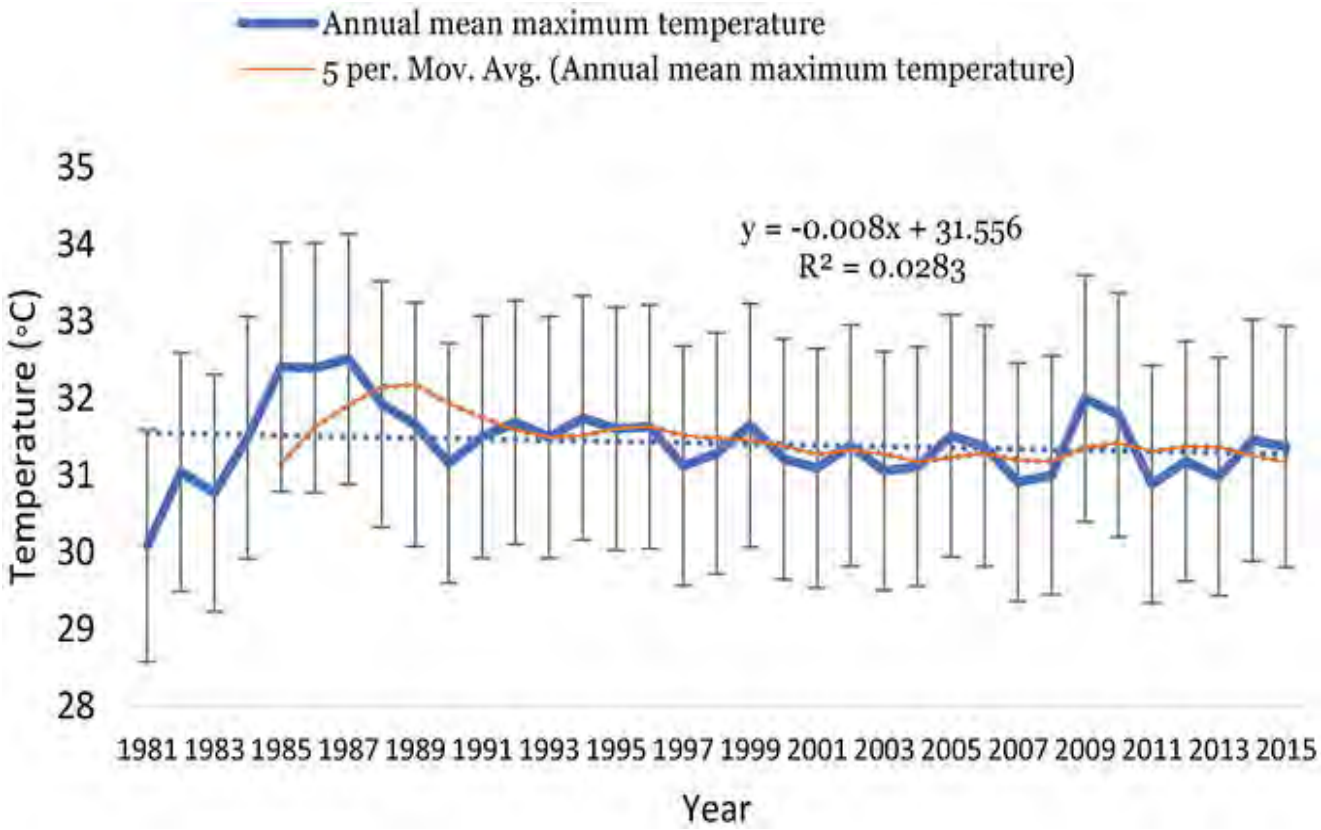


Figure-1: Annual mean maximum temperature (1981–2015)- Secondary data adopted from Bangladesh Meteorological Department (BMD) & Rabbani et al., 2021.

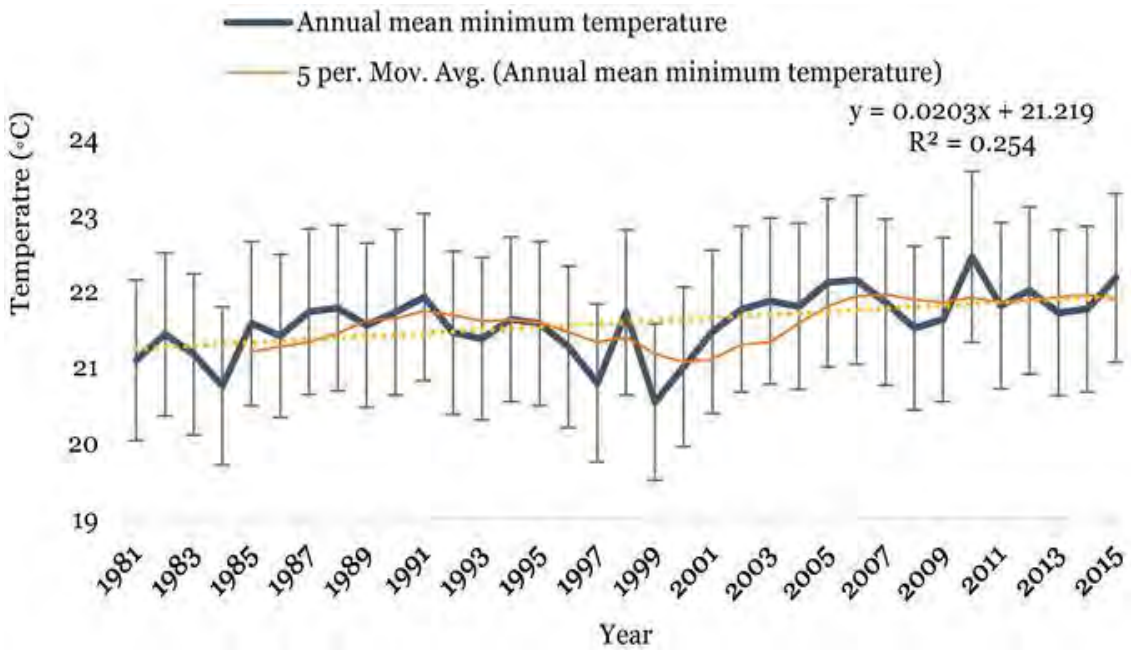


Figure-2: Annual mean minimum temperature (1981–2015)- Secondary data adopted from Bangladesh Meteorological Department (BMD) & Rabbani et al., 2021.

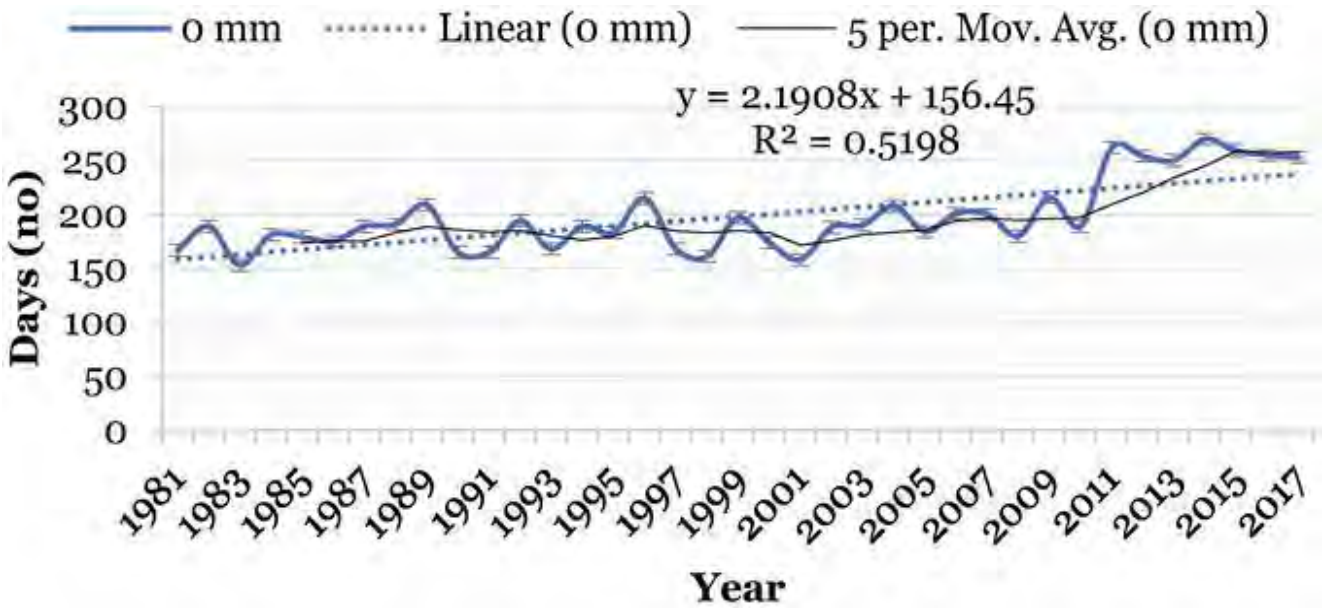


Figure-3: Trend of "no of days without rainfall" during 1981–2017 in Satkhira (Salinity intrusion and sea level rise)- Secondary data adopted from Rabbani et al., 2018.

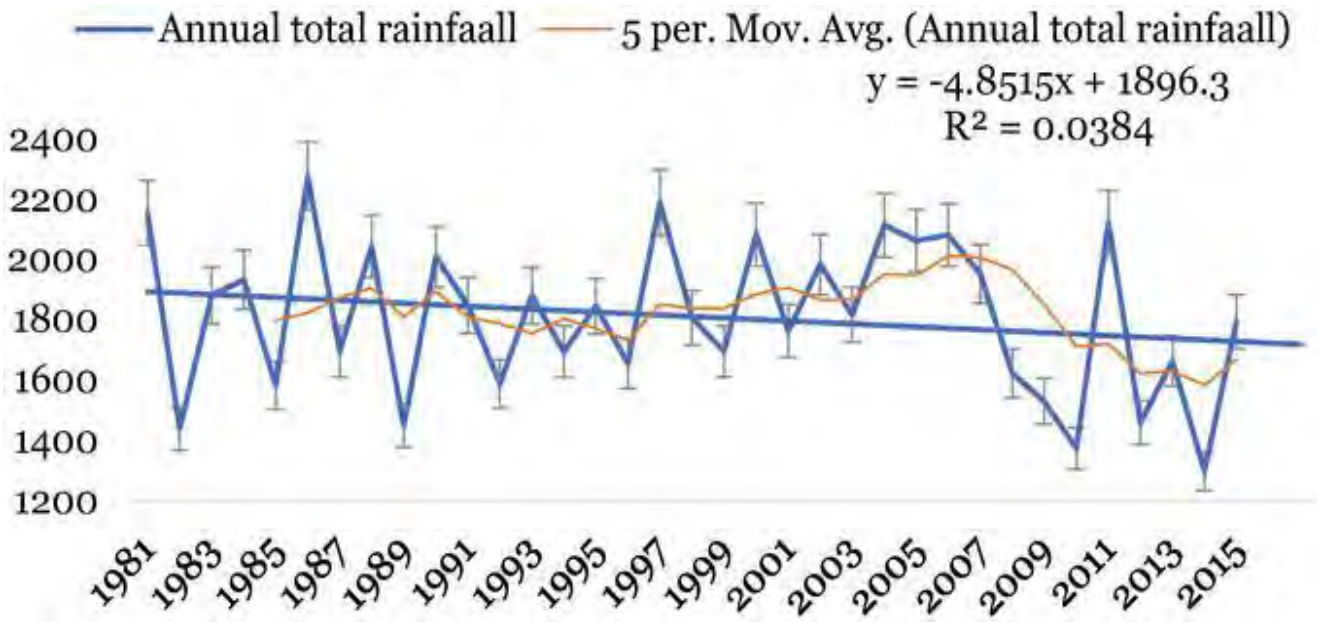


Figure-4: Annual (total) rainfall in Satkhira during 1981–2015- Secondary data adopted from Rabbani et al., 2018.

Secondary analysis wherein time-series records from Bangladesh Meteorological Department (BMD) along with research by Rabbani et al. (2021, 2018) show a clear trend of increasing temperature in the region (Figures 1, and 2), lengthening dry spells (Figure 3), and fluctuating rainfall (Figures 4). Such climatic patterns justify sufferers' experiences that climate-related hazards--cyclones, salinity intrusion, and sea level rise--are not only scientifically documented but also directly felt by local communities. Such hazards impact agriculture and livelihoods in an intertwined course.

To adapt, many farmers experimented with cultivation of new varieties of rice that are salt-tolerant. This went through well till 2009, when Cyclone Ayla struck the area, resulting in swift salinity increase in soils. Almost all the farmers in the area lost their entire crops in that year. Thereafter, the next two years were characterized by high salinity and extremely low rice yields. Between the years 2009 and 2011, the total loss of rice harvest by the four surveyed villages amounted to $1.9 million (Rabbani et al., 2013).

Picture-1: Floods due to heavy rainfall

Picture-2: Water logging

Picture-3: Infrastructure damage

Picture-4: Crop damage due to Water logging

Source: *Field data collection-2023-2024*

2.1.2 Impact of Climate Change on Agriculture

Picture-5: Impacts on Paddy field by Water logging

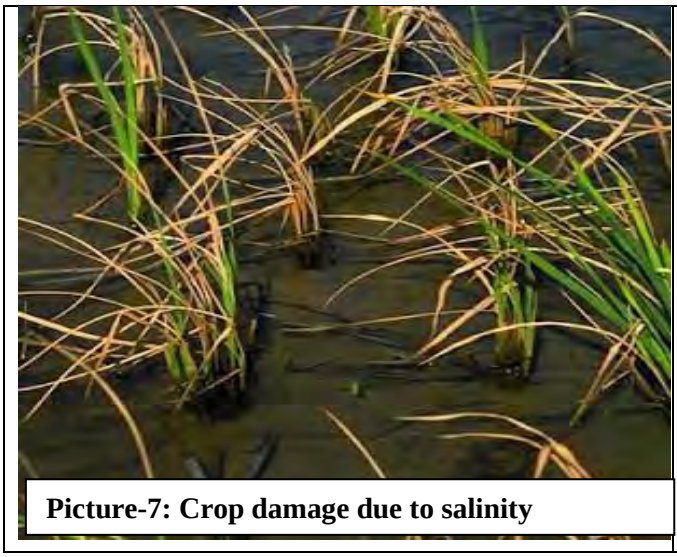
Agriculture in Satkhira is subject to different difficulties impacting the local economy and farmers. Market fluctuations, pest and disease damage, water management problems, soil salinity, and climate change effects all contribute to these losses. 62.3 percent of the people from the area have shifted their way of life as salinity has destroyed their former and customary livelihood possibilities, therefore creating alternative jobs including shrimp farming, crab fattening, and daily labor. Even in these other

possibilities, high salinity and viral infection (Rezoyana et al., 2023) still cause problems. Worldwide, food and diet security is under risk because of changing temperatures. Greenhouse gas levels in the atmosphere increase as a result of the greenhouse effect, driving temperatures higher. The world's financial standing will be significantly damaged by a 2-degree Celsius rise in average world temperature by 2100. Rising temperatures counteract this effect by affecting crop duration, weed plant, pest quantity, evapotranspiration, and crop respiration rates and evapotranspiration and risepest numbers. Rising at a terrifying velocity, the concentration of CO2—a major greenhouse gas component—has increased plant productivity and augmented photosynthesis, hence causing faster growth. Climate change shapes the enzymatic activity of microbial populations (Malhi et al., 2021).

Picture-6: Crop damage due to high salinity

2.1.2.1 Crop damage

Climate change in Shyamnagar Upazila has made the soil saltier hurting crops and making floods and cyclones more likely. Even with problems like not enough water and poor soil most farmers (86%) have started to use crop rotation and plants that can handle salt (Islam et al. 2019).



Picture-7: Crop damage due to salinity

Picture-8: Crop damage due to salinity

(***Source:*** *Field data collection-2023-2024)*

Climate change and its unpredictable nature have become a big problem for Bangladesh's growth and food supply. Even after spending a lot of money, storms, floods, and dry spells have destroyed lives and caused huge money troubles in the past 20 years. Ongoing work to fight poverty will face more problems because of climate change. To get a better understanding, we need to look at how climate change affects food supply and farming in Bangladesh using a complete all-around approach. Higher temperatures, more carbon dioxide in the air, changes in flood and drought patterns, and the expected rise in sea levels, along with other climate worries, help create a fuller picture of how farming might be affected (Yu, 2010)

2.1.2.2 Environmental Degradation

Munshiganj Union of Satkhira district is an extreme victim of environmental degradation due to climate change. The loss of balance of the natural environment in this agriculture-dependent region has threatened the livelihood and sustainable development of the farming community (Lázár, A. N et al., 2015). Soil fertility is decreasing due to saline water entering agricultural land. Due to excessive salinity, tree roots are failing to absorb nutrients and crop growth is being hampered. Due to mismanagement, rivers and canals are being filled up, causing long-term waterlogging due to rainwater accumulation. Crops on the land rot and are destroyed in the waterlogged water and farming is being disrupted (Feist et al., 2021).

As a result, the agricultural environment is gradually declining. Due to cyclones and tidal surges, saline water is entering and polluting fresh water sources. Lack of safe and clean water is simultaneously affecting agriculture, fisheries and human health (Alam et al., 2020). Due to the loss of ecological balance, the aquatic and terrestrial fauna of Munshiganj Union is under serious threat. Fish, frogs, birds and aquatic plants are disappearing, which is weakening the local ecosystem. Land use pressure, the tendency to cut trees for fuel and forest loss due to cyclones are reducing afforestation. As a result, the tendency to land erosion and natural disasters is increasing. Addressing these challenges requires integrated conservation and sustainable development efforts.

The literature referred above definitively shows that particularly in the Munshiganj Union, climate change is greatly and complicatedly influencing agriculture in Satkhira. Rising temperatures, extreme weather events, saline intrusion, changing patterns of rainfall all pose major difficulties for the neighboring countryside. The great vulnerability of coastal areas like Munshiganj underlines the need of more focused study of the impacts of climate change on indigenous crops and agricultural systems.

Climate models predict overhaul across the board, but the resiliency of local crops and farmers' adaptations methods is hardly known. Although research has missed the long-term impact on soil quality, which is vital for coastal agriculture, salinization and soil erosion are two environmental concerns threatening food production. Furthermore, too little study has been done on how several recurring extreme weather events such as cyclones, flood, and drought that disturb the agriculture of the region all together affect it. This highlights the need to know more about how over time these events might damage local agricultural systems and way of life.

2.2 Impact of Climate Change on Livelihoods

Livelihood is the means and acts through which families and people ensure the essentials of life, comprising food, water, shelter, clothes, and other necessary goods and services. Though employment or income generation defines livelihood, it also encompasses a wide range of means, tools, and capacities used by people and communities to satisfy their basic requirements and enhance their standard of love. It includes various means of earning a living for people, supporting themselves and maintaining their well-being. Livelihoods comprise activities done to support oneself and one's family. These comprise wage labor, other income-generating operations, formal employment, self-employment, entrepreneurship, farming manufacturing. Including the idea of the foundation of this paradigm, the definition given by Robert Chambers and Gordon Conway in the 1980s, which stated that livelihoods encompassed all the necessary activities, resources (social and material), and skills for survival, included the core of this theory. Sustainability means a capability to withstand and recover from stresses and strains while maintaining or expanding present and future capacity and resources without damaging the natural resource base (Carney, 1998). Sustainable livelihoods underline resilience, flexibility, and environmental equilibrium as true sustainability implies that future generations have the same access to resources and chances for a stable livelihood. This strategy forms the foundation of many current development plans since it emphasizes the need of ecological sustainability together with economic and social well-being.

2.2.1 Impact of Climate Change on Socio-economic conditions

Climate change is currently a major issue in Satkhira district. However, Shyamnagar Upazila is an important area for the development of the district. The socio-economic development of the upazila primarily depends on the performance of the agricultural sector, where small and medium industries play an important role. Over the past decade, the socio-economic status of the upazila has improved, mainly due to the growth of small and medium industries and businesses related to agricultural products (Siddiqi et al., 2020).

Shortage of cultivable land was ranked as the second most severe problem. With the growing population, cultivable land is increasingly being utilized for non-farm sectors such as housing, construction facilities, and other industrial activities in Bangladesh (Nur et al., 2005). In 1971 (after Independence), the cultivable land was 14.4 million hectares, but this has since decreased to 8.44 million hectares (Bangladesh Bureau of Statistics (BBS, 2006).

2.2.2 Impact of Climate Change on Traditional Livelihood

Since it is necessary for traditional subsistence, agriculture makes up most of the land use in Shyamnagar Upazila. It is observed, nevertheless, that physical landowners do not really engage in their property improvement. Rather, they rent it to small marginal locals and lease it to corporate farms. Hence the intensive use of the land, which leads to lower topsoil quality and general fertility. The chief crops grown in this area are turnip, potatoes, rye, oats, barley, and wheat (Siddiqui et al., 2020).By 2050, the International Panel on Climate Change stated that Bangladesh might have 17% less land and 30% less food production—which will aggravate poverty (as per climate financing for sustainable development; 2020-2021), to pose threat to seaside inhabitants (Islam et al., 2023). Still, human-made stressors and natural catastrophes (including climate change and rising sea levels) have rendered all countries very sensitive (Ahmed et al., 2022).

Bangladesh' population lives mostly in rural regions and relies mostly on agriculture for support; 70 percent. According to BBS, 2014, Bangladesh is the seventh most densely settled nation on earth. Agroforestry can therefore greatly lessen the dangers related to loss of biodiversity and effects of climate change. Above all else, meeting their fundamental requirements helps farmers to raise their quality of life (Khan et al., 2022; Paudel et al., 2022). Dey et al. (2020) and Mahmood et al. (2021a, b) suggest that local small towns benefit greatly from the harvesting of fish, crabs, and honey as well from the sales of wood, firewood, tourism, and several seasonal businesses.

The research shows that by 2020, some 3.5 million people living near Satkhira rely directly or indirectly on agriculture for these services (Islam et al., 2020; Mohiuddin. 2021). An analysis of the dependency of small villages near the Sundarbans mangrove system in Shyamnagar Upazila, Satkhira, Bangladesh, will show also their living status. A. From the Sundarbans, most of them gather small wood, honey, plants, gol leaves, and goran leaves. Cattle were only owned by 63% of people; 84% worked with non-government organizations (Azad et al., 2021).

2.2.3 Economic Impact on Livelihood due to climate change

Coastal communities in Bangladesh face increased risks for farming, fishing, and livestock due to climate change. Rising salinity levels and changes in freshwater availability are lowering yields of native plants. In coastal areas, businesses including population, fisheries, aquaculture, agriculture, and tourism are very vulnerable to natural catastrophes and climatic change. In the area, these changes are resulting in several social, financial, environmental, and physical problems (Islam, 2015).

Paddy, shrimp farming, and other crops are the major sources of revenue in Satkhira, which is mostly a rural region. Climate change affects farming techniques rather via saltwater intrusion, rising soil salinity, and cyclone and flood crop destruction. Reduced crop yields threaten food security and living standards. Human, agriculture, and shrimp farms are affected by rising sea levels, temperature changes, and ocean acidity. These changes affect the earnings of fishermen, fish farmers, and farmers; agriculture and fishery disturbances tied to climate change directly affect the employment and income sources of small towns. People's more vulnerable financial circumstances follow upon loss of employment.

Cyclones and floods make Satkhira particularly susceptible to habitat and infrastructure destruction. In Satkhira as well, increased likelihood of dehydration, malnutrition, and heat-related disorders aggravate public health by means of climate change. This stresses the health-care sector and affects overall quality of life. Consequently, farmers are using planting schedules and agricultural techniques, soil fertility, pesticide and fertilizer rotations, tree planting, mixed cropping, among other things to alleviate hunger, as well as to relieve poverty and natural disasters associated with climate change. Climate-tolerant fertilizers are being used on the soil together with the identification of climate-tolerant seeds (Batungwanayom et al., 2023). Integrated farming systems, more use of irrigation, crop diversification techniques and salt-tolerant cultivation have been embraced by Satkhira district of Bangladesh farmers.

Government and non-governmental organizations (NGOs) and farmers working in various ways help farmers along several fronts in their attempt to tackle environmental degradation and the effects of climate change. Nevertheless, several challenges including scarcity of land and water, harsh weather, poor soil quality, credit and market access problems, absence of livestock, and unawareness of adaptability exist (Abedin and Shaw, 2014).

2.2.4 Impact of Climate Change on Health

Climate change has a negative impact on coastal communities' health. Variations in the seasons may influence the incidence and spread of diseases. For example, if the rainy season begins sooner than anticipated, there may be a rise in diseases spread by mosquitoes, such as dengue fever and malaria. Flood-related contaminated water sources have led to an upsurge in waterborne illnesses like as cholera, diarrhea, and typhoid fever in Sathkhira. Additionally, heat-related ailments have increased because of rising temperatures. In a similar way, if the dry season lasts a long time, people may be forced to rely on risky water sources, which could lead to an increase in waterborne illnesses. Seasonal variations could have a severe effect on the coastal community due to a lack of adequate treatment facilities (Mollick & Tapas, 2024).

2.2.5 Impact of Climate Change on other Factors of Livelihood

Extreme climate change has made the study area highly vulnerable to income and livelihood opportunities. As a result, much of the population lives below the poverty line. The average household income of the respondents in Shyamnagar upazila was Tk 8,119.00 making it the poorest among the four upazilas. Their reliance on natural resources from the Sundarbans and nature harvesting has decreased because of climate change. Moreover, salinity has decreased yields of crops and restricted access to some locations. Recent limits on their access to the Sundarbans have worsened their financial vulnerability (Rahaman, et al., 2024).

Climate change and other factors may significantly affect livelihoods in Satkhira and similar regions. These include limited transport infrastructure, price volatility, low education levels, access to health care, malnutrition, social and gender discrimination, land fertility, and conflict and displacement. Limited transport infrastructure limits access to markets for agricultural products and handicrafts, while price fluctuations affect livelihoods. Limited job possibilities and obstacles with changing to more sustainable living activities result from low educational levels.

Productivity too suffers from health and well-being issues, lack of medical care and malnutrition, for example. Negative impact on food imports, availability, and other financial components result from climate change and severe weather, which also cause extensive food grain losses. Bangladesh has long struggled with catastrophic weather events and climate variability to reduce losses in agricultural production. Using data from 1984 to 2017, we study the impact of extreme weather events on food crop losses and food security in Bangladesh. Food supply, losses and imports as well as inflation and GDP growth rate.

Food security and variable cereal losses are negatively correlated; when imports from global food markets increase, import dependence also increases. Additionally, food losses contribute greatly to inflation. Climate change and climate-related extremes generally compromise food security across nations, thereby making especially challenging the realization of the Sustainable Development Goals, Goals 1 and 2. In consequence, one could argue that Bangladesh's food security has suffered. By the interaction of other factor with climate change economic system (Islam, et al., 2022).

2.2.6 Impact on Children's Education

Education has been severely impacted by climate change in coastal regions such as Satkhira. Dropout rates rise because of frequent natural catastrophes that destroy educational infrastructure. Following natural disasters, many students in Bangladesh's southern region drop out each year. According to the BANBEIS- 2023 report, the number of students dropping out due to recent disasters 2023 shows that the dropout rate (85.53%) has increased after natural disasters in the coastal regions of Bangladesh (BANBEIS Report, 2023). Coastal erosion causes most of them to lose their homes and property. As a result of poverty, migration, and underage marriage, many discontinue their education.

Furthermore, because most schools in these at-risk locations serve as both refuge and educational institutions, any significant natural disaster disrupts regular lessons, lowers the standard of instruction, and ultimately speeds up the dropout rate. For example, the dropout rate in Gabura Union is approximately 20%, and after the pandemic, it may increase to 30%. During emergencies, schools frequently act as shelters, endangering the continuation of education (Earth Journalism Network, 2021).

2.2.7 Role of the Sundarbans

The Sundarban Mangrove is regarded as one of the world's most abundant hotspots for biodiversity and the largest mangrove in a single tract (FAO, 2007). About 10,000 square kilometers make up its surface, with 60% (6,017 km^2) located in Bangladesh and the remaining 4,000 km^2 in India. Many people believe that the Sundarbans were the first ecosystem to be systematically managed when they were declared a reserve forest in 1869 (FAO, 2007; M. M. Islam & Shamsuddoha, 2018a). In 1992, this mangrove was designated a RAMSAR site, and in 1997, it was inducted into the UNESCO World Heritage List (UNESCO, 1997). The ecosystem's diversity is demonstrated by the fact that the mangroves are home to around 1186 known species of plants and animals (Iqbal, 2020). The Sundarban mangrove has been an important breeding and nursing ground for marine species that are globally threatened. It is also the last remaining habitat for many endangered animals, such as the Royal Bengal tiger (Panthera tigris), the endangered Gangas River dolphin (Platanista gangetica), the masked finfoot, the waterbird, and other reptile species (Iqbal, 2020; Sarker et al., 2016). For their livelihood and food security, the communities residing in the impact zone (within 20 km) of the forest boundaries mostly depend on the Sundarban forest ecosystem (M. M. Islam & Shamsuddoha, 2018b).

Additionally, it directly supports the cultural, life-supporting, and general well-being of the coastal populations. By protecting coastal habitat from cyclones and tidal surges, this Sundarban mangrove forest significantly improves the socioeconomic standing of coastal populations (Iqbal, 2020; Sarker et al., 2016). The mangrove ecosystem and its species have been severely harmed by wide-ranging climate variables such sea level rise, land area loss, storm surges caused by cyclones, water, and salinization brought on by greenhouse gas emissions. The degradation in the mangrove ecology of the Sundarbans has been attributed to enhanced global warming and climate variability (Ghosh et al., 2019). According to recent studies, sea level rise and other climate factors may be to blame for this increased cyclone intensity (Mahadevia & Vikas, 2019). Lakes, flood plains, and other lowlands become salinized and turn brackish due to increased erosion and sea level rise in Sundarban mangroves (Haque & Reza, 2017). Although the process of salinity intrusion in mangrove forests is ongoing, it has been largely impacted by increasing levels of saline intrusion, which have led to significant dysfunction of both flora and fauna. Climate change and deforestation, however, pose a threat to this natural barrier. To preserve its protective qualities and promote biodiversity, conservation initiatives are crucial.

2.2.8 Impact of the Bay of Bengal

Satkhira is experiencing coastal erosion and saline intrusion because of the Bay of Bengal's rising sea levels and increased cyclonic activity. The Sundarban mangrove now sits at an average height of around 2 meters above mean sea level, with global average sea-level rise predicted to reach 0.98 meters or more by 2100 compared to baseline (1985-2005) (Ghosh et al., 2019). Consequently, land area loss and flooding pose a threat to this special environment. Despite their ability to withstand flooding, mangrove trees may perish or become more susceptible because of frequent and prolonged flooding (Ball, 1988).

In recent years, there has been a linear decline in the Sundarban mangrove land area. For example, the total area of mangroves decreased from 11,904 km² between 1904 and 1924 to 11,663 km² by 1967. According to Dasgupta et al. (2020), the decreasing trend continued, reaching 11,506 km^2 in 2001 and 11,45 km^2 by 2015–2016. Cyclone activity has increased over the past 40 years, which has had a detrimental effect on the mangrove ecosystem. Bangladesh has seen 13 destructive tropical cyclones between 2000 and 2020, and the country bears the greatest burden of fatalities from tropical storms alone (Dasgupta et al., 2020). In addition to killing thousands of people along the coast, an increase in cyclone storms also destroys the current mangrove ecosystem. Alternative livelihood strategies are now necessary due to the degradation of agricultural land and the displacement of communities caused by these changes (The Guardian, 2024)

2.2.9 Impact on Bhobodoho Beel

Bhobodoho Beel is an important wetland in Shyamnagar Upazila of Satkhira district, which plays an important role in waterlogging and agricultural production (Roy, S. 2021). However, the impact of climate change is showing various negative effects in this region. Being a coastal district, Satkhira is facing salinity problems. This area experiences waterlogging due to inadequate drainage and embankment failures. Due to climate change, rising sea levels and cyclones are causing saltwater intrusion, which is damaging agricultural land and freshwater sources. As a result, agricultural production is decreasing, and food security is being threatened.

Salinity has led to a shortage of drinking water. This has resulted in prolonged flooding, affecting agriculture and livelihoods (Hasan, 2019). Residents are forced to collect water from far and wide. The use of unclean water has increased the incidence of water-borne diseases such as diarrhea, cholera and dysentery.

Climate change has reduced the income of farmers and fishermen, causing many to migrate to cities. The tendency of children to drop out of school and join labor has increased, which is causing social unrest. Effective water management and infrastructure improvements are needed to mitigate these impacts. Previous literature clearly shows that agriculture is a backbone of the economy in Munshiganj Union, and majority of farmers grow rice, shrimp, and produce crops. However, intervention of adverse climate conditions has substantially affected agricultural productivity in this area, putting food security and economic stability in farming households at serious risk.

Limited studies have been conducted on alternative livelihoods like small-scale enterprise development and migration, but very little attention has been given to understanding how such alternatives of livelihoods mesh with one another and with the traditional farming systems in Munshiganj. Further description of livelihood diversification strategies, including non-agricultural activities interfaced with agriculture, could unravel some invaluable information towards strengthening and establishing sustainable livelihoods.

2.3 Existing Livelihood Practices in Coastal Bangladesh

2.3.1 Existing Livelihood

Different livelihoods exist in Shyamnagar Upazila, such as agricultural crop production, rice cultivation, jute cultivation, vegetable cultivation, aquaculture, salt-tolerant plants. (Shawkhatuzamman et al., 2023). Besides, Satkhira, Bangladesh, offers loads of livelihoods such as rice cultivation, greens, fish farming, livestock rearing, honey collection, wood and wooden extraction, pottery and cottage industries. The vicinity's proximity to the mangrove forests of the Sundarbans provides employment possibilities. However, the impact of weather exchange poses demanding situations for sustainable improvement. Agro forestry complements farmers' livelihoods by way of imparting crucial resources, reducing biodiversity loss, and mitigating the results of climate trade (Khan et al., 2022, Paudel et al., 2022). The neighborhood populace appreciably blesses from the production of fish, crabs, honey, timber, gas timber materials, tourism, and seasonal corporations (Dey et al., 2020, Mahmood et al., 2021a, b). About 3.5 million humans in Satkhira and the coast depend on the Sundarbans and agriculture for their essential needs (Azad et al., 2021 and Mohiuddin, 2021).

2.3.2 Impact of Existing Livelihood

Existing livelihood impacts on climate change include agricultural productivity, flood risk, soil degradation, crop yields, adaptation strategies, resilience building, greenhouse gas emissions, sustainable agriculture, resource management, erosion control, water management, drought prevention, economic vulnerability, environmental stress, biodiversity loss, and climate resilient crops (Malhi, et al., 2021). In coastal areas of Satkhira, saline water intrudes, affecting crop yield and performance. Changes in rainfall disrupt agricultural cycles, leading to crop failure and loss of income. Cyclones cause extensive crop damage, while ocean temperatures and acidity affect fish populations. Increased salinity affects shrimp farming, leading to alternative livelihoods and migration to urban areas.

Climate-related events also increase health risks, including water-borne diseases and malnutrition. Munshiganj Union of Satkhira district is facing significant coastal problems like cyclones, flood, inundation, saltwater intrusion (Abedin et al., 2014). These factors force disadvantaged coastal communities to relocate. Additionally, social, economic, political, and shock forces shift coastal populations. However, locals have developed a variety of adaptive strategies to meet their livelihood needs, including harvesting rainwater, growing different types of rice, and creating organic vegetable gardens (Ashrafuzzaman, 2023).

Aquaculture, Plantation, Agro forestry, and Medicinal Plants. Besides raising livestock and various food crops, they are trying to diversify their sources of income by collecting fish, trees and firewood. (Islam et al., 2023). Most farmers are adapting their rice, fish, and vegetable farming practices in response to climate change as they struggle with ever-increasing temperatures and erratic rainfall. More than 80% of the farmers are engaged in subsistence work in various shifts including various types of agricultural work. The main adaptation strategies farmers are using include crop diversification, improved fertilizers and forestation (Batungwanayo et al., 2023).

Traditional knowledge and practices in climate change adaptation have been little known in coastal Bangladesh, including Munshiganj Union in Satkhira District. While indigenous knowledge has always been critical to natural resource management, more research is needed to understand shifting or integrating customs into contemporary climate adaptation plans.

Additionally, communities are reliant on marine resources-fisheries, for example-face their struggles overfishing, salinization, and degradation of ecosystems among others, yet little is known about how such groups are tackling such challenges in pursuit of livelihoods.

More so, scant is known about the ways in which community networks and social capital may enhance resilience to climate change. Gaining insight into how local groups band together, managing livelihoods by sharing resources, may yield important insights into climate adaptation. How livelihood practices and skills are transmitted from generation to generation and how climate change might interfere with this process, resulting in the loss of critical knowledge for environmental adaptation, is also poorly studied. Policies need to be implemented and further tailored to the needs of people in coastal communities, especially the traditional dependents, for enhanced resilience to climate change and, therefore, to build effective adaptation frameworks.

2.4 Alternative Livelihood Options for Coastal Communities

2.4.1 Alternative Livelihood

Bangladesh's Satkhira district offers alternative livelihoods such as aquaculture, shrimp farming, integrated farming systems, eco-friendly handicrafts, mangrove-based livelihoods, cattle ranching, and micro-enterprises. For household's dependent on informal livelihoods, crop agriculture is the main source of income (87%) Additional sources of income include fishing (63%), fish and crab farming (48%), agricultural labour (3.7%), non-agricultural labour (34%), cattle rearing (33%), poultry farming (36%), rickshaw or van pulling (23%), small business (10%) and boating (7%) respectively.

Agriculture is the primary source of income for the residents of Shyamnagar Upazila. Non-agricultural labor, industry, trade, transportation and communication, services, construction, religious services, rent, and remittances are additional sources of revenue (Siddiqui et al., 2020). The principal crops include rice, jute, wheat, potatoes, mustard, sesame, linseed, lemons, and vegetables. Some local rice types, such Talmugur and Patnai rice, are nearly extinct. Fish, poultry, and hatcheries are shipped to various regions and even overseas. Woodworking, weaving, needlework, bamboo work, goldsmithing, ironwork, and ceramics are examples of cottage businesses. Rice, jute, and shrimp are the principal export goods. The largest mangrove forest, the Sundarbans, is one of the natural resources.

The upazila is also home to a variety of plants and animals (Rashid et al., 2023 and Ali, 2016). Smallholder farmers in developing countries provide a direct source of income for an estimated 2.6 billion people. Unfortunately, these farmers enjoy issues of unexpected vulnerability, together with crop failure and food or economic instability (Fan Rue., 2020).

Farmers in the coastal Shyamnagar sub-district of Bangladesh are already adopting numerous alternative farming practices such as animal husbandry, cage aquaculture, mixed farming, keora nurseries, grass developing and crab fattening to adapt to the converting weather (Abedin et al., 2014). The have a look at exhibits that three.5 million human beings in Satkhira and Upakulai, Bangladesh, rely on Sundarbans and agriculture for crucial services, with sixty-three% proudly owning cattle and eighty-four% worried in NGOs (Islam et al., 2020, Mohiuddin, 2021, Azad et al., 2021).

2.4.1.1 Livestock

Climate change has posed numerous ramifications such as increasing freshwater scarcity and disease that has crippled the poultry and livestock industry. Cattle in saline regions are at greater risk of malnourishment because of the water and forage deficiency. Bangladesh is suffering from biodiversity loss due to the discontinuation of local fish species owing to harsh climatic conditions. The expansion of saline regions due to increased cyclones has negatively impacted the livestock and fisheries sector because of the rapid increase in diseases due to a lack of forage. Some freshwater fish species such as the native Rohu, which are prominent in the Indo-Bangladesh waterways are facing extinction (Rezoyana et al., 2023).

Recently, Bangladesh has faced multiple natural disasters that have led to a significant reduction in the population of cattle. The death of cattle is the result of extensive drowning during surges of cyclonic storms in Bangladesh. Floods have a multitude of direct and indirect means of leading to the demise of livestock, and the aftermath of a cyclone can drastically increase the potential for cattle deaths.

Picture-9: Poultry farming

Picture-10: Livestock

Picture-11: Duck Farming

Alternative Livelihoods (livestock and poultry farming (***Source:*** *Field data collection-2023-2024)*

There are consequences of droughts on livestock too, but they do not pose a direct threat. Droughts reduce the availability of water and elevate temperatures which lead to a greater risk of disease for livestock. Sadly, the shots of cold the region does have do not guarantee an elimination or decrease in the growth of deadly diseases. Sadly, the cattle population is predicted to face a drastic rise in risk, forcing them to overcome natural disasters. While cyclones and droughts may not seem powerful enough to single handedly ruin the cattle economy of Bangladesh, the potential issue they bring along with climate change makes them a potential reason for its destruction (Ahmed, 2006; GoB, 2005).

In conclusion, these changes will negatively alter diverse ecosystems and put livestock agriculture at risk. It is crucial to take action on livestock farming as it leads to increased amounts of gases such as methane, due to the adaptation of their farming techniques into more industrial ones. There are multiple potential means to reduce emissions such as promoting more green pastures alongside nature preservation.

2.4.1.2 Fisheries

The vulnerability of the fisheries sector within the economy, diet, and social structure of Bangladesh makes that sector sensitive to climate change. Different scenarios such as sea-level rise as well as changes in soil and water salinity may lead to the collapse of freshwater aquaculture, shrimp cultivation, and the Sundarbans- the largest mangrove forest in the world and could lead to the extinction of marine fish as well as considerable economic damages (Islam et al, 2024). Bangladesh is one of the most sensitive countries to climate change due to its geographical location.

Bangladesh is the primary area affected by climate-induced disasters, which have become more frequent there. Many natural disasters including landslides, cyclones, low pressures, coastal floods, storms and rainfall have occurred in the present study. These disasters occur more frequently at a marked rate. According to the survey, there is continuous land erosion. Direct intrusion of tidal water into the mainland is causing salt intrusion and reducing productivity. The coastal area is very important for fishing, but as the fishing season is changing and there are not enough alternative income-generating activities (AIGAs), individuals are forced to look for alternative sources of income, both short and long term (Islam et al., 2018).

Picture-12: Crab farming

Picture-13: Shrimp farming

Alternative profession -Crab farming and Fisheries (***Source:*** *Field data collection-2023-2024)*

Most income sources of local people in the Munshiganj Union, within the district of Satkhira, are reliant on rural and coastal ecosystems. Traditionally, small-scale enterprise fishing and aquaculture or farming is the major income source for people here. Climate change continues to threaten these livelihoods through rising sea levels, erratic weather patterns, and salinity intrusion. Limited studies have investigated the barriers to adopting alternative livelihoods such as aquaculture, ecotourism, or renewable energy.

Picture-14: Crab farming

Picture-15: Fisheries

Alternative profession -Crab farming and Fisheries (***Source:*** *Field data collection-2023-2024)*

These options are often presented as viable remedies for the disruptions caused by climate change, but their acceptance may be impeded by a few institutional, cultural, and economic considerations. Appreciation of these barriers is essential to formulate feasible livelihood diversification strategies. Moreover, very little is known about the economic viability of the alternative livelihoods in terms of costs, income, and challenges in market accessibility for coastal communities when adopting those alternatives. Further research is thus recommended to bridge this gap in knowledge to assure long-term sustainability and resilience in communities, looking at how these options can effectively be integrated into existing livelihoods.

2.5 Institutional Responses and Policy Frameworks

Climate-induced disasters pose a serious threat to coastal communities in Bangladesh. Various research prove that technology innovation and adaptation are critical in reducing vulnerability and enhancing preparedness. Programs like the Hurricane Preparedness Program help in the evacuation of the most vulnerable communities, while microfinance organizations provide loans and credits for repairing and reconstructing homes. The Cyclone Preparedness Program (CPP) and Microfinance Institutions (MFIs) support the evacuation and reconstruction of vulnerable communities. Local institutions enhance climate risk reduction through livelihood strategies, credit services, and knowledge sharing. The study calls for an integrated approach in the framework of sustainable development and integration of innovation and adaptation technologies. Local institutions enhance climate risk reduction through livelihood strategies, credit services, and knowledge sharing. Policy recommendations emphasize a comprehensive framework for coastal community resilience and the integration of innovation and adaptation technologies for sustainable development (Khan, 2024).

Picture-16: Salt-tolerant rice Cultivation

Picture-17: Cultivation of Salt-tolerant rice

2.5.1 National and International initiatives in Agriculture and Livelihood

According to the impacts of climate change, specifically salinity intrusion, on households sustained through informal livelihoods in the coastal Satkhira district of southwest Bangladesh. A total of 27 percent of households were forced to change their livelihoods to effectively plant salinity and drought resistant crops. In fact, more than half of public and private organizations have been satisfied with recent adaptation initiatives (Fahim, T. C., & Arefin, S. 2024).

2.5.1.1 Rice cultivation

In the coastal regions of Bangladesh, rice seedlings have been greatly affected by both temperature and rising humidity due to climate change. A systematic literature review showed 61% negative effects and 18% positive effects in studies. The study also found a long-term cumulative negative effect with a positive relationship between temperature and humidity on rice yield over 38 years. The study suggests that better adaptation strategies are needed for sustainable rice production, including training farmers on changing climate parameters, using climate information services and adopting climate-smart rice production (Mousumi et al., 2024).

A study conducted in Bangladesh showed that integrated nutrient management (INM) can reduce soil salinity, increase rice yield and reduce global warming potential (GWP) without harming yield. The study also showed that BRRI Paddy 67, a salinity-tolerant variety, significantly increased rice yield by 52% compared to BRRI Paddy 88. In addition, urea deep placement reduced GWP without harming yield. The study also showed that BRRI Dhan67 significantly reduced yield-scaled CH4 emissions by 22% compared to BRRI Dhan88. These results suggest that selecting salt-tolerant rice varieties and implementing appropriate fertilizer management practices can increase economic profitability, ensure food security, and mitigate the adverse effects of climate change on coastal saline soils (Islam, et al., 2024).

2.5.1.2 Maize and sunflower cultivation

Maize and sunflower production is an integral part of the global agricultural system and plays an important role in food security, economic development and ecological sustainability. Variability in precipitation, waterlogging and natural hazards have posed to be spectators to this noticeable challenge of intensifying cropping systems in the coastal alluvial soil of Bangladesh. Heavy rainfall occurred 18-23% of the years under study, producing water logging and crop damage, apart from rice. The return interval of heavy rainfall from November to December is 1.3-1.4 years and 1.5-2.5 years, respectively. Such incidents delayed the establishment of crops other than rice and reduced sunflower and maize yields by 50–64% and sweet melon and watermelon yield by 55–84%.

Adaptation methods for sunflowers include breeding, crop management and modifying the sowing areas. Further north, this will offer new opportunities for cultivation, which also tend to promote a cereal-based cropping system. For this reason, sunflowers will also take part in the mitigation solutions as minor emitters of greenhouse gases. Sunflowers' growth in the future may depend upon adaptation, competition and calling upon profit for food and energy (Debaeke et al., 2017). The report predicts that climate change in the southeast region will affect Bulgarian agriculture, crop yields and the structure of the region's economy from 2020-2050. Impact of climate change on wheat, barley, maize and sunflower yields, especially in the south-eastern region of Bulgaria (Branzova, 2015).

2.5.1.3 Vegetable cultivation

Vegetable cultivation is central to world agriculture in the provision of essential elements to humans, affecting food security. However, climate change challenges indicate a need for sustainable practices that balance food production with conservation of the environment. With the world population growing to six billion by the year 2050, hunger and malnutrition are set to increase. Vegetables are the basic toolbox to feed and provide livelihood security to these people who might face hunger.

Picture-18: Vegetable cultivation

Picture-19: Vegetable cultivation

Picture-20: Vegetable cultivation

Picture-21: Vegetable cultivation

Vegetable cultivation as alternative profession (***Source:*** *Field data collection-2023-2024)*

Nevertheless, climate change could impose unprecedented stress on vegetables and may lead to serious crop failure. Factors such as high temperature, limited soil moisture and increasing water availability could limit productivity and consumer acceptance. Climate change also adversely affects soil fertility, pests, diseases and pollinator behavior. All this could result in reduced production and productivity leading to possible food stock imbalances. Hence, understanding the impact of climate change on vegetable cultivation could be crucial for timely interventions (Ayyogari, 2014).

2.5.1.4 Betel leaf cultivation

Betel cultivation can have both positive and negative impacts on climate change. On one hand, betel nut trees are known to have high carbon sequestration capacity, which means they can absorb and store carbon dioxide from the atmosphere. It can help mitigate climate change by reducing greenhouse gas emissions and increasing carbon sinks (Ullah et al., 2020).

The study investigates the impact of betel nut cultivation on livelihood and income enhancement in Rajshahi district of Bangladesh. The results show that continuous production of betel leaf ensures minimum income for the farmers and 77% of the farmers believe that betel nut production has improved their standard of living. Major issues include inadequate capital, market risk, production risk, institutional risk, human risk and financial risk (Mahfuza et al., 2023).

The rising rate and intensification of climate change pose causes of serious concern for farming communities across the world. The impacts of climate change in Bangladesh are not hidden; the consequences are evident in the livelihoods and agricultural productivity of farmers. In this context, this case study focused on the farming community of Munshiganj Union, Satkhira District, to show alternative sources of income for the people distressed by climate change. More specifically, the available literature on the impacts of climate change on farming communities provides a big picture with the emphasis on commonly perceived challenges of the agricultural sector in general. Very few studies have investigated Munshiganj Union in particular, which would constitute one gap in knowledge concerning this community's potential and threats.

2.5.1.5. Citrus Cultivation

Bangladesh's citrus farming has been impacted by climate fluctuation. Citrus fruit export potential expanded dramatically with the creation of the World Trade Organization and the globalization of global trade. Citrus growers thus had to contend with heightened competition on the global market. Due to the growing demand for lemons, it is important to understand how climate change is affecting lemon productivity and the present production methods (Dutta et al., 2023). Farmers in the eastern areas have seen more precipitation and temperature swings, which have resulted in problems like pest infestations and lower harvests. Although there is no evidence specifically about Satkhira, the region's citrus growing may be affected similarly by similar meteorological conditions.

The geographical, socio-economic, and environmental conditions of Munshiganj Union are unique and require a tailored approach in assessing the impacts of climate change on livelihoods and finding viable alternative livelihood options. Among the important issues often ignored in research is the gender-specific impact of climate change on livelihoods. The proof that women are highly vulnerable within agriculture to climate change exists because most food insecurity and economic instability rest upon them.

Little research is carried out that can clearly explain how the impacts of climate have affected women's responsibilities, resources, and decision-making in agriculture. Understanding gender relations within all these contexts will be indispensable to achieve truly inclusive and successful livelihood initiatives. The objective of this research paper is thus to contribute toward the resilience and economic stability of the farming community in Munshiganj Union, Satkhira District, through assessment and identification of sustainable alternative livelihood options, focusing on specific vulnerabilities created by climate change and different needs of men and women.

2.6 Policy Framework

The constraints and opportunities for climate change were combined within the framework of the Bangladesh Climate Change Strategy and Action Plan 2009 into ongoing development plans for economic and social development. The updated plan has 11 thematic areas with dedicated programs for short-, medium-, and long-term objectives: 52 in total. Bangladesh operates, in all the sectors-fisheries, aquaculture, urban areas, ecosystems, wetlands, biodiversity, and capacity development-to prepare against the climate change risks with its National Adaptation Plan covering 2023-2050. The evaluation conducted of the BCCSAP 2009 was limited to eight projects relating to food security, social protection, and health.

A cyclone preparedness program has set up a certain scheme aimed at loss of life and property in the coastal towns by providing with early warning, evacuations, shelters, and first aid by volunteers. In three aspects, the BCCSAP objectives progressed: capacity-building at the government level, community-based adaptation, and the early warning about cyclones, storm surges, and floods.

The community response was quite positive, with about an 88% rating of high relevance and effectiveness. There were 23 working projects covering climate change impacts implemented from 2010 to 2019. Three projects were evaluated-forward-looking projects on basic climate change effects related to food security-implemented by the BARI, BINA, and BSMRAU agencies between September 2010 and June 2019. Even if the focus of the projects was on implementation, they were successful in achieving considerable progress toward the development of innovative cropping patterns and addressing food security and livelihood issues.

Large-scale policies targeting the impacts of climate change are underlined by the development of alternative livelihoods for communities vulnerable to climate change in some areas, such as Munshiganj Union, Satkhira district. In continued partnership with NGOs and international partners, the Government of Bangladesh also pursues a common line of policies aimed at resilience-building and sustainable livelihoods necessary for the protection of vulnerable communities from climate-induced risks.

2.6.1 Bangladesh Climate Change Strategy and Action Plan (BCCSAP) 2009

The BCCSAP-Following closure, a key national strategy that outlines Bangladesh's response to climate change, with an emphasis on adaptation and resilience, has come to show six areas of ultimate importance:

Food Security and Social Protection-Support alternative, climate-resilient livelihood development with a focus on salination-resistant crop production, aquaculture, and livestock management.

Disaster Risk Management-Will ensure coastal communities have one step ahead with early warning systems, community disaster preparedness plans, and the establishment of infrastructure like cyclone shelters to minimize the impact of several natural disasters.

Research and Knowledge Management-Support innovation aimed at agriculture and fisheries: this intends to include the introduction of new technologies, seed varieties, and management practices that will ensure the future-facing conditions of climate change.

In Munshiganj Union, this BCCSAP framework encourages salinity-tolerant crops, brackish water aquaculture, and the addition of drought-resistant livestock to build community resilience. Under BCCSAP projects initiated by local communities give emphasis to safe drinking water, food security, and social protection for poor cases.

2.6.2. National Adaptation Plan (NAP) 2023-2050

The NAP, a long-term strategic plan now under development, follows recommendations from the United Nations Framework Convention on Climate Change (UNFCCC). It aims to create a unique all-encompassing process for climate adaptation. The plan will focus on improving the ability of local communities to adapt to climate change near the coast. Its main goals include:

Building resilient livelihoods: Promoting diverse income sources through climate-smart farming, fish farming, and activities that add value (such as eco-friendly tourism and jobs in clean energy).

Getting communities involved and taking charge: Making sure local areas like Munshiganj have a say in decisions leading to more ownership of adaptation plans and solutions that fit each place.

Helping people learn new skills: Offering training and education to farmers and fishers about other ways to make a living how to manage money, and how to stay safe during disasters.

The NAP is working to spot and fix problems that make it hard to adapt, like not having clean water, good seeds, animals that don't get sick, and enough money.

2.6.3. National Agriculture Policy (2018)

To improve food security and ensure long-term agricultural practices in the face of climate change, the policy stresses climate-smart agriculture. This will be accomplished for the Munshiganj region:

Encouragement to cultivate drought and salinity-tolerant crops: Help farmers adapt to rising salinity levels by developing crop varieties that can withstand both water scarcity and salinity.

Agro-ecological zoning allows farmers to select the best appropriate crops and livestock for their ever-changing environment using agro-ecological parameters.

2.6.4. National Fisheries Policy 1998

The National Fisheries Policy aims to improve the productivity and sustainability of Bangladesh's fishing industry. The policy promotes the following in coastal areas like Munshiganj; **Support for brackish water aquaculture:** Promotes the development of shrimp, crab, and prawn farming as an alternative to traditional freshwater fishing, which is becoming increasingly endangered owing to saltwater intrusion.

Sustainable fisheries practices: Promotes the development of sustainable fishing practices that protect the marine environment while increasing revenue.

2.6.5. Non-Governmental Organizations (NGOs) and Donor-Led Initiatives

NGOs and foreign partners have played a supportive role in augmenting government efforts by taking initiatives focused on livelihood diversification and climate resilience. Typically, these groups focus on the following:

Livelihood diversification programs include small-scale enterprises, training and resources for aquaculture and poultry farming, and other alternative sources of income.

Financial services and microcredit are available to support coastal communities to invest in climate-resilient livelihood options.

Community-Based Adaptation (CBA) initiatives: Encouraging local participation in adaptation initiatives to ensure solutions meet the unique needs of communities.

2.6.6. Delta Plan 2100

The Bangladesh Delta Plan 2100 is an intersection of water resource management practices with climate change mitigation alongside targeting sustainable development in the long run towards achieving an optimum level of water management especially in coastal and delta regions. It stands out with three prongs: climate resiliency, poverty alleviation, and sustainable economic growth.

Improved water resource management: Targeting water scarcity and salinity-related issues for sustainable farming and aquaculture and ensuring proper fodder for livestock rearing.

Sustainable economic opportunities: Encouraging investments into climate-resilient industries through fisheries and renewable energy that will help them adapt to the existing environmental conditions along the coast.

*2.6.*7. Bangladesh's Nationally Determined Contribution (NDC) commitments:

Sectoral Mitigation Targets:

Achieve a 5% reduction (12 million tons) in greenhouse gas (GHG) emissions by 2030 compared to the Business-as-Usual (BAU) scenario.

With international support, aim for an extra 10% conditional reduction (24 million tons).

The focus sectors are energy, industrial processes and product use (IPPU), agriculture, forestry, and other land use (AFOLU), and waste.

NDC Implementation Roadmap and Action Plan:

Strengthen the 2018 implementation plan to guarantee clear processes and timetables for meeting GHG reduction targets.

Implement sector-specific policies in line with IPCC principles, including emerging sectors that contribute to emissions.

International Financial Support:

Obtain 175 billion USD by 2030 to fully undertake mitigation efforts under the NDC. International financing options: GCF and other climate adaptation funds with bilateral/multilateral partnerships.

Low Carbon and Climate Resilient Economy:

Low carbon brings development together with economic growth and resilience. Align the mitigation activities to Bangladesh's aspirations of being a middle-income country with per capita emissions average preferred by the poorer counties.

Create or Verify More Progressive Monitoring and Reporting:

Devise providing itself with the MRV facilities to function to account for itself and declare emission reductions as fulfillment of its NDCs. Secure transparently and accountable submission of reports to the UNFCCC. Integrate NDC commitments into national policies such as BCCSAP, Five-Year Plans, and NAP. Enhance community engagement and awareness by including local communities, businesses, and stakeholders in climate mitigation measures. Encourage green jobs and economic prospects through low-carbon projects.

2.6.8. Environmental Policies – Climate Change Environment Policy:

Bangladesh Environment Protection Act, 1995 implementation strategies for coastal and climate-sensitive areas like Munshiganj Union:

Bangladesh's Environment Conservation Act of 1995 aims to safeguard the environment through pollution control and conservation measures. Despite this, enforcement challenges persist, and environmental degradation continues, highlighting the need for stronger policy implementation and community engagement.

Protection of environmental balance:

Coastal areas like Munshiganj Union are facing environmental damage due to climate change and natural disasters. According to the Bangladesh Environment Protection Act, 1995, it is possible to create a legal system to control pollution and protect natural resources in this area. Under the law, local governments and the Department of Environment can conduct Environmental Impact Assessment (EIA), which will reduce environmental damage in the process.

Declaration of Controlled Areas:

This law allows coastal areas to be declared as "controlled areas". As a result, it will be mandatory to take environmental aspects into account in the process of new industries or constructive development in risky areas like Munshiganj Union, which is helpful in protecting the environment.

Environmental Clearance:

The law has made it mandatory for any development project to obtain an environmental clearance. An Environmental Impact Assessment (EIA) should be conducted before establishing an agricultural, fishing or tourism industry in Munshiganj Union, so that the harmful impact of the project on the environment can be reduced.

Pollution Control:

The Bangladesh Environment Protection Act, 1995 provides a specific framework for pollution control. Agriculture and fish farming are being affected due to water, air, and soil pollution in Munshiganj Union. Under this act, it is possible to control pollution by determining the level of pollution, such as preventing water pollution, reducing salinity, etc.

Sustainable Use of Natural Resources:

The law can focus on the sustainable use of natural resources such as forests, soil, water, etc. It is possible to ensure the protection and improved use of natural resources by conserving rainwater, mangrove afforestation, and practicing organic agriculture in Munshiganj Union.

Raising Public Awareness:

The law is important for raising environmental awareness. Awareness can be created among the local people and farmers about the impact of the law on the environment and proper environmental management methods. It will be possible to launch community training and programs for environmental conservation.

Penalties for Violation of the Law:

Under the Environmental Protection Act, there are prescribed penalties for pollution or destruction of the environment. If environmental damage occurs in any area of Munshiganj Union, legal action can be taken, which will enable strong measures to be taken to protect the environment. Thus, the Bangladesh Environmental Protection Act, 1995 can serve as a strong legal basis to protect the environment and ensure sustainable development in coastal and climate-sensitive areas like Munshiganj Union.

2.6.9. Nature-Based Community Solutions

Nature-based solutions, such as mangrove restoration and sustainable agriculture, offer promising avenues for climate adaptation. In Satkhira, initiatives like community-based afforestation and eco-friendly farming practices have been implemented to enhance resilience and provide alternative livelihoods (UNDP, 2022).

Farmers and the public of Munshiganj Union are at extreme risk due to climate change and natural disasters. Nature-based social solutions to address this crisis not only restore the environment, but also ensure livelihood, health and social stability.

Firstly, mangrove afforestation and planting various local trees in coastal areas is an effective initiative. Trees like Golpata, Keora, Goran etc. reduce the speed of storm surges and prevent land erosion and maintain balance in the ecosystem. Taking initiatives for social afforestation along rivers and canals with the involvement of local people makes it possible to protect the environment and conserve biodiversity simultaneously.

Secondly, waterlogging can be reduced, and irrigation facilities can be ensured by re-excavating canals and ponds. Currently, many agricultural lands are submerged in monsoon water for a long time, resulting in crop damage. Re-excavating canals and ponds can provide additional water drainage and ensure a source of water for agriculture during the dry season. It is also helpful in local fish farming.

Thirdly, the practice of organic farming and the use of salt-tolerant crops pave the way for sustainable development of agriculture. Chemical fertilizers and pesticides degrade soil and water quality.

The use of organic fertilizers, composting and vermi compost production among farmers will increase the fertility of the land. In addition, farmers can adapt to climate change by cultivating salt-tolerant rice or vegetables.

Fourthly, integrated farming is a cost-effective and profitable method. Cultivating fish in ponds, raising poultry on the banks and cultivating vegetables on the same land creates multiple sources of income and meets nutritional needs. This is especially suitable for small and marginal farmers who want to earn more income from limited land.

Fifthly, rainwater harvesting is an important method to eliminate the shortage of potable water in coastal areas. Due to increased salinity, tube well water often becomes unusable. Rainwater can be collected from rooftops, schools, or community centers and used for drinking, cooking, and agriculture.

Sixth, eco-friendly house construction methods are particularly useful for people living in storm-prone areas. Sustainable houses can be built locally using bamboo, mud, straw, jute, etc., which are environmentally friendly and cost-effective. If the houses are built on high platforms, they can protect them from damage caused by storm surges or floods.

Finally, community participation is the most important factor in implementing nature-based solutions. Raising awareness by involving local people, especially women and youth, can increase the effectiveness of project implementation. Through community clubs, public hearings, and integrated planning, people can take the lead in their own problems and solutions, which ensure sustainable adaptation in the long term.

The policy framework in Bangladesh combines government-led policies, including the BCCSAP, NAP, and Coastal Zone Policy, with NGO activities to strengthen resilience and provide alternative livelihood options to climate victims, especially farming communities in the Munshiganj Union. These policies aim to guarantee the protection of livelihoods of vulnerable populations through climate-smart agriculture, sustainable fisheries, and alternative income-generating opportunities.

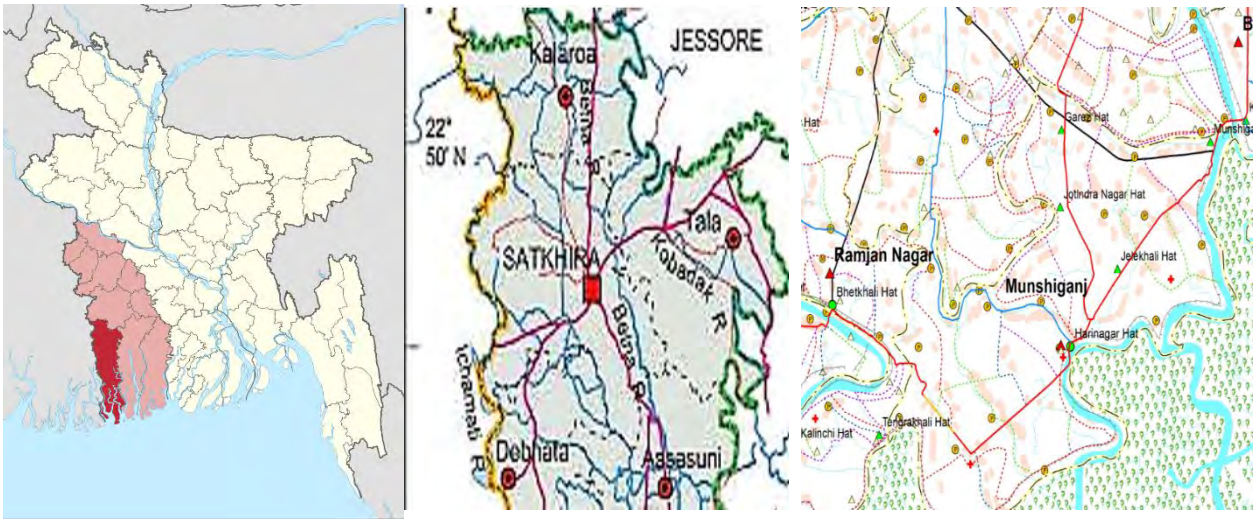
CHAPTER THREE

Methodology

Climate change increasing challenges rural communities reliant on agriculture, disrupting traditional livelihoods and deepening socio-economic vulnerabilities. This methodological introduction outlines a framework for exploring alternative livelihood options for farmer's communities in Munshiganj Union, Satkhira District, Bangladesh, grappling with climate change's adverse effects.

3.1 Study design: The study employed both quantitative and qualitative research methods, triangulating data from semi-structured questionnaires, Key Informant Interviews (KII), Focus Group Discussions (FGDs), and case studies. This mixed-methods approach allowed for a comprehensive understanding of the challenges and opportunities related to alternative livelihood options for farmer communities who were the victims of climate change in Munshiganj Union of Satkhira districts.

3.2 Study area: The study was conducted in Munshiganj Union, Satkhira District, focusing on areas such as Harinagar (Study area-1), Garaze Bazar (Study area-2), Kultoli (Study area-3), Jelekhali (Study area-4), Kodomtola (Study area-5), Kachukhali (Study area-6) and Dhankhali (Study area-7) respectively. These areas are highly vulnerable to salinity intrusion and flooding and are home to farming communities facing significant livelihood challenges.



Sources: Wikipedia, Weather spark & LGED District map

3.3 Population of the Study: The populations of this study were farmers, local community leaders, government officers, NGO representatives, traders, buyers and sellers of agricultural products, financial institutions, environment and climate experts, local traders, local entrepreneurs, agronomists and journalists who are directly engaged with or knowledgeable about the community's livelihood challenges.

3.4 Sample size: The moderate sample size of 104 allows for detailed community examination and manageable data collection. The sample size of 104 was determined considering the scope, timeframe, and logistical feasibility of the research from seven distinct areas to reflect variation in livelihood options for climate victims in this region.

3.5 Sample size determination:

The sample size was determined by using the following formula:

n= z2pq/d2

Were,

n= desired sample size

z = 1.96 (95% confidence interval)

p = Prevalence = 0.50 (unknown prevalence)

q = 1-p

d = 0.1 (10% margin of error to get a smaller sample due to constraints)

n = (1.96)2 (0.50) (0.50) / (0.1)2

= 0.96040.01≈96 + 08% non-response= 103.8≈ 104 = about 104

A total of 104 sample respondents will be selected from the study area.

SN	Study Location	Sample Size
1.	Harinagar	14
2.	Garaze Bazar	16
3.	Kultoli	14
4.	Jelekhali	14
5.	Kodomtola	14
6.	Kachukhali	16
7.	Dhankhali	16
	Total in Sample	**104**

3.6 Sampling Technique: A convenient sampling technique was used to reach the target sample. Convenience sampling was employed due to the logistical challenges of accessing remote areas and the availability of respondents during the fieldwork period. This sampling technique allowed for the inclusion of farmers directly affected by climate-induced livelihood changes, ensuring that the study captured a wide spectrum of perspectives.

3.7 Selection of Sample: All targeted respondents will have been covered as a random sample (104 respondents) in face-to-face interviews under the comprehensive questionnaire survey.

3.8 Modality of Data Collection Instruments:

To get a comprehensive picture of climate-induced livelihood changes and alternative livelihood options of farmer community of Munshiganj Union at Satkhira districts, four data collection methods such as semi-structured questionnaire survey and Key Informant Interviews (KII), FGDS and Case studies were adopted:

3.9 Semi-structured questionnaire: An essential use of semi-structured interview schedules in fieldwork is to cross-check key-informant and FGD data. The semi-structured questionnaire included sections on demographic data, livelihood changes, and perceptions of climate change. In this study, semi-structured interviews were primarily used to collect qualitative insights such as perceptions, narratives, and contextual livelihood barriers. A total of 104 semi-structured questionnaire surveys were conducted with farmers, local community leaders, government officers, NGO representatives, traders, buyers and sellers of agricultural products, financial institutions, environment and climate experts, local traders, local entrepreneurs, agronomists, and journalists who have a clear understanding of alternative livelihood options for climate victims within the farming community.

Before the questionnaire was fully implemented, a pilot test was conducted with a small sample to ensure its validity. The feedback from the pilot respondents helped improve the relevance and clarity of the questions. Experts in the fields of alternative livelihoods and climate change were also consulted to assess the validity of the questionnaire content and ensure that it was aligned with the research objectives. Through this approach, it was ensured that the data collected was accurate and reflected the key research issues.

	Data Collection Method	Total No	Target Respondents
	Semi-structured questionnaire	104	Farmers
	Key Informant Interview (KII)	13	Farmers, Local Community Leaders, Government Officials, and NGO Representatives
	Focused Group Discussions (FGDs)	FGDs-1-(10 Participants of Harinagar)	Farmers, Traders, Local Community Leaders, Government Officials, and NGO Representatives
		FGDs-2- (12 Participants of Garaze Bazar)	
		FGDs-3- (14 Participants of Kultoli)	
		FGDs-4- (12 Participants of Kachukhali)	
		FGDs-5- (10 Participants of Dhankhali)	
	Case Study	10	Farmers

3.10 Key Informant Interview (KII): Generally, key informants who were directly engaged with or knowledgeable about the community's livelihood challenges were selected. A total of 13 Key Informant Interviews (KII) were conducted with farmers, local community leaders, government officials, and NGO representatives, respectively.

3.11 Focused Group Discussions (FGD): Five (05) Focused Group Discussion sessions were conducted in the field to substantiate the quantitative analysis findings and gain greater insight into the climate victims of the farmer's community of Munshiganj Union of Satkhira District. FGDs were designed to encourage open discussion on community-wide challenges and solutions. Five FGDs were conducted, involving 10 to 12 participants for each FGD. A total of 5 FGDs were held with groups of farmers, traders, local community leaders, government officials, and NGO representatives, to ensure the voices of each group of study.

3.12 Case Study: A total of 10 case studies were conducted with local farmers who have experienced climate-related hardships and have already transitioned to alternative livelihood strategies. Case studies of local farmers provided in-depth insights into the challenges and coping strategies adopted by climate-affected individuals.

3.13 Data analysis: After discussion of the FGDs, KIIs, and tape-recorded cassettes–all have been carefully examined, edited, and transcribed. The data computations were done by anthropoid sub-program under specified classification and categorized format for qualitative thematic analysis by N-Vivo Software. Quantitative data collected using the KOBO-TOOLBOX survey software on various related issues of the respondents were analyzed using the latest version of SPSS (IBM version 25) with basic statistical methods.

3.14 Data Triangulation: Data triangulation was used to cross-validate findings from different data sources. Survey results were compared with insights from FGDs and KIIs to ensure consistency and reliability. For instance, quantitative data on income changes were compared with qualitative data from FGDs that explored perceptions of livelihood vulnerability, ensuring a more comprehensive understanding of the community's challenges. In this study, triangulation was used to combine qualitative insights from focus group discussions (FGDs) and key informant interviews (KIIs) with quantitative data from household surveys. This strategy enabled researchers to validate and complement quantitative findings with detailed qualitative insights, resulting in a more complete understanding of the factors driving alternative adoption. These qualitative factors were then cross-checked with survey data that defined these barriers, such as a question about whether financial constraints or lack of information were important barriers to adoption.

3.15 Technical approaches to 'Quality Control: The preservation of data quality was upheld through rigorous checking and cross-checking procedures executed by the core researchers. The quality controllers conducted on-site visits and employed mobile phones to inspect questionnaires and data, thereby guaranteeing the credibility and quality of the data.

3.16 Consent from the Participants and Ethical Issues: Before conducting interviews and focus group discussions (FGDs), informed consent was obtained from all participants. The data collection processes were carried out in Bengali, the native language of the participants. Permission was granted by the participants to record the interviews and FGDs on audio tape. To protect the privacy of the informants, pseudonyms were utilized.

CHAPTER FOUR

Findings

The study examines adaptive resilience of farming communities of Munshiganj Union in the district of Satkhira, against diversifying livelihood practices, primarily to accommodate climate change thinking. Thereby, it illustrates both the resourcefulness of these communities and their inability to afford the new practices from shifting traditional agriculture into aquaculture and livestock production. With support from NGOs, government programs, and community-based adaptation initiatives, small-scale entrepreneurship is expanding, opening new economic opportunities. However, this progress is balanced by challenges such as dependence on external funding and resources, cultural barriers limiting women's full participation, and ongoing pressures from environmental and economic instability. This information explores the communities' struggle to achieve sustainable livelihoods while adapting to climate impacts, balancing resilience with vulnerability.

4.1: Quantitative findings

Table-4.1.1: Socio-demographic status of the respondent

Variables	**N=104**	**%**
Age of the respondent		
>=67	1	1.0
17-26	7	6.7
27-36	31	29.8
37-46	41	39.4
47-56	23	22.1
57-66	1	1.0
Gender		
Men	82	78.8
Woman	22	21.2
Number of earners in the household		
Less than 2 persons	27	26.0
2 - 3 person	74	71.2
More than 4	3	2.9
Educational qualification		
Illiterate	27	26.0

Primary	41	39.4
Secondary	19	18.3
High school	10	9.6
Graduate	6	5.8
Postgraduate	1	1.0
Religion		
Muslim	53	51.0
Hindu	51	49.0
Marital condition		
Unmarried	7	6.7
Married	95	91.3
Widow	2	1.9

Table-4.1.1 stated the detailed information regarding different demographic characteristics of respondents. The majority of respondents (39.4%) belonged to the age group of 37-46 years, followed by 27-36 years (29.8%). In the context of gender, majority of the respondents were male (78.8%), aged 37-46 years (39.4%), and most of them educational qualification was primary education (39.4%). Most of the households had 2-3 earners (71.2%) and most of them were Muslim (51%). Marital status indicated that the majority were married (91.3%), with minimal representation of single (6.7%) and widowed individuals (1.9%). These results suggest a population with balanced religious representation and a predominance of male respondents who are predominantly middle-aged, married and moderately educated.

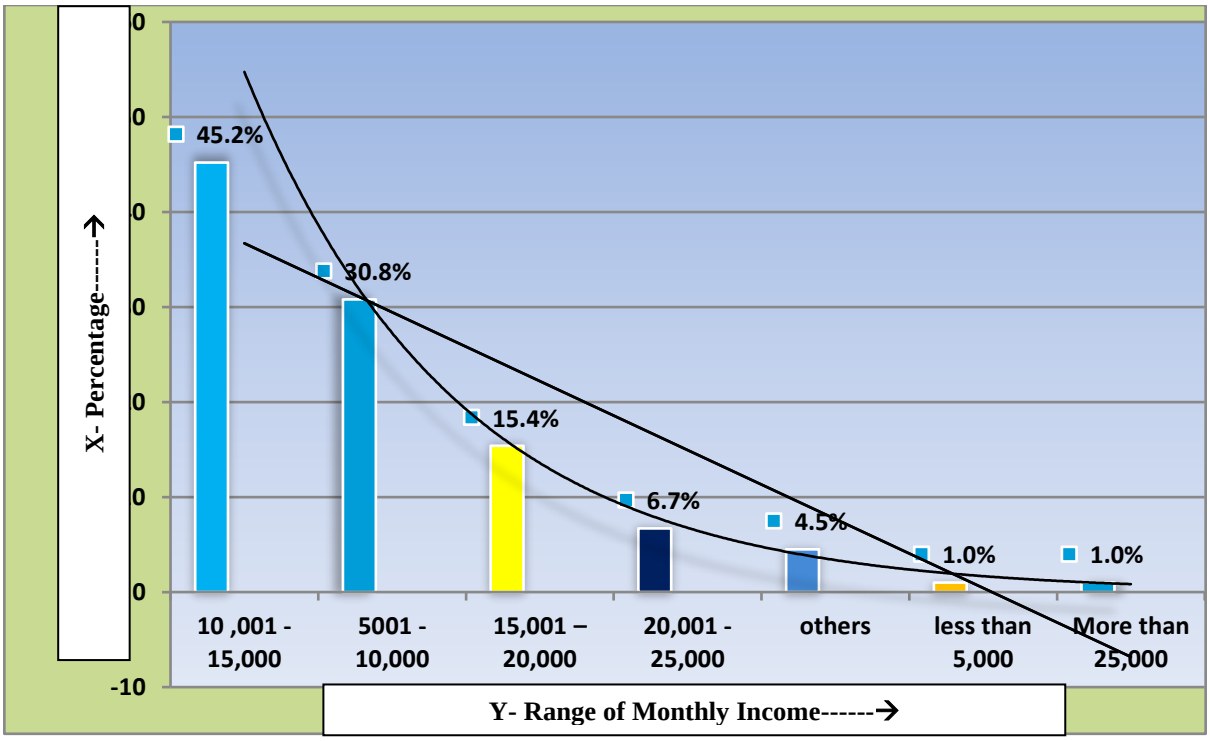


Figure-5: Status of Family Monthly Income

Figure 5 illustrates the range of family income monthly for the respondents. The data reveals that the greatest portion of households (45.2%) monthly income range between 10,001 to 15,000 BDT. A smaller proportion of families (15.4%) monthly income between 15,001 and 20,000 BDT in a month, 6.7% of them between 20,001 and 25,000 BDT. Most of the respondents stated that lower monthly income restricts their ability to dedicate resources to adaptation measures such as diversifying their livelihood, adopting smart climate agriculture which all seem to be needed more as the effects of climate change continue to worsen. Their adaptative abilities and available resources are inadequate leading to substantial exposure to climate risks which subsequently renders them as being financially unstable. Such a scenario not only has implications to their present welfare but largely limits the scope of investment into viable means of earnings in the future. As a result, many of these households remain in a poverty and vulnerability cycle with limited means of developing resilience against climate change shocks.

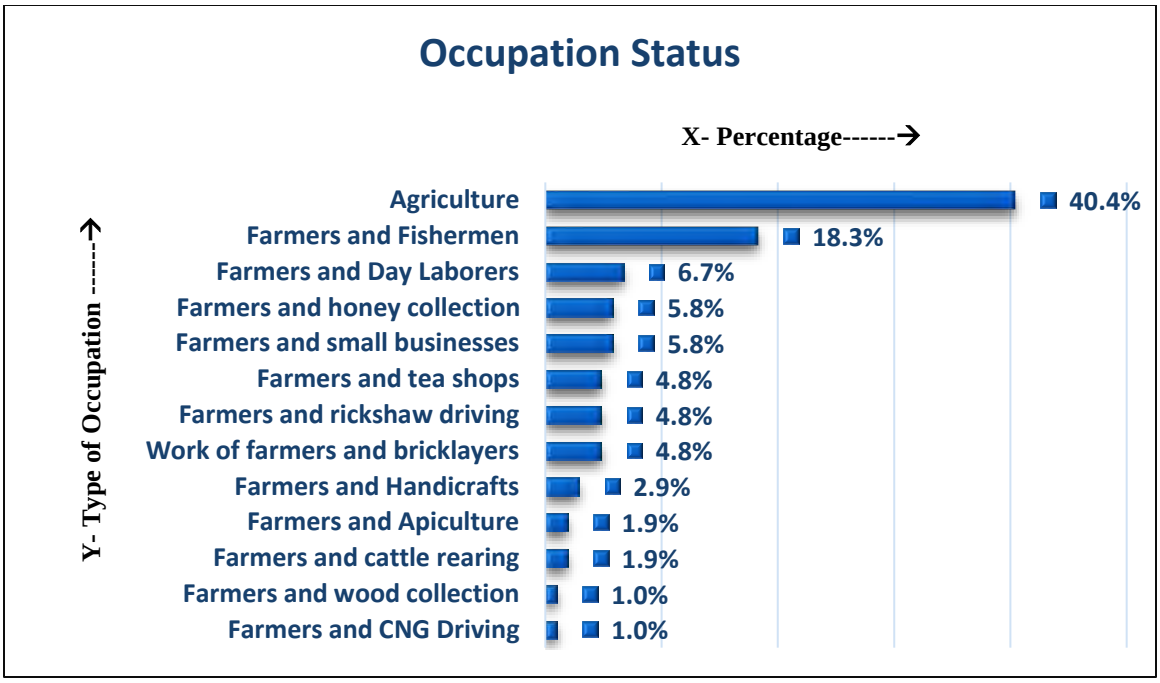


Figure-6: Occupation Status of the respondents

According to figure-6, the data shows that respondents are engaged in various occupations with majority of them in agricultural related activities. Exact two-fifth (40.4%) of the respondents are involved in agricultural work. Besides, 18.3% of the respondents are farming plus dipping in fishing, which shows the complement to these rural livelihoods. Figure also shows other combinations of occupations that were represented in smaller numbers. For example, 6.7% of the respondents are day labor, 5.8% are farming plus small business or honey collection.

Other smaller but significant proportions of the respondents are farming plus bricklaying (4.8%), rickshaw driving (4.8%), or running tea shops (4.8%). Other rare combinations are farming plus handicrafts (2.9%), cattle rearing (1.9%), apiculture (1.9%), wood collection (1.0%), and CNG driving (1.0%). This shows the multi-dimensional dependence of the respondents' sources of income and how the rural people are adaptable in achieving successful livelihoods through diversified occupation.

(Multiple Respond Counted)

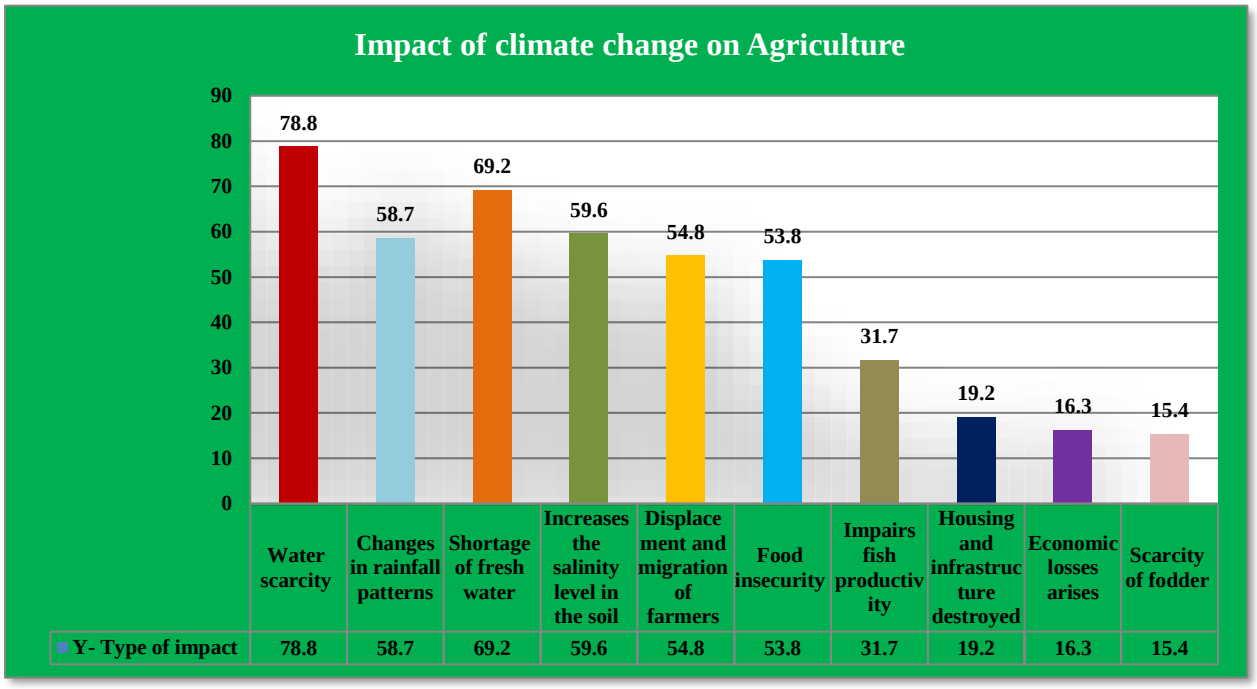


Figure-7: Impact of climate change on Agriculture

Figure 7 portrays some challenges associated with climate change in agriculture. Majority of the respondents (78.8%) illustrated that water scarcity emerged as the leading concern, impacting agriculture. Besides, according to their perception, limited freshwater available for irrigation (69.2%), and changing patterns in rainfall (58.7%) and the increase of salinity in soil (59.6%) which both affect crop sustainability and soil health. Socio-economic problems are also prominent whereas 54.8% of these farmers reported displacement/migration and 53.8% reported food insecurity, which shows that climate change impacts the means of living and food availability. Impaired fish productivity (31.7%) provides an indication of the potentially far-reaching implications for aquaculture, while thatching grass/timber and damage to farmers' crops (23.1 and 19.2% respectively) together highlight broader environmental and economic consequences. Further down but still important are economic losses (16.3%) and scarcity of fodder (15.4%). This finding revealed that climate change exerts considerable strain on water resources, soil health and farm outputs with consequent broad-based impacts across sectors.

Variable	Level	N	%
Increases pest and disease pressure			
	Yes	42	40.4
Scarcity of frees water occurs			
	Yes	52	50.0
Losing soil fertility			
	Yes	48	46.2
Soil nutrients decrease			
	Yes	24	23.1
Crop's damage			
	Yes	24	23.1
Water scarcity and irrigation challenges			
	Yes	70	67.3

Table-4.1.2: Impact of climate change on agriculture productivity

Table 4.1.2 data revealed the type of effects on the environment and agriculture negatively due to climate change. Major issue prevalent on these areas was water scarcity and irrigation problems experienced by 67.3% of respondents; this indicates a critical challenge for sustainable agriculture. Another challenge pointed out by 58.7% of respondents was a shift in the rainfall pattern, which significantly disrupts the natural water cycle necessary for crop growth. Again, freshwater scarcity, which affects 50.0% of respondents, worsens the maintenance of an even agricultural production system.

Another serious point of concern is soil degradation: loss of soil fertility was reported by 46.2% of respondents, and 23.1% reported decreased soil nutrients, both of which are very necessary for healthy crop yields. Moreover, increased pest and disease pressures leading to higher crop losses and low yields were reported by 40.4% of respondents. These clearly indicate that climate change challenges widely the agriculture itself; affecting the water resource availability, the soil health, and the pest control, productivity and resilience of rural livelihoods are thereby threatened.

(Multiple Respond Counted)

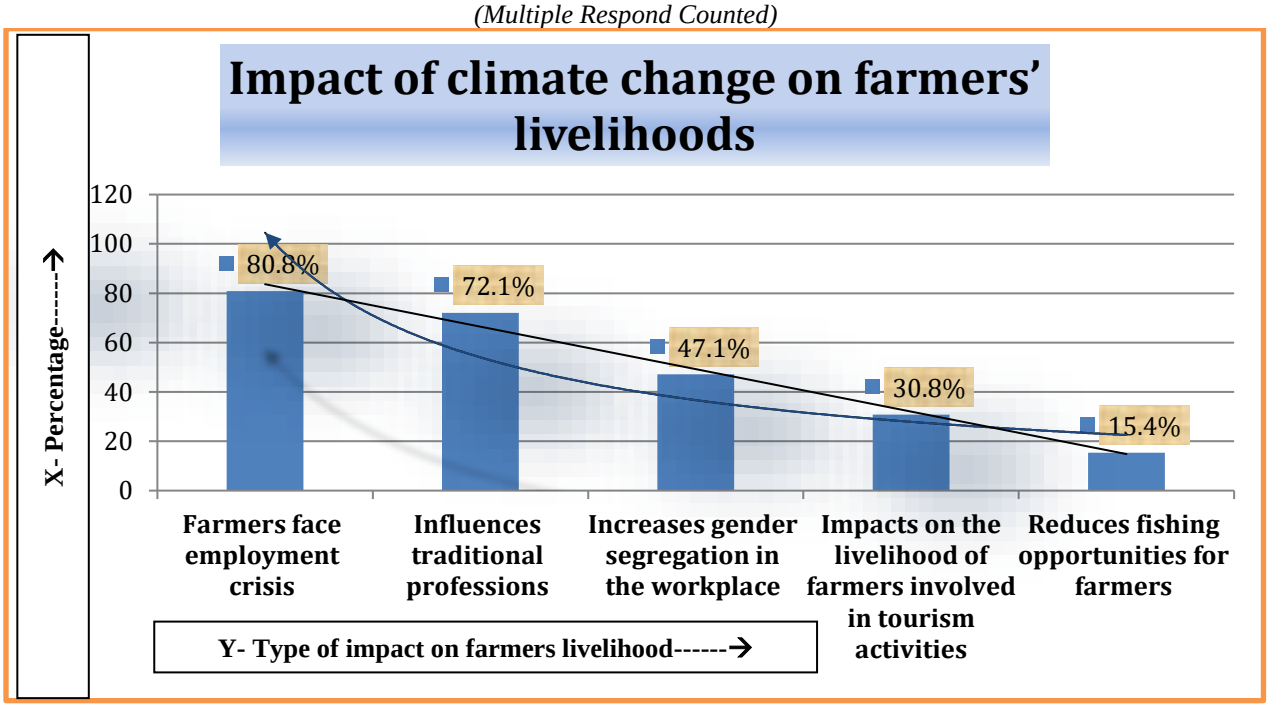
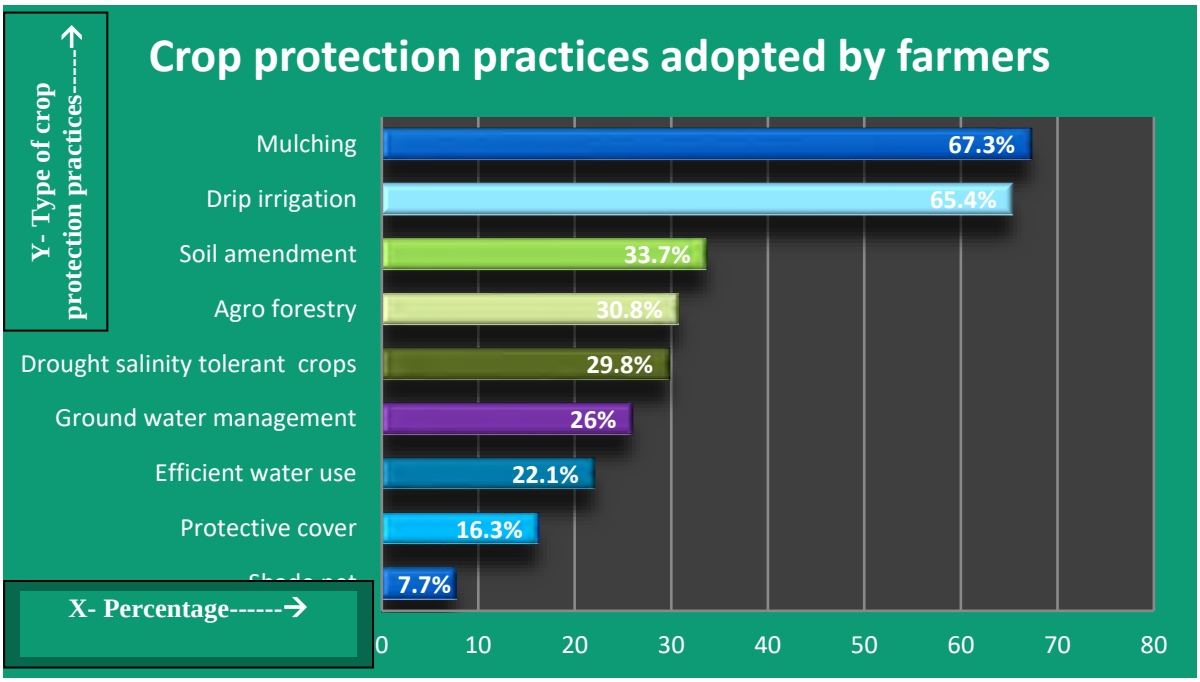


Figure-8: Impact of climate change on farmers' livelihoods

Figure-8 provides an overview of the perceptions on impact of climate change on different traditional professions and employment. Most of the respondents (72.1%) perceived that climate change affects traditional professions in general. Besides, (80.8%) respondents perceived that farmers encounter employment problems due to climate change. Close to half of the respondents (47.1%) perceived increase in gender disparities because of climate change impacts with changes occurring through gender segregation at workplace. Nearly one-thirds of the respondents (30.8%) were aware that livelihoods of farmers involved in tourism business are negatively affected by climate change impacts and (15.4%) respondents thought that climate change reduces opportunities for fishing occupation among farmers.



(Multiple Respond Counted)

Figure-9: Crop protection practices adopted by farmers due to climate change

Figure 9 illustrated the farmers' crop protection strategies in reaction to climate change. According to data, it has been observed that various adaptation strategies to save their crops such as drip irrigation (65.4%) and mulching (67.3%), the two most popular methods, both aims to preserve soil moisture and increase water efficiency. The use of soil amendment, which improves soil quality and crop resilience, is used by 33.7% of farmers, followed by agroforestry (30.8%) and crops that can withstand drought and salinity (29.8%). Besides, more than one-fifths (26%) of farmers manage their groundwater, and 22.1% utilize efficient water usage techniques, demonstrating attempts to combat water scarcity. Two less popular methods for shielding crops from bad weather are shade netting (7.7%) and protective covers (16.3%). According to the figure, it identified that farmers are prioritizing water efficiency, moisture retention, and climate and soil resilience.

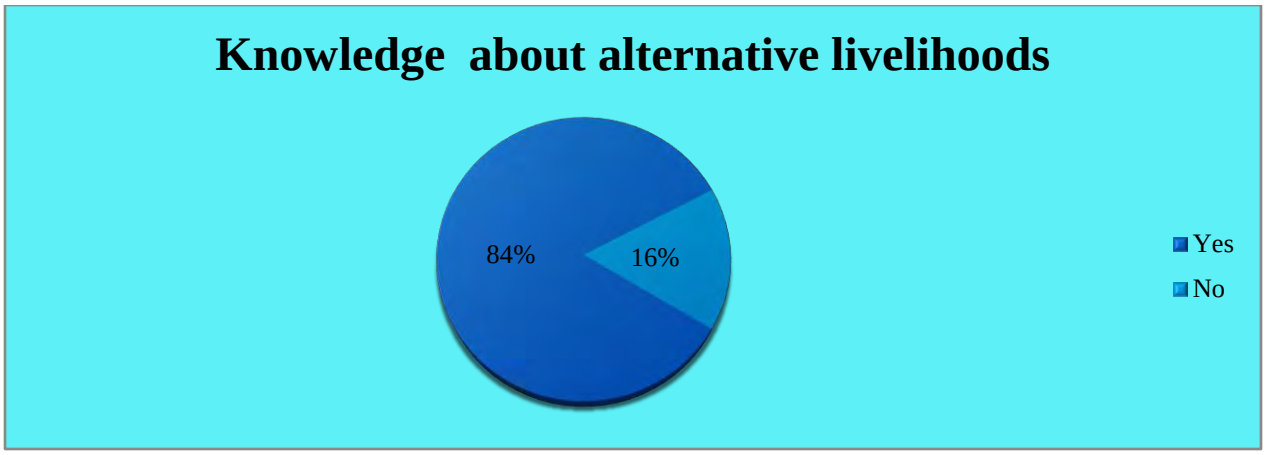


Figure-10: Knowledge about alternative livelihoods

According to the Status of knowledge about alternative livelihoods, figure 10 depicts that, the vast majority (83.7%) of respondents are contemplating or have considered alternative livelihoods, suggesting a strong desire to diversify either income or job sources. On the contrary, 16.3% of the respondents have neither considered nor explored alternative livelihoods, which implies a minimal proportion that either prefers their current situation or is facing barriers while looking for alternatives.

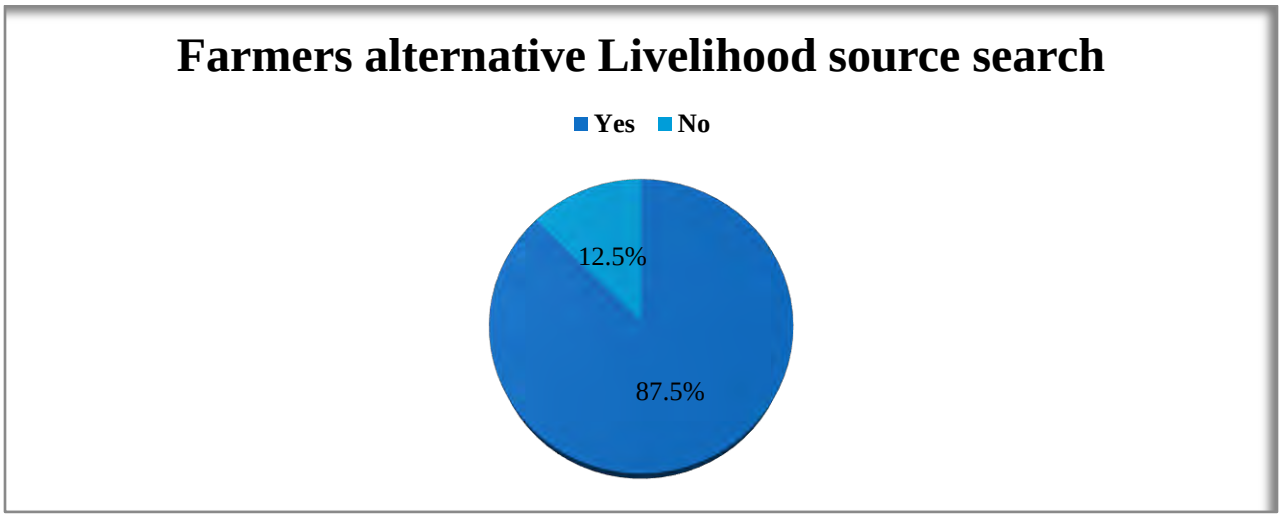
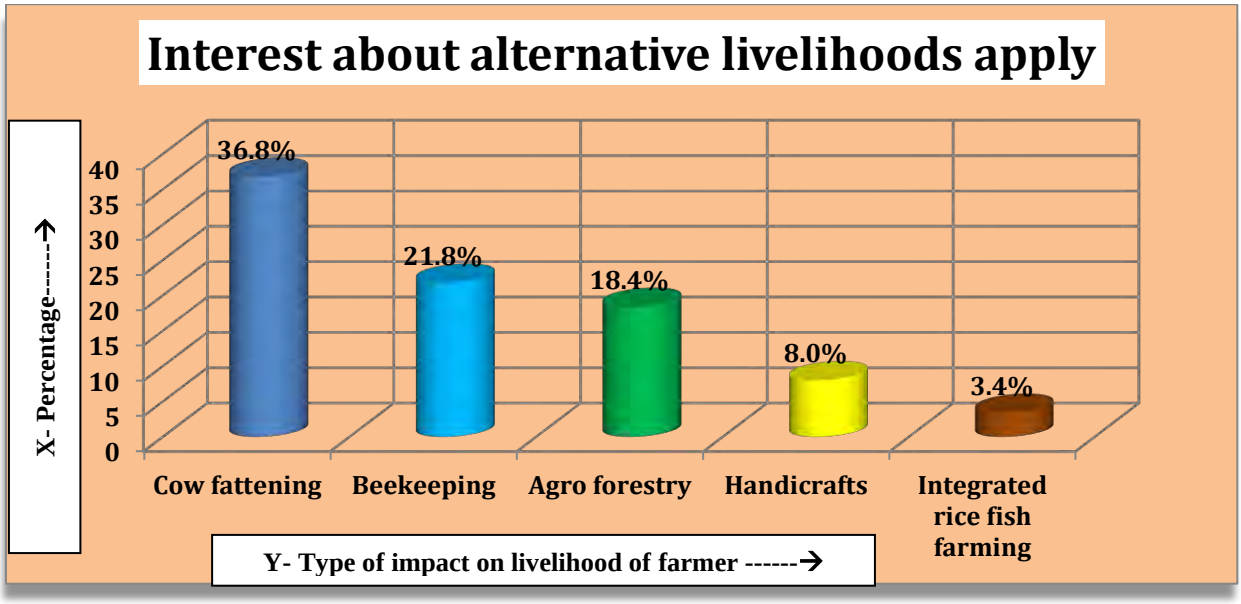


Figure-11: alternative livelihood the source search among farmers

According to the farmers' awareness and understanding of the sources of alternative livelihoods, figure 11 stated that a significant majority of respondents (87.5%) were aware about alternate sources of income. This finding illustrated that majority of the farmers were aware of their alternative livelihood options and actively use or consider other sources of income.

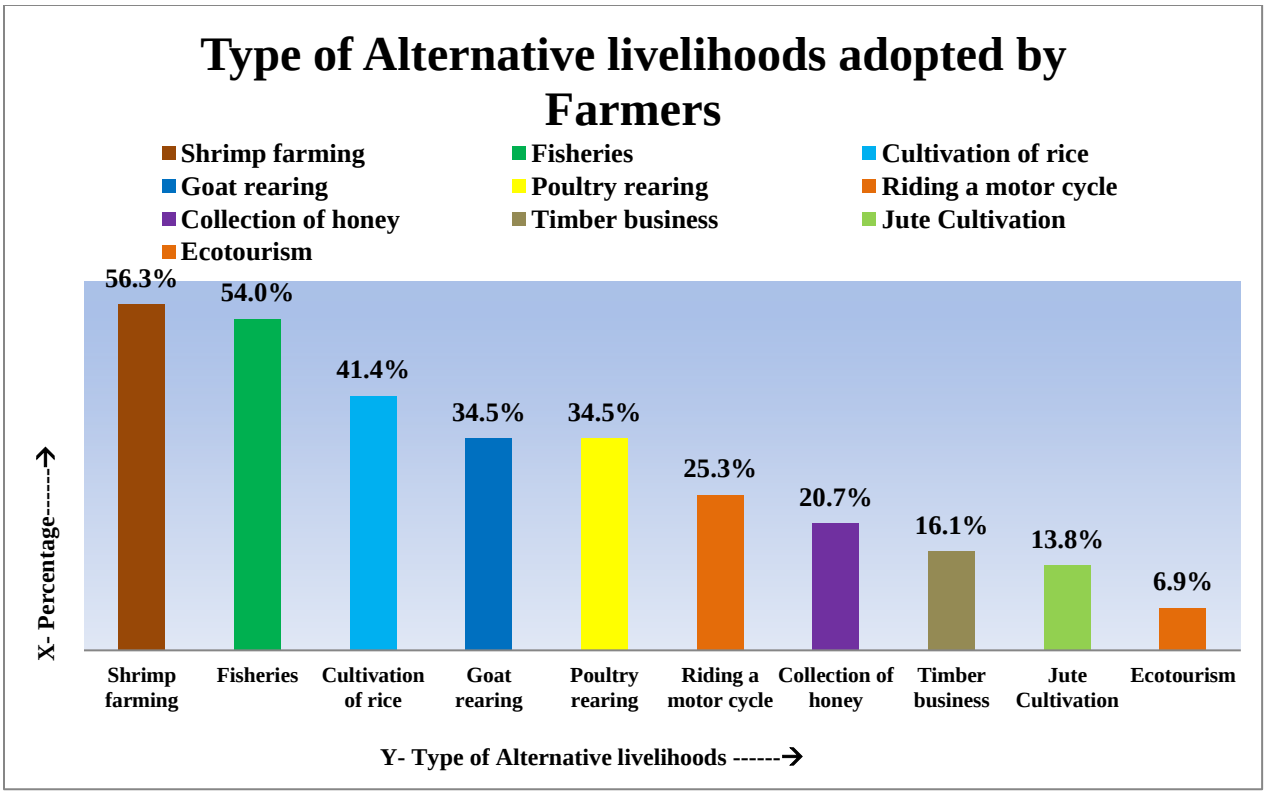
In contrast, 12.5% of those respondents are unaware of any other sources of income. The findings highlight the capacity to adjust to shifting environmental conditions may be hampered by this minority's lack of knowledge or information access.



(Multiple Respond Counted)

Figure-12: Interest in alternative livelihoods apply

Figure 12 highlighted the farmer's perceptions and interest in alternative livelihoods. The findings indicate that cow fattening is the most favored alternative, with 36.8% of respondents considering it a viable livelihood option. Apiculture is also of considerable interest, as 21.8% of respondents mention beekeeping as a possible alternative. Furthermore, 18.4% of respondents are drawn to agroforestry, which combines forestry and agriculture methods for sustainable land use. A smaller proportion (8.0%) of respondents express a moderate interest in artisanal activities and view handicrafts as a potential source of income. Finally, despite being a new approach, just 3.4% of respondents opined that they would be interested in taking up combined rice-fish farming, which makes it one of the least explored possibilities. These results show a broad variety of preferences that depend on how familiar and practicable each option is seen to be.



(Multiple Respond Counted)

Figure-13: Type of Alternative livelihoods adopted by Farmers

Figure 13 depicts the type of alternative livelihoods adopted by farmers due to the negative impact of climate change. According to respondents' perceptions, shrimp farming (56.3%) and fishing (54%) are the most frequent alternative livelihoods respectively. Besides, more than two-fifths (41.4%) of the respondents adopted rice cultivation. Slightly more than one-thirds (34.5%) of respondents revealed goat and poultry farming was a major move towards livestock-based livelihoods. Other alternative livelihoods mentioned by respondents include honey collecting (20.7%), timber industry (16.1%), motorcycles (25.3%) and jute cultivation (13.8%) respectively.

Table-4.1.3: Occupational practices changes has taken place in the profession in the last 10 years

Variable	Level	N	%
Cultivation of salt tolerant crops from conventional crops	Yes	51	49.0
	No	53	51.0
Conversion from crop farming to aquaculture	Yes	94	90.4
	No	10	9.6
Mushroom Cultivation	Yes	13	12.5
	No	91	87.5
Vegetable Gardening	Yes	26	25.0
	No	78	75.0
Animal husbandry	Yes	19	18.3
	No	85	81.7
Rearing of cows and goats	Yes	18	17.3
	No	86	82.7
Poultry Farming	Yes	35	33.7
	No	69	66.3

(Multiple Respond Counted)

Table 4.1.3 provides a brief overview of how the occupational practices of the respondents have changed over the past decade. According to the data, a significant percentage of respondents (90.4%) revealed that they have shifted from agricultural production to aquaculture. This finding indicates a significant move towards aquaculture in response to the changing circumstances. Another major development is the production of salinity-tolerant crops: as adopted by 49% of respondents, this is an indication of adaptation to increasingly saline soils, which is a common phenomenon driven by climate change. In addition, poultry farming (33.7%) and animal husbandry-related activities such as vegetable gardening are practiced by 25%, apparently sowing seeds to produce diverse crops. Animal husbandry and goat husbandry are practiced even less yet are significantly represented with 18.3% and 17.3% of respondents respectively adopting this type of practice. The least change was in mushroom production where a small proportion of respondents (12.5%) participated in this activity. These changes demonstrate the different ways in which respondents have adapted their livelihood options to new environmental and economic realities – clearly in favor of aquaculture and salt-tolerant crops.

Table- 4.1.4: Alternative profession according to ideas about alternative livelihoods

Variable	Level	N	%
Engaged in Nonagricultural Livelihood	Yes	52	50.0
	No	52	50.0
Handicrafts	Yes	11	10.6
	No	93	89.4
Small Transactions	Yes	8	7.7
	No	96	92.3
Horticulture and Agro forestry	Yes	18	17.3
	No	86	82.7
Integrated farming from fishing	Yes	9	8.7
	No	95	91.3
Adoption of renewable energy solutions	Yes	10	9.6
	No	94	90.4
Vocational training and skill development	Yes	15	14.4
	No	89	85.6

Table 4.1.4 indicates a balanced view towards agricultural and non-agricultural activities, with half (50.0%) of the respondents engaged in non-agricultural activities. Many alternative livelihoods are not widely adopted. For example, only 10.6% of the respondents practice handicrafts, while 7.7% of the respondents adopted small transactions. Of these respondents, 8.7% practice integrated fisheries-based farming, while 17.3% practice horticulture and agroforestry. In addition, 9.6% of the respondents have adopted sustainable energy solutions, while 14.4% are seeking skill development and vocational training. These results indicate that a large proportion of the respondents remain loyal to traditional farming methods and, of course, some of them are interested in exploring new sources of income. Since the low rate of adoption of more modern ones indicates that there may be barriers to these alternatives, preference is given to more traditional methods.

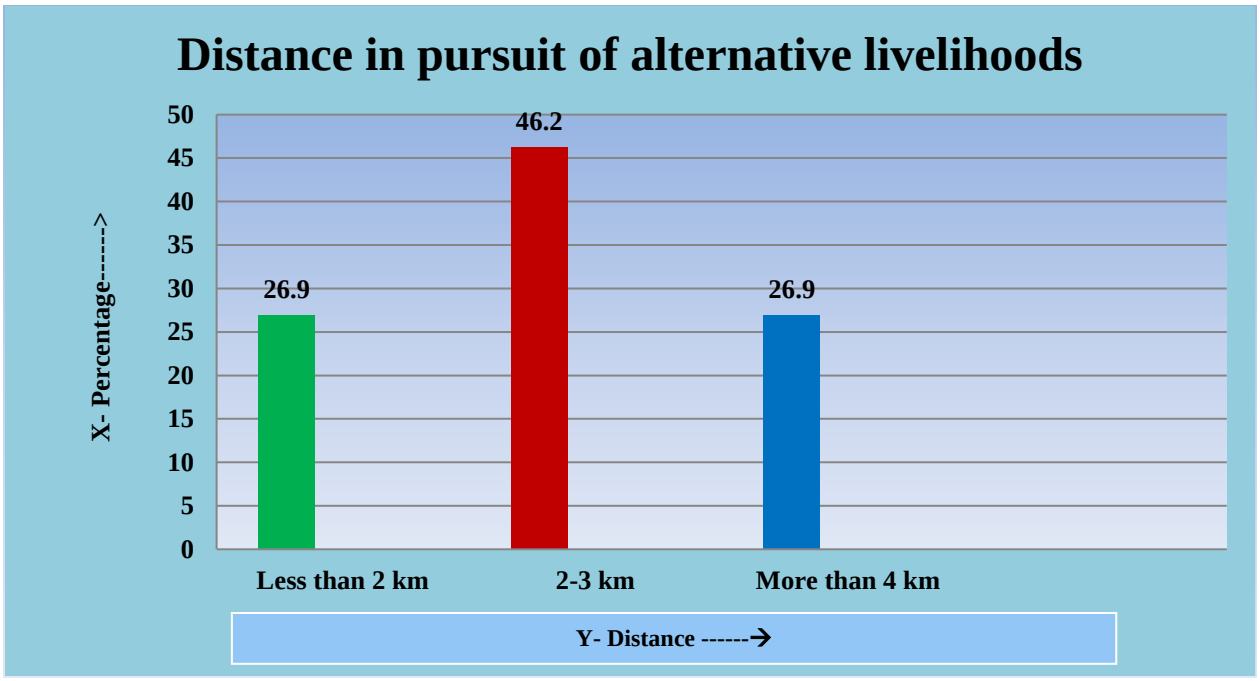


Figure-14: Daily commuting distance in pursuit of alternative livelihoods

Figure 14 indicates the distance that respondents seek alternate sources of income travel each day. According to the data, the most common distance travelled is 2 to 3 km, which more than half of respondents (46.2%) do every day. The fact that a large proportion of respondents (26.7%) claimed they travelled less than 2 km each day shows that some alternative sources of income are relatively close to their homes. In a similar vein, another set of respondents (26.9%) travel more than 4 km per day, demonstrating that a sizable proportion of people are willing to travel further in search of other income sources.

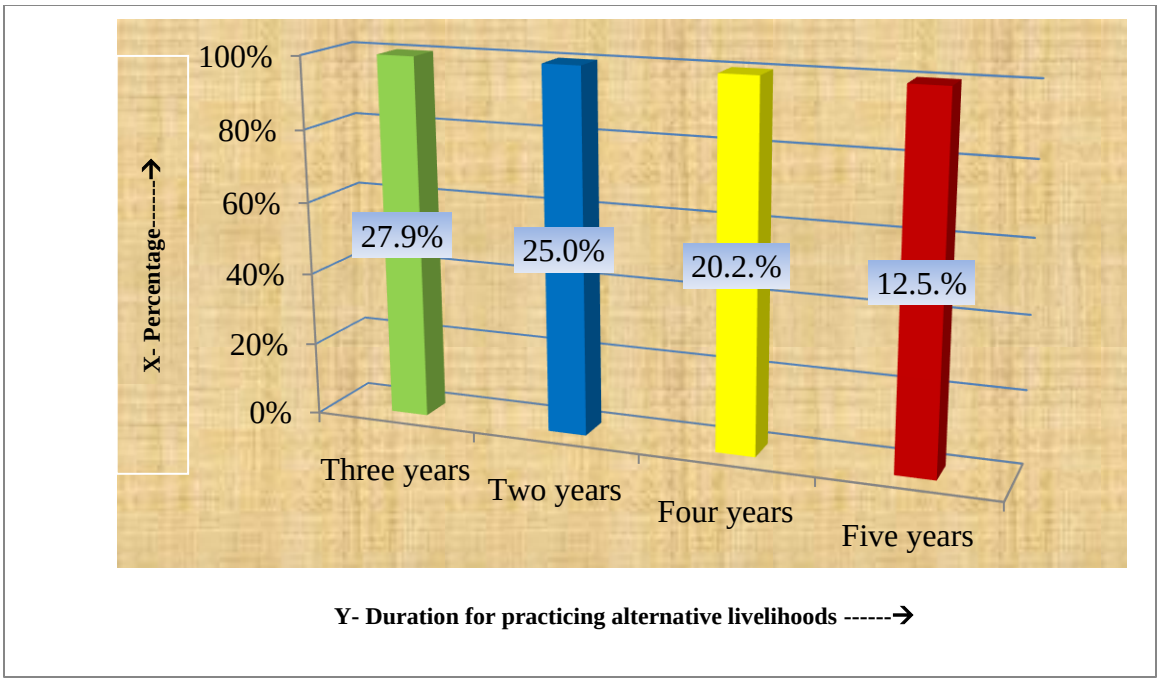
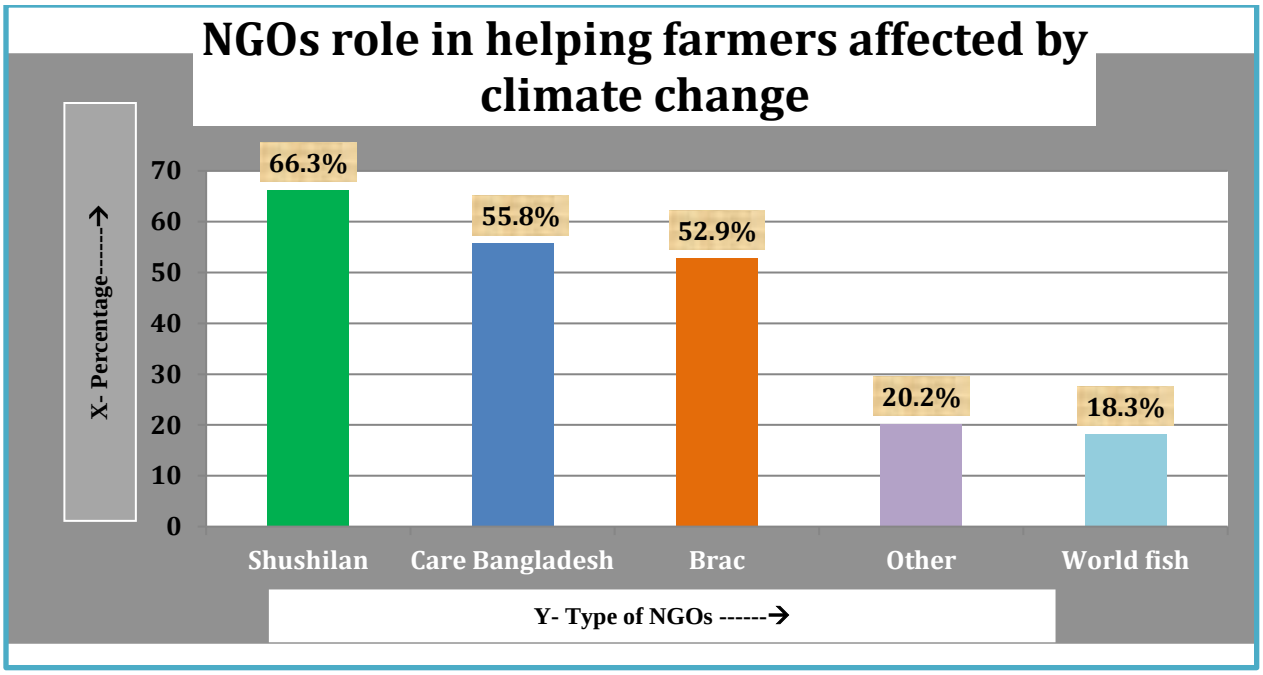


Figure-15: Duration for practicing alternative livelihoods

Figure 15 depicts the duration of alternative livelihoods of respondents. According to 27.9% of respondents, the most common term is three years, with the duration of involvement in alternative livelihoods being over this period. Next, more than one-fifth (25%) of respondents have been active in their alternative livelihoods for two years, which demonstrates that a significant number of people have undergone recent changes. A total of one-fifth (20.2%) of respondents has been practicing their alternative livelihoods for four years, while (12.5%) have been doing so for five years, indicating that a portion of respondents are relatively persistent in their alternative livelihood activities.



(Multiple Respond Counted)

Figure-16: NGOs role in helping farmers affected by climate change

Figure 16 highlights the role of several NGOs in supporting farmers affected by climate change. According to the data, 66.3% of respondents said that Sushilan is the NGO most actively involved in supporting them. Therefore, CARE Bangladesh is recognized by 55.8% of respondents for helping farmers cope with the effects of climate change. BRAC is also well known for its great participation, with 52.9% of respondents stating that the organization has helped them. On the other hand, World Fish is identified by a smaller portion of respondents (18.3%), who recognize its contribution. Furthermore, 20.2% of respondents reported support from other NGOs that were not explicitly named, meaning that multiple groups are trying to help farmers affected by climate difficulties.

Table- 4.1.5: Environmental and motivational factors influencing alternative livelihood search

Variable	Level	N	%
Environmental degradation	Yes	46	55.4
Drought	Yes	41	49.4
Cyclone	Yes	43	51.8
Heavy rain	Yes	37	44.6

(Multiple Respond Counted)

According to Table 4.1.5, data highlighted the respondents' motivations for seeking alternative livelihoods including several environmental and personal reasons. Each variable reflects a distinct problem or motivation that influences career decisions. More than half of the respondents (55.4%) opined that environmental degradation played a major role in their search for alternate livelihoods. This high percentage demonstrates the significant impact of environmental degradation on traditional livelihoods and the need for long-term solutions. Besides, drought was indicated by nearly half of respondents (49.4%) as a reason for seeking new alternative livelihood options.

Respondents stated that drought conditions have severe impact on agricultural productivity, particularly in rural areas, prompting people to look for more secure income streams. Furthermore, 51.8% of respondents considered cyclones to be a serious issue, implying that frequent and severe cyclonic events require immediate attention. These disasters devastate crops and property, reducing the sustainability of traditional livelihoods and forcing people to consider other possibilities. A lower number, 44.6% of thew respondents cited heavy rain as a factor harming their livelihoods. While not as common as other environmental issues, prolonged or severe rainfall can cause flooding and soil degradation, disrupting farming operations and adding to the need for alternative income sources. This suggests that a subset of the population is motivated by personal interests or ambition rather than environmental factors.

Table-4.1.6: Social barriers driving the search for alternative livelihoods

Variable	Level	N	%
Lack of livelihood diversity	Yes	17	20.5
Lack of educational opportunities	Yes	14	16.9
Difficulties in accessing health care	Yes	5	6.0
Limited job opportunities	Yes	30	36.1

(Multiple Respond Counted)

Table 4.1.6 data highlight the social barriers to finding alternative livelihoods. According to the findings, about 20.5% of respondents cited lack of diversity in their jobs as a reason for seeking other opportunities. This data illustrates the importance of livelihood diversification, as one-fifth of the community does not have multiple sources of income, which leaves them vulnerable to environmental change and economic downturn. Besides, a small proportion of respondents (16.9%) stated limited access to educational opportunities as a barrier.

Respondents stated that, lack of education can hinder skill development and make it more difficult for people to change careers or adapt to new economic opportunities. In addition, 36.1% of respondents cited lack of job opportunities as a reason for seeking a new career. This high percentage indicates a serious shortage of employment options in the community, emphasizing the importance of taking steps to increase job availability and access. Ultimately, limited job prospects and lack of livelihood diversification are the most important social constraints driving communities to seek other livelihoods. According to respondents, addressing these socio-cultural constraints can help affected people build sustainable and affordable livelihoods.

Table-4.1.7: Economic and agricultural challenges influencing the search for alternative livelihoods.

Variable	Level	N	%
Decrease in agricultural productivity	Yes	10	12.0
Lack of salt tolerant seeds	Yes	13	15.7
Damage to infrastructure	Yes	10	12.0
Food insecurity	Yes	26	31.3
Economic instability	Yes	38	45.8

(Multiple Respond Counted)

Table 4.1.7 identifies various economic and agricultural issues that encourage respondents to pursue alternative livelihoods. About 12.0% of respondents cited declining agricultural productivity as an important factor. In addition, low yields or less consistent agricultural production can make traditional farming less sustainable, forcing farmers to seek alternative sources of income. More than one-tenth (15.7%) of respondents cited the lack of salt-tolerant seeds as a reason for alternative livelihoods. They revealed that salt-tolerant seeds are crucial for crop production in areas with high salinity, such as coastal areas. Moreover, the lack of these seeds makes it more difficult for farmers to manage productive crops, making alternative livelihoods more attractive. Also, more than one-tenth (12%) of respondents indicate infrastructural degradation as a challenge. Respondents claimed that poor infrastructure interferes with market access, transportation, and farming, forcing people to seek alternative sources of income. Extreme weather and natural disasters often exacerbate this problem.

A significant factor cited by 31.3% of respondents was food insecurity. Respondents said that food insecurity increases as agricultural production declines and food availability becomes unpredictable, necessitating the development of sustainable livelihood options that can ensure both access to food and stable incomes. In addition, most respondents (45.8%) identified economic instability as a major factor. Fluctuations in agricultural income due to market changes or climate impacts make it difficult for people to maintain financial security, making alternative livelihoods an important option for stability. Overall, the data shows that economic insecurity, food shortages, and specific agricultural problems (such as the lack of salt-tolerant seedlings and reduced yields) all have a major impact on the search for alternative livelihoods. These findings emphasize the need for adaptive approaches that address both the economic and environmental aspects of community livelihood concerns.

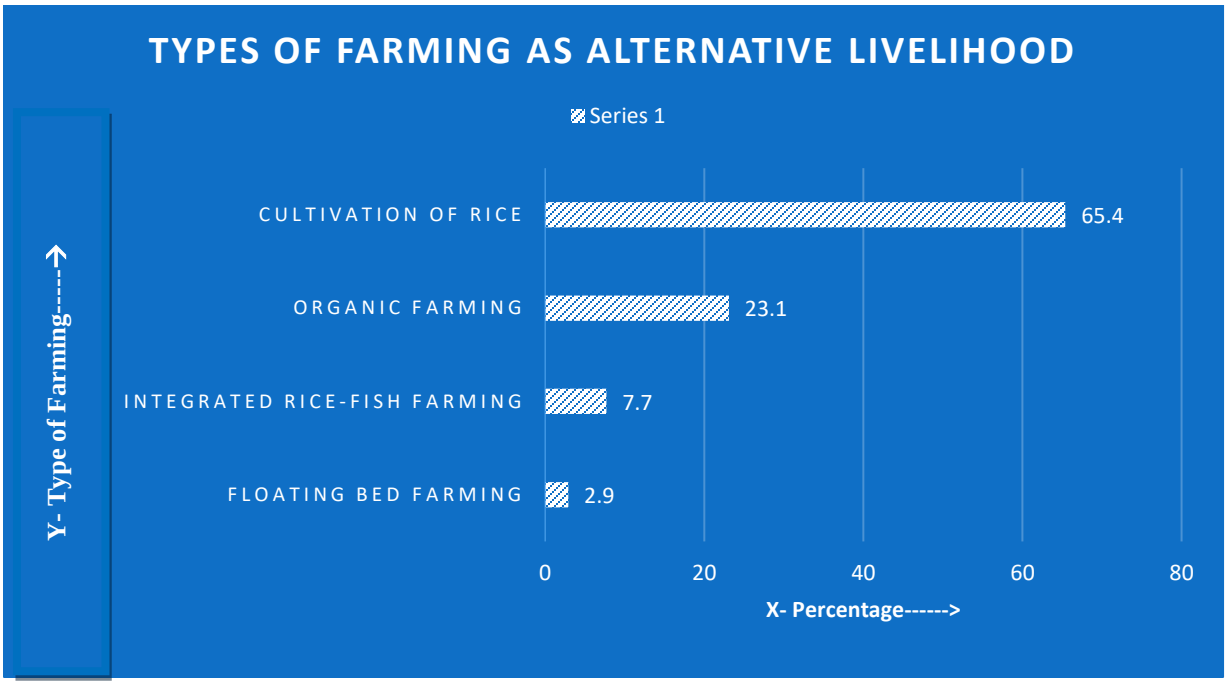


Figure-17: Types of farming as alternative livelihood

Figure 17 shows the type of different crops cultivated as alternative livelihoods by respondents. According to the data, significant majority of the respondents (65.4%) stated that rice is the most popular crop farming as alternative livelihood. Besides, more than one-fifths (23.1%) of the respondents use organic farming, indicating a growing interest in sustainable agricultural practices. Also, less than one-tenths (7.7%) of respondents practice integrated rice-fish farming, a form of mixed farming that combines agriculture and aquaculture. Floating bed farming, although less common, is practiced by 2.9% of respondents, demonstrating an innovative response to environmental problems such as wetlands. Furthermore, a small percentage of respondents (1.0%) reported cultivating other crops, indicating a variety of agricultural techniques. These data reveal a considerable reliance on rice farming, as well as a shift towards more sustainable and integrated agricultural practices among some respondents.

Table-4.1.8: Type of crops that farmers have adopted as alternatives to traditional rice cultivation

Variable	Level	N	%
Salt tolerant rice	Yes	47	51.6
	No	44	48.4
Cultivation of corn	Yes	37	40.7
	No	54	59.3
Salt tolerant rice varieties	Yes	46	50.5
	No	45	49.5
Beans	Yes	12	13.2
	No	79	86.8
Sesame	Yes	6	6.6
	No	85	93.4
Sunflower	Yes	13	14.3
	No	78	85.7
Spinach	Yes	6	6.6
	No	85	93.4
Carrots	Yes	6	6.6
	No	85	93.4
Tomatoes	Yes	17	18.7
	No	74	81.3
Sweet potatoes	Yes	19	20.9
	No	72	79.1
Pumpkin	Yes	55	60.4
	No	36	39.6
Watermelon	Yes	79	86.8
	No	12	13.2
Cabbage	Yes	29	31.9
	No	62	68.1
Cauliflower	Yes	13	14.3
	No	78	85.7
Integrated rice fish farming	Yes	2	2.2
	No	89	97.8
Eco-friendly jute cultivation	Yes	2	2.2
	No	89	97.8

Farmers adopted crop substitutes for rice cultivation from the data shown in Table 4.1.8 above, it appears that salinity-tolerant rice is the most adopted variety since its introduction, which 51.6% of the respondents are currently cultivating. The variety performs well under soils that have the level of salinity, which, among other factors, has been occurring because of climatic changes.

The highest number of corn farmers is represented at 40.7 percent among the respondents. Drought tolerance and low water requirement of corn make it the best choice for farmers with rainfall variability and water scarcity. Rice cultivation with salt tolerance is also one of the vital adaptation strategies for farmers, which 50.5% of the respondents chose as their crops for increased tolerance against salinity. Other results are that 14.3% of respondents planted sunflower, which is a useful alternative crop for areas where traditional farming may be less viable under climate change. 13.2% of the respondents grow beans, nutritious and soil-rich, instead of rice.

The next are spinach and sesame, which are less common, 6.6%, a finding considered by the respondents to be close to each other, hence increasing the diversity of alternative crops. Watermelon was also found to be the most preferred alternative, as 86.8% of the respondents opted for this crop. High yield and value addition in watermelon make it a favorite crop for the farmers to diversify their farming strategies.

Pumpkin is another preferred crop, with 60.4% of respondents involved in its cultivation. This indicates that pumpkin, due to its sustainability and market demand, is an important alternative to rice. Similarly, cabbage is the other important diversified farming trend crop cultivated by 31.9% of respondents. 20.9% adoption rate in the sweet potato by respondents indicates that it is an important healthy substitute to rice. Respondents cultivate tomatoes at an adoption rate of 18.7%, indicating a vital, adaptive, and profitable crop.

Less common crops grown are cauliflower by 14.3% and carrots by 6.6% of the respondents, which show usefulness in more diversified farming systems. Finally, other more specialized approaches include integrated rice-fish farming and environment-friendly jute farming, practiced by 2.2% of respondents. Though rare, these practices have opened new methods for sustainable agriculture under conditions of climate change.

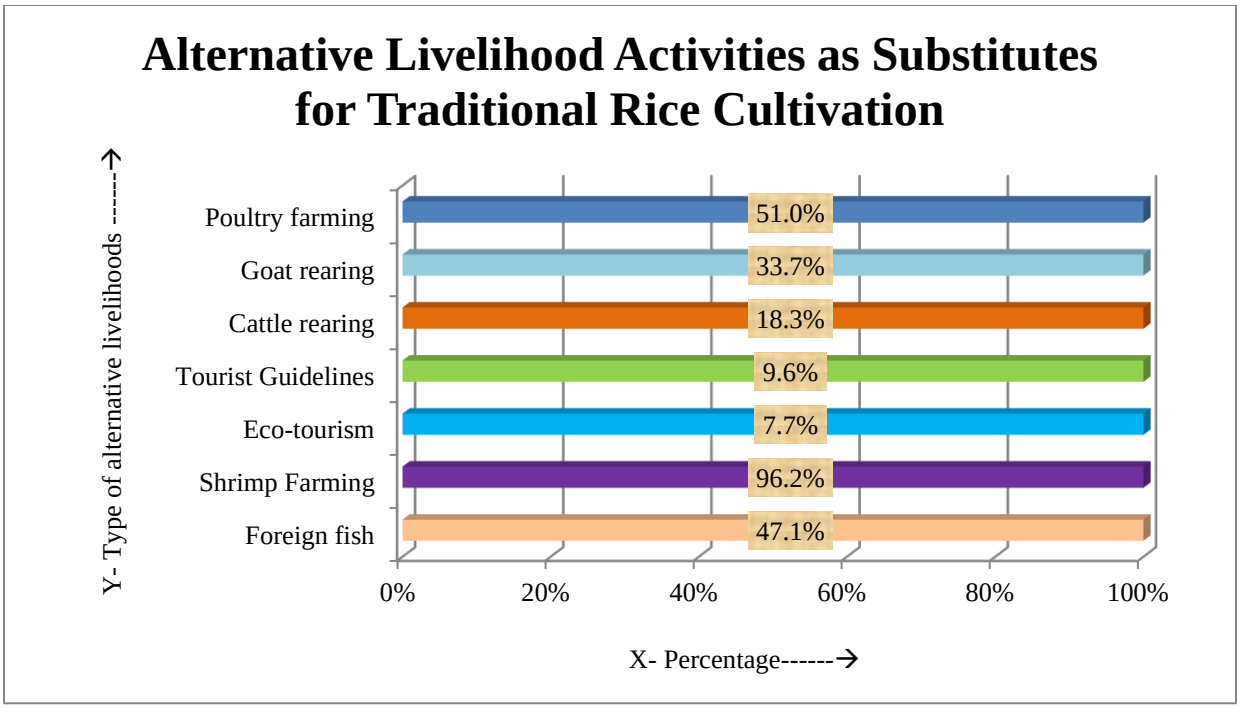


Figure-18: Alternative livelihoods for farmers replacing traditional rice cultivation

Figure 18 show the alternative livelihood options that farmers pursue instead of traditional rice farming. According to the findings, shrimp farming is the most popular option, with a significant number of respondents (96.2%) participating in this activity. The great profitability of shrimp farming and its flexibility to adapt to changing environmental conditions are likely reasons for its widespread acceptance. Besides, foreign fish aquaculture is another popular option, with 47.1% of respondents engaging in it. This indicates that aquaculture, especially with foreign fish species, is an important strategy for diversifying farmers' income sources. Also, more than half (51%) of the respondents adopt poultry farming, which demonstrates its versatility and availability as an alternative livelihood.

Furthermore, 33.7% of respondents rear goats, which demonstrates its importance as an alternative to animal husbandry. Cattle farming is another livestock farming choice, with 18.3% of respondents engaging in it. This shows that, while animal husbandry is less common than other activities, it remains a significant source of income for some farmers. Furthermore, 33.7% of respondents raise goats, which proves their value as an alternative to animal husbandry. Cattle raising is another alternative to animal husbandry, with 18.3% of respondents participating in it. This shows that, while animal husbandry is less common than other activities, it remains a significant source of income for some farmers.

Table-4.1.9: Alternative paddy varieties by farmers in response to climate change distribution and sources of livelihood options

Variable	Level	N	%
BRRI 47	Yes	98	94.2
	No	6	5.8
BRRI 61	Yes	38	36.5
	No	66	63.5
BINA 8	Yes	24	23.1
	No	80	76.9
BRRI 28	Yes	22	21.2
	No	82	78.8
BRRI 55	Yes	23	22.1
	No	81	77.9
BINA Rice 11	Yes	28	26.9
	No	76	73.1
BINA 10	Yes	29	27.9
	No	75	72.1
BINA 47	Yes	26	25.0
	No	78	75.0

Table 4.1.9 demonstrates that farmers have made significant progress in adopting alternative livelihoods to deal with the effects of climate change. According to the data, most respondents (94.2%) used BRRI 47 as part of their alternative livelihoods, making it the most prevalent source. In a smaller proportion, 36.5% of respondents adopted BRRI 61, whereas 26.9% adopted BINA Rice 11.

Similarly, 27.9% adopted BINA 10, 23.1% BINA 8, and 25.0% BINA 47. These sources show the numerous changes that farmers are making to cope with changing environmental conditions. These alternative sources have made a modest but significant contribution to diversifying alternative livelihoods.

Table-4.1.10: Various alternative professions that farmers can adopt as substitutes for fish farming

Variable	Level	N	%
Cow fattening	Yes	59	56.7
	No	45	43.3
Agroforestry	Yes	60	57.7
	No	44	42.3
Floating bed cultivation	Yes	32	30.8
	No	72	69.2
Beekeeping	Yes	57	54.8
	No	47	45.2
Organic farming	Yes	49	47.1
	No	55	52.9
Handicrafts	Yes	18	17.3
	No	86	82.7
Manufacture of artisan products	Yes	16	15.4
	No	88	84.6
Cultivation of herbal medicine	Yes	7	6.7
	No	97	93.3

Table-4.1.10 shows that agro forestry is the most beneficial alternative as (57.7%) of the respondents participate in this practice. It reflects an increasing emphasis on sustainable land use and the integration of trees into farming systems. Cow fattening is practiced by (56.7%) of the respondents. It involves traditional agriculture which is an alternative to a very profitable livestock-based livelihood. Beekeeping is also mentioned and (54.8%) of the respondents practice it indicating that it is yet another alternative livelihood that sustains biodiversity and provides further income through honey production.

Organic farming has accounted for (47.1%) of participation by the respondents. This has made it into a very viable alternative as consumers are increasingly demanding much greener and health consciousness in agricultural products. Floating bed cultivation is adopted by (30.8%) of respondents, especially when used in flood-prone areas, thus signifying its adaptation power. Handcraft as well as artisan product manufacturing involves relatively fewer respondents: (17.3%) and (15.4%), respectively. These professions can be labeled as creative and cultural alternative professions that can supplement income. Lastly, (6.7%) of respondents practice cultivation for herbal medicine showing a potential position alternative livelihood but with high chances of being profitable.

Table-4.1.11: Analysis of alternative professions that farmers might take up instead of crab farming

Variable	Level	N	%
Mango orchard gardener	Yes	38	36.5
	No	66	63.5
Honey collection	Yes	50	48.1
	No	54	51.9
Timber business	Yes	60	57.7
	No	44	42.3
Collection of bay leaves	Yes	28	26.9
	No	76	73.1
Traveling business	Yes	37	35.6
	No	67	64.4
Daily labor	Yes	29	27.9
	No	75	72.1
Sewing	Yes	16	15.4
	No	88	84.6
Boat building	Yes	49	47.1
	No	55	52.9
Boat business	Yes	62	59.6
	No	42	40.4

Table 4.1.11 presents a summary of alternative occupations that farmers can take up instead of crab farming. Almost three-fifths (59.6%) of the respondents revealed that boat business is the most popular option. Another option is timber business, where (57.7%) consider it a viable option. Honey collection (48.1%) and boat making (47.1%) figure prominently as other important options. Mango orcharding is an option for (36.5%) of the respondents, while it is an option for travel business (35.6%). Other occupations such as bay leaf collection (26.9%), daily labor (27.9%), tailoring (15.4%) and making handicrafts (15.4%) are less widely accepted as alternative options.

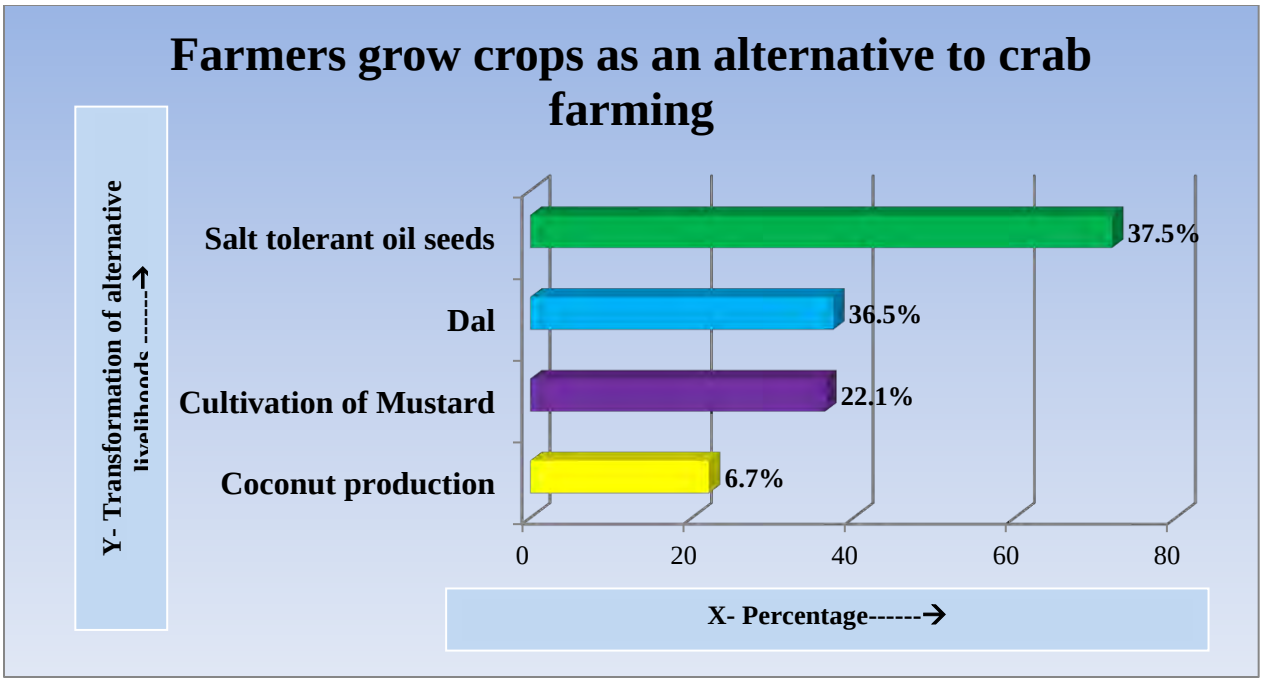


Figure-19: Alternative cropping options for farmers to transition from crab farming

Figure 19 shows the alternative crops grown by farmers instead of crab farming. It is evident that a significant portion of the respondents (37.5%) chose salt-tolerant oilseeds as the most preferred alternative crop. Another three alternative crops such as Dal (lentils) were chosen by 36.5% of the respondents, while mustard farming was considered by 22.1% and coconut production by 6.7% respectively.

Table-4.1.12: Gender-based impacts of climate change on livelihoods

Variable	N	%
Women's opportunities in agriculture are reduced	26	25.0
Occupational migration of men and women decreases	57	54.8
Female and male entrepreneurship declines	18	17.3
Training opportunities for both men and women are reduced	3	2.9

Table 4.1.12 reveals that more than half (54.8%) of the respondents stated that climate change reduces occupational migration of men and women. In addition, one-fourth (25.0%) of the respondents stated that climate change increases gender inequality and reduces opportunities for women in agriculture. The respondents stated that women are facing several barriers in alternative livelihoods due to socio-cultural norms and lack of access to resources. Although some women are engaged in non-traditional roles.

Environmental changes show how severely the different roles of women and men in agricultural resources have been affected. Less than one-fifth (17.3%) of the respondents opined that climate change reduces opportunities for entrepreneurship due to climate change. A small proportion of the respondents (2.9%) illustrated that the impact of climate change is reducing training opportunities for both men and women. The idea here seems to be that training opportunities may be part of other variables, but it will be more insignificant.

Table-4.1.13: Actions to be taken to introduce sustainable and alternative livelihoods of farmers

Variable	Level	N	%
Farmers need to learn techniques to use efficient	Strongly Agree	12	11.5
	Agree	92	88.5
	Neutral	0	0.0
	Disagree	0	0.0
	Strongly disagree	0	0.0
Training and capacity building programs need	Strongly Agree	9	8.7
	Agree	94	90.4
	Neutral	1	1.0
	Disagree	0	0.0
	Strongly disagree	0	0.0
Technical training should be provided to the	Strongly Agree	7	6.7
	Agree	93	89.4
	Neutral	4	3.8
	Disagree	0	0.0
	Strongly disagree	0	0.0
Farmers need to be financially supported	Strongly Agree	48	46.2
	Agree	55	52.9
	Neutral	0	0.0
	Disagree	0	0.0
	Strongly disagree	1	1.0
Farmers need to provide small loans or loans	Strongly Agree	46	44.2
	Agree	56	53.8
	Neutral	1	1.0
	Disagree	1	1.0
	Strongly disagree	0	0.0
Market linkages are needed for farmers to sell	Strongly Agree	47	45.2
	Agree	54	51.9
	Neutral	3	2.9
	Disagree	0	0.0
	Strongly disagree	0	0.0
Farmers need to arrange fair market prices for	Strongly Agree	45	43.3
	Agree	59	56.7
	Neutral	0	0.0
	Disagree	0	0.0
	Strongly disagree	0	0.0
Farmers need to be given an early idea about the	Strongly Agree	2	1.9

	Agree	61	58.7
	Neutral	40	38.5
	Disagree	1	1.0
	Strongly disagree	0	0.0
Government needs to subsidize farmers for	Strongly Agree	51	49.0
	Agree	50	48.1
	Neutral	1	1.0
	Disagree	2	1.9
	Strongly disagree	0	0.0

Table 4.1.13 highlights the respondents' views on the steps taken to introduce sustainable and alternative livelihoods for farmers. According to the findings, a strong majority of respondents (88.5%) agreed on educating farmers on learning strategies for using effective methods. Again, in terms of implementing new practices, education is important in support of training and capacity building programs (90.4%). Also, 89.4% are in favor of technical training.

Financial support is needed, as (46.2%) strongly agree and (52.9%) agree that there should be financial support for farmers. Similarly, (44.2%) strongly agree and (53.8%) agree that microcredit or financial assistance should be provided. There is great support for improving market linkages and providing fair market prices, while (45.2%) strongly agree and 51.9% of the respondents agree for market access, and (43.3%) strongly agree and (56.7%) agree for fair price arrangements. (49.0%) strongly agree with the call for government subsidies and (48.1%) agree that such support would be needed.

Table-4.1.14: Association between family monthly incomes with climate change impact on environment

Dependent : Q7 Family monthly income		less than 5,000	5001 - 10,000	10 ,001 - 15,000	15,001 – 20,000	20,001 - 25,000	More than 25,000	Total	P Value
Tota l N (%)		N(%)=1 (1.0)	N(%)=32 (30.8)	N(%)=47 (45.2)	N(%)=16 (15.4)	N(%)=7 (6.7)	N(%)=1 (1.0)	N(%)=1 04	
Changes in rainfall patterns	Yes	1 (100.0)	21 (65.6)	23 (48.9)	9 (56.2)	6 (85.7)	1 (100.0)	61 (58.7)	
	No	0 (0.0)	11 (34.4)	24 (51.1)	7 (43.8)	1 (14.3)	0 (0.0)	43 (41.3)	0.303
Increases pest and disease pressure	Yes	0 (0.0)	12 (37.5)	17 (36.2)	9 (56.2)	3 (42.9)	1 (100.0)	42 (40.4)	
	No	1 (100.0)	20 (62.5)	30 (63.8)	7 (43.8)	4 (57.1)	0 (0.0)	62 (59.6)	0.507
Scarcity of fresh water occurs	Yes	1 (100.0)	18 (56.2)	20 (42.6)	8 (50.0)	5 (71.4)	0 (0.0)	52 (50.0)	
	No	0 (0.0)	14 (43.8)	27 (57.4)	8 (50.0)	2 (28.6)	1 (100.0)	52 (50.0)	0.437
Soil fertility is lost	Yes	1 (100.0)	14 (43.8)	22 (46.8)	6 (37.5)	4 (57.1)	1 (100.0)	48 (46.2)	
	No	0 (0.0)	18 (56.2)	25 (53.2)	10 (62.5)	3 (42.9)	0 (0.0)	56 (53.8)	0.663
Soil nutrients decrease	Yes	0 (0.0)	8 (25.0)	10 (21.3)	3 (18.8)	3 (42.9)	0 (0.0)	24 (23.1)	
	No	1 (100.0)	24 (75.0)	37 (78.7)	13 (81.2)	4 (57.1)	1 (100.0)	80 (76.9)	0.782
Water scarcity and irrigation challenges	Yes	0 (0.0)	18 (56.2)	39 (83.0)	11 (68.8)	2 (28.6)	0 (0.0)	70 (67.3)	
	No	1 (100.0)	14 (43.8)	8 (17.0)	5 (31.2)	5 (71.4)	1 (100.0)	34 (32.7)	0.007

Table 4.1.14 analyses explored the relationship between household monthly income and two environmental factors: changes in rainfall patterns and increased pest and disease pressure. The data reflects household monthly income and two environmental factors that monitor the effects of changes in rainfall patterns and increased pest and disease pressure over time.

According to the analysis, there was no statistically significant relationship between household income according to the distribution of income groups and perceptions of these environmental changes, as p-values of 0.303 were found for changes in rainfall patterns and 0.507 for increased pest and disease pressure. This means that there is no strong effect of changes in household or household income on perceptions of the impact of pest and disease pressure, even with the opposite change in rainfall patterns.

Table-4.1.15: Association between occupations with climate change impact on environment (Cont'd)

Dependent : Q10 Occupation	Coding category	Agriculture	Farmers and Fishermen	Farmers and small businesses	Farmers and Handicrafts	Farmers and cattle rearing	Farmers and honey collection	Work of farmers and bricklayers	Total	P value
Total N (%)		N(%)=42 (40.4)	N(%)=19 (18.3)	N(%)=6 (5.8)	N(%)=3 (2.9)	N(%)=2 (1.9)	N(%)=6 (5.8)	N(%)= 5 (4.8)	N(%)= 104	
Changes in rainfall patterns	Yes	40 (95.2)	8 (42.1)	2 (33.3)	1 (33.3)	0 (0.0)	4 (66.7)	2 (40.0)	61 (58.7)	
	No	2 (4.8)	11 (57.9)	4 (66.7)	2 (66.7)	2 (100.0)	2 (33.3)	3 (60.0)	43 (41.3)	<0.001
Increases pest and disease pressure	Yes	36 (85.7)	3 (15.8)	1 (16.7)	0 (0.0)	0 (0.0)	1 (16.7)	0 (0.0)	42 (40.4)	
	No	6 (14.3)	16 (84.2)	5 (83.3)	3 (100.0)	2 (100.0)	5 (83.3)	5 (100.0)	62 (59.6)	<0.001
Scarcity of fresh water occurs	Yes	23 (54.8)	9 (47.4)	3 (50.0)	1 (33.3)	2 (100.0)	4 (66.7)	1 (20.0)	52 (50.0)	
	No	19 (45.2)	10 (52.6)	3 (50.0)	2 (66.7)	0 (0.0)	2 (33.3)	4 (80.0)	52 (50.0)	0.536
Soil fertility is lost	Yes	29 (69.0)	8 (42.1)	0 (0.0)	1 (33.3)	0 (0.0)	2 (33.3)	2 (40.0)	48 (46.2)	
	No	13 (31.0)	11 (57.9)	6 (100.0)	2 (66.7)	2 (100.0)	4 (66.7)	3 (60.0)	56 (53.8)	0.011
Soil nutrients decrease	Yes	15 (35.7)	4 (21.1)	1 (16.7)	1 (33.3)	0 (0.0)	1 (16.7)	1 (20.0)	24 (23.1)	
	No	27 (64.3)	15 (78.9)	5 (83.3)	2 (66.7)	2 (100.0)	5 (83.3)	4 (80.0)	80 (76.9)	0.640
Water scarcity and irrigation challenges	Yes	19 (45.2)	13 (68.4)	6 (100.0)	2 (66.7)	2 (100.0)	4 (66.7)	5 (100.0)	70 (67.3)	
	No	23 (54.8)	6 (31.6)	0 (0.0)	1 (33.3)	0 (0.0)	2 (33.3)	0 (0.0)	34 (32.7)	0.024

Table 4.1.15, the relationship between the reported impacts of climate change on some selected occupations and the environment that undergoes impacts such as changes in rainfall variability, increased pest and disease pressure, drought, reduced soil fertility, reduced soil nutrients and higher irrigation requirements has been analyzed. The findings indicate that rainfall variability affects most people in occupations such as agriculture. For example, 95.2% of respondents have noticed changes while only 4.8% said otherwise stated a significant association with $p < 0.001$. Then pest and disease pressure are also affecting all farmers in agriculture. Currently, 85.7% of agriculture and farmers are facing this problem. Pest and disease pressure is least observed in other activities such as cattle rearing and honey collection. Also, half of the respondents (50%) in each occupation said that they experience water scarcity. Not significant ($p=0.536$) so the widespread prevalence of water scarcity is true. Among these categories, livestock farmers reported the highest decrease in soil fertility, with a p value of 0.011.

Table-4.1.16: Association between occupations with climate change impact on environment (Cont'd)

Dependent: Q10 Occupation	Coding category	Farmers and rickshaw driving	Farmers and CNG Driving	Farmers and tea shops	Farmers and wood collection	Farmers and Day Laborers	Total	P value
Total N (%)		N(%)=5 (4.8)	N(%)=1 (1.0)	N(%)=5 (4.8)	N(%)=1 (1.0)	N(%)=7 (6.7)	N(%)= 104	
Changes in rainfall patterns	Yes	1 (20.0)	0 (0.0)	0 (0.0)	1 (100.0)	2 (28.6)	61 (58.7)	
	No	4 (80.0)	1 (100.0)	5 (100.0)	0 (0.0)	5 (71.4)	43 (41.3)	<0.001
Increases pest and disease pressure	Yes	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (14.3)	42 (40.4)	
	No	5 (100.0)	1 (100.0)	5 (100.0)	1 (100.0)	6 (85.7)	62 (59.6)	<0.001
Scarcity of fresh water occurs	Yes	3 (60.0)	0 (0.0)	2 (40.0)	0 (0.0)	2 (28.6)	52 (50.0)	
	No	2 (40.0)	1 (100.0)	3 (60.0)	1 (100.0)	5 (71.4)	52 (50.0)	0.536
Soil fertility is lost	Yes	0 (0.0)	1 (100.0)	3 (60.0)	0 (0.0)	2 (28.6)	48 (46.2)	
	No	5 (100.0)	0 (0.0)	2 (40.0)	1 (100.0)	5 (71.4)	56 (53.8)	0.011
Soil nutrients decrease	Yes	0 (0.0)	0 (0.0)	1 (20.0)	0 (0.0)	0 (0.0)	24 (23.1)	
	No	5 (100.0)	1 (100.0)	4 (80.0)	1 (100.0)	7 (100.0)	80 (76.9)	0.640
Water scarcity and irrigation challenges	Yes	5 (100.0)	1 (100.0)	3 (60.0)	1 (100.0)	7 (100.0)	70 (67.3)	
	No	0 (0.0)	0 (0.0)	2 (40.0)	0 (0.0)	0 (0.0)	34 (32.7)	0.024

Table 4.1.16 Cross-analysis highlights the relationship of respondents' occupations with the impact of climate change on the environment. In addition to the above-mentioned occupations, in line with the topic outlined in the title, there are some challenges in terms of changes in rainfall patterns, insect and disease pressure, water scarcity, soil fertility declines and irrigation, which have been identified as impacts of climate change. Regarding changes in rainfall patterns, most respondents reported these changes with a correlation of a p value < 0.001 between occupation-rainfall changes. Increased insect and disease pressure showed an almost universal reporting pattern with almost all rickshaw pullers, tea stalls and wood-collecting farmers raising this issue (p-value < 0.001). Water scarcity shows almost no difference as it has a p-value = 0.536, meaning that all occupations face it at almost the same rate; about 50 percent of respondents from each occupation suffer from water scarcity.

Table-4.1.17: Association between occupations with climate change impact on environment

Dependent : Q10 Occupation	Coding category	Farmers and Apiculture	Farmers and Golpata collection	Farmers and pea workers	Farmers and working in garments in cities	Farmers and oil fryers	Farmers and small businesses	Total	P value
Changes in rainfall patterns	Yes	0 (0.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	61 (58.7)	
	No	2 (100.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	43 (41.3)	<0.001
Increases pest and disease pressure	Yes	0 (0.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	42 (40.4)	
	No	2 (100.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	62 (59.6)	<0.001
Scarcity of fresh water occurs	Yes	2 (100.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	52 (50.0)	
	No	0 (0.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	52 (50.0)	0.536
Soil fertility is lost	Yes	0 (0.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	48 (46.2)	
	No	2 (100.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	56 (53.8)	0.011
Soil nutrients decrease	Yes	0 (0.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	24 (23.1)	
	No	2 (100.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	80 (76.9)	0.640
Water scarcity and irrigation challenges	Yes	2 (100.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	70 (67.3)	
	No	0 (0.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	34 (32.7)	0.024

Table 4.1.17 highlighted the relationship of different occupations with climate change impact on environment. Findings depicted that changes in rainfall patterns, insect and disease pressure, water scarcity, loss of soil fertility and soil nutrient depletion, and challenges related to water scarcity and irrigation were considered as environmental impacts on the occupation. According to the changes in rainfall patterns, apiculture farmers (100%) illustrated that their rainfall had not changed, whereas most of the total sample, 58.7%, revealed that they had. These results indicate a statistically significant relationship (p-value < 0.001). There was a significant difference between the different occupations regarding the perception of rainfall changes. Similarly, increase in insect and disease pressure revealed that all apiculture farmers reported no increase whereas a significant portion of the total sample, 40.4%, experienced insect and disease pressure. Again, the difference was statistically significant (p-value < 0.001), indicating further differences in climate impacts across occupations. In terms of water scarcity, almost half (50.0%) of the respondents are experiencing water scarcity globally. In terms of this challenge, across all occupations, no significant differences were observed (p-value = 0.536). Apiculture farmers also experienced water scarcity. Regarding soil fertility loss, more than half (53.8%) of the apiculture farmers stated that soil fertility had not decreased, but 46.2% of them opined that soil fertility had decreased (p-value = 0.011).

Table-4.1.18: Association influences traditional professions with environmental impact

Dependent: Influences traditional professions	Coding category	No	Yes	Total	P value
Total N (%)		N(%)=29 (27.9)	N(%)=75 (72.1)	N(%)=104	
Changes in rainfall patterns	Yes	7 (24.1)	54 (72.0)	61 (58.7)	
	No	22 (75.9)	21 (28.0)	43 (41.3)	<0.001
Increases pest and disease pressure	Yes	4 (13.8)	38 (50.7)	42 (40.4)	
	No	25 (86.2)	37 (49.3)	62 (59.6)	0.001
Scarcity of fresh water occurs	Yes	12 (41.4)	40 (53.3)	52 (50.0)	
	No	17 (58.6)	35 (46.7)	52 (50.0)	0.382
Soil fertility is lost	Yes	9 (31.0)	39 (52.0)	48 (46.2)	
	No	20 (69.0)	36 (48.0)	56 (53.8)	0.088
Soil nutrients decrease	Yes	6 (20.7)	18 (24.0)	24 (23.1)	
	No	23 (79.3)	57 (76.0)	80 (76.9)	0.920
Water scarcity and irrigation challenges	Yes	26 (89.7)	44 (58.7)	70 (67.3)	
	No	3 (10.3)	31 (41.3)	34 (32.7)	0.005

The data cross-tabulation (Table-4.1.18) examines the environmental factor-the influence of traditional professions. The respondents were grouped into two: those who argued that environmental changes do influence their traditional professions and those who did not. This analysis was based on 104 respondents. A total of respondents (27.9%) indicates that their traditional professions do not influence by changes in environmental factors. Totals up to 72.1% state that environmental changes do have an influence on traditional professions. On the part of respondents who do not realize any influence of change on traditional professions, (75.9%) said no changes in rainfall patterns were observed, while (24.1%) have noted changes. On the contrary, of those who were confirmed to have influenced their traditional professions, (72.0%) said they had observed changes in rainfall patterns while only (28.0%) said they had seen no change. Out of the respondents who do not see an influence on their traditional professions, (86.2%) said they did not witness an increase in pest and disease pressure, while it was only (13.8%) that said they did. On the contrary, there are (49.3%) of respondents who said environmental factors influence traditional professions and did not observe an increase in pest and disease pressure while (50.7%) experienced it.

The significant p-value generated in the association of perception of influence on traditional professions with these two environmental effects, changes in rainfall regimes ($p < 0.001$) and increase in pest and disease pressure ($p = 0.001$), indicates that such associations are significant statistically. This means that perceiving an effect of environmental changes on traditional professions increases the likelihood of that change being observed in the rainfall pattern and an increase in pest and disease pressure.

Table-4.1.19: Association between impacts on the livelihood of farmers involved in tourism activity environmental impact

Dependent: Impacts on the livelihood of farmers involved in tourism activity	Coding category	No	Yes	Total	P value
Total N (%)		N(%)=72 (69.2)	N(%)=32 (30.8)	N(%)=104	
Changes in rainfall patterns	Yes	37 (51.4)	24 (75.0)	61 (58.7)	
	No	35 (48.6)	8 (25.0)	43 (41.3)	0.041
Increases pest and disease pressure	Yes	23 (31.9)	19 (59.4)	42 (40.4)	
	No	49 (68.1)	13 (40.6)	62 (59.6)	0.016
Scarcity of fresh water occurs	Yes	41 (56.9)	11 (34.4)	52 (50.0)	
	No	31 (43.1)	21 (65.6)	52 (50.0)	0.056
Soil fertility is lost	Yes	27 (37.5)	21 (65.6)	48 (46.2)	
	No	45 (62.5)	11 (34.4)	56 (53.8)	0.015
Soil nutrients decrease	Yes	14 (19.4)	10 (31.2)	24 (23.1)	
	No	58 (80.6)	22 (68.8)	80 (76.9)	0.286
Water scarcity and irrigation challenges	Yes	49 (68.1)	21 (65.6)	70 (67.3)	
	No	23 (31.9)	11 (34.4)	34 (32.7)	0.986

According to the cross-tabulation in Table 4.1.19, the analysis reflects the information on the environmental variables related to their impact on the livelihoods of farmers engaged in tourism activities. The p-values refer to the concept of impact on livelihoods and the relationship between the two environmental variables, change in rainfall pattern (p=0.041) and increased pest and disease pressure (p=0.016). Therefore, it can be considered statistically significant. This shows that farmers engaged in tourism activities who experience impacts on their livelihoods are more likely to experience changes in rainfall patterns and increased pest and disease pressure.

Table-4.1.20: Association between drip irrigation with environmental impact

Dependent: Drip irrigation	Coding category	No	Yes	Total	P value
Total N (%)		N(%)=36 (34.6)	N(%)=68 (65.4)	N(%)=104	
Changes in rainfall patterns	Yes	13 (36.1)	48 (70.6)	61 (58.7)	
	No	23 (63.9)	20 (29.4)	43 (41.3)	0.001
Increases pest and disease pressure	Yes	4 (11.1)	38 (55.9)	42 (40.4)	
	No	32 (88.9)	30 (44.1)	62 (59.6)	<0.001
Scarcity of fresh water occurs	Yes	16 (44.4)	36 (52.9)	52 (50.0)	
	No	20 (55.6)	32 (47.1)	52 (50.0)	0.536
Soil fertility is lost	Yes	9 (25.0)	39 (57.4)	48 (46.2)	
	No	27 (75.0)	29 (42.6)	56 (53.8)	0.003
Soil nutrients decrease	Yes	5 (13.9)	19 (27.9)	24 (23.1)	
	No	31 (86.1)	49 (72.1)	80 (76.9)	0.170
Water scarcity and irrigation challenges	Yes	28 (77.8)	42 (61.8)	70 (67.3)	
	No	8 (22.2)	26 (38.2)	34 (32.7)	0.151

According to the data cross tabulation (Table-4.1.20), the relationship between the adoption of drip irrigation as an environmental change by a respondent based on the degree of change in rainfall or increase in pest and disease pressure has been analyzed. A total of 104 respondents were divided into two groups in the analysis; those who use drip irrigation and those who do not. The p-value on the relationship between the use of drip irrigation and two environmental parameters - change in rainfall pattern ($p = 0.001$) and increase in pest and disease pressure ($p < 0.001$) - confirms a statistically significant relationship.

This means that farmers may face changes in their rainfall pattern and increase in pest and disease pressure through drip irrigation. The conclusions drawn from the results suggest that some environmental changes such as rainfall irregularity and pest and disease outbreaks may lead to the adoption of drip irrigation, which will require these farmers to consider adaptive strategies.

Table-4.1.21: Association between family monthly incomes with respondent's alternative occupation

Dependent: Q7 Family monthly income	Coding category	less than 5,000	5001 - 10,000	10 ,001 - 15,000	15,001 – 20,000	20,001 - 25,000	More than 25,000	Total	P value
Total N (%)		N(%)= 1 (1.0)	N(%)=32 (30.8)	N(%)= 47 (45.2)	N(%)=1 6 (15.4)	N(%)= 7 (6.7)	N(%)=1 (1.0)	N(%)=1 04	
Fisheries	Yes	1 (100.0)	19 (70.4)	13 (33.3)	7 (53.8)	6 (100.0)	1 (100.0)	47 (54.0)	
	No	0 (0.0)	8 (29.6)	26 (66.7)	6 (46.2)	0 (0.0)	0 (0.0)	40 (46.0)	0.006
Shrimp farming	Yes	1 (100.0)	19 (70.4)	15 (38.5)	7 (53.8)	6 (100.0)	1 (100.0)	49 (56.3)	
	No	0 (0.0)	8 (29.6)	24 (61.5)	6 (46.2)	0 (0.0)	0 (0.0)	38 (43.7)	0.019
Cultivation of rice	Yes	0 (0.0)	11 (40.7)	14 (35.9)	6 (46.2)	4 (66.7)	1 (100.0)	36 (41.4)	
	No	1 (100.0)	16 (59.3)	25 (64.1)	7 (53.8)	2 (33.3)	0 (0.0)	51 (58.6)	0.505
Jute Cultivation	Yes	0 (0.0)	6 (22.2)	4 (10.3)	1 (7.7)	1 (16.7)	0 (0.0)	12 (13.8)	
	No	1 (100.0)	21 (77.8)	35 (89.7)	12 (92.3)	5 (83.3)	1 (100.0)	75 (86.2)	0.732
Ecotourism	Yes	0 (0.0)	3 (11.1)	3 (7.7)	0 (0.0)	0 (0.0)	0 (0.0)	6 (6.9)	
	No	1 (100.0)	24 (88.9)	36 (92.3)	13 (100.0)	6 (100.0)	1 (100.0)	81 (93.1)	0.800
Goat rearing	Yes	0 (0.0)	9 (33.3)	10 (25.6)	7 (53.8)	4 (66.7)	0 (0.0)	30 (34.5)	
	No	1 (100.0)	18 (66.7)	29 (74.4)	6 (46.2)	2 (33.3)	1 (100.0)	57 (65.5)	0.197
Riding a motorcycle	Yes	0 (0.0)	6 (22.2)	12 (30.8)	2 (15.4)	2 (33.3)	0 (0.0)	22 (25.3)	
	No	1 (100.0)	21 (77.8)	27 (69.2)	11 (84.6)	4 (66.7)	1 (100.0)	65 (74.7)	0.805
Collection of honey	Yes	1 (100.0)	12 (44.4)	4 (10.3)	0 (0.0)	1 (16.7)	0 (0.0)	18 (20.7)	
	No	0 (0.0)	15 (55.6)	35 (89.7)	13 (100.0)	5 (83.3)	1 (100.0)	69 (79.3)	0.002
Timber business	Yes	0 (0.0)	4 (14.8)	5 (12.8)	3 (23.1)	2 (33.3)	0 (0.0)	14 (16.1)	
	No	1 (100.0)	23 (85.2)	34 (87.2)	10 (76.9)	4 (66.7)	1 (100.0)	73 (83.9)	0.774
Poultry rearing	Yes	1 (100.0)	7 (25.9)	15 (38.5)	5 (38.5)	1 (16.7)	1 (100.0)	30 (34.5)	

	No	0 (0.0)	20 (74.1)	24 (61.5)	8 (61.5)	5 (83.3)	0 (0.0)	57 (65.5)	0.318
Cow fattening	Yes	1 (100.0)	9 (33.3)	14 (35.9)	6 (46.2)	1 (16.7)	1 (100.0)	32 (36.8)	
	No	0 (0.0)	18 (66.7)	25 (64.1)	7 (53.8)	5 (83.3)	0 (0.0)	55 (63.2)	0.401
Agroforestry	Yes	1 (100.0)	7 (25.9)	5 (12.8)	2 (15.4)	1 (16.7)	0 (0.0)	16 (18.4)	
	No	0 (0.0)	20 (74.1)	34 (87.2)	11 (84.6)	5 (83.3)	1 (100.0)	71 (81.6)	0.254
Beekeeping	Yes	1 (100.0)	6 (22.2)	7 (17.9)	4 (30.8)	0 (0.0)	1 (100.0)	19 (21.8)	
	No	0 (0.0)	21 (77.8)	32 (82.1)	9 (69.2)	6 (100.0)	0 (0.0)	68 (78.2)	0.081
Handicrafts	Yes	0 (0.0)	5 (18.5)	1 (2.6)	1 (7.7)	0 (0.0)	0 (0.0)	7 (8.0)	
	No	1 (100.0)	22 (81.5)	38 (97.4)	12 (92.3)	6 (100.0)	1 (100.0)	80 (92.0)	0.279
Integrated rice fish farming	Yes	0 (0.0)	2 (7.4)	0 (0.0)	0 (0.0)	1 (16.7)	0 (0.0)	3 (3.4)	
	No	1 (100.0)	25 (92.6)	39 (100.0)	13 (100.0)	5 (83.3)	1 (100.0)	84 (96.6)	0.274

Table-4.1.21 illustrates the relationship between family monthly income and the three agricultural activities: fisheries, shrimp farming, and rice production. The p-values for the relationship between family monthly income and involvement in fisheries ($p = 0.006$) and shrimp farming ($p = 0.019$) indicate that these associations are statistically significant. This finding means that families are likely to be more inclined to take part in these activities since they vary in income levels. Yet, rice cultivation does not denote the relationship of family income significantly since a p-value of 0.505 shows that this activity distributes fairly across income levels. Findings confirm that income influences the choice of agricultural activities, being more inclined among higher-income families in fisheries and shrimp farming and less among these income cohorts in rice cultivation.

Table-4.1.22: Association between respondent's alternative occupation sources with family monthly income (Contd)

Dependent : Q10 Occupation	Coding category	Agriculture	Farmers and Fishermen	Farmers and small businesses	Farmers and Handicrafts	Farmers and cattle rearing	Farmers and honey collection	Total	P value
Total N (%)		N(%)=42 (40.4)	N(%)=19 (18.3)	N(%)=6 (5.8)	N(%)=3 (2.9)	N(%)=2 (1.9)	N(%)=6 (5.8)	N(%)=104	
Fisheries	Yes	31 (86.1)	11 (68.8)	0 (0.0)	0 (0.0)	0 (0.0)	3 (60.0)	47 (54.0)	
	No	5 (13.9)	5 (31.2)	4 (100.0)	2 (100.0)	1 (100.0)	2 (40.0)	40 (46.0)	<0.001
Shrimp farming	Yes	35 (97.2)	8 (50.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (60.0)	49 (56.3)	
	No	1 (2.8)	8 (50.0)	4 (100.0)	2 (100.0)	1 (100.0)	2 (40.0)	38 (43.7)	<0.001
Cultivation of rice	Yes	32 (88.9)	3 (18.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	36 (41.4)	
	No	4 (11.1)	13 (81.2)	4 (100.0)	2 (100.0)	1 (100.0)	5 (100.0)	51 (58.6)	<0.001
Jute Cultivation	Yes	12 (33.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	12 (13.8)	
	No	24 (66.7)	16 (100.0)	4 (100.0)	2 (100.0)	1 (100.0)	5 (100.0)	75 (86.2)	0.073
Ecotourism	Yes	4 (11.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	6 (6.9)	
	No	32 (88.9)	16 (100.0)	4 (100.0)	2 (100.0)	1 (100.0)	5 (100.0)	81 (93.1)	0.097
Goat rearing	Yes	14 (38.9)	8 (50.0)	1 (25.0)	0 (0.0)	0 (0.0)	1 (20.0)	30 (34.5)	
	No	22 (61.1)	8 (50.0)	3 (75.0)	2 (100.0)	1 (100.0)	4 (80.0)	57 (65.5)	0.523
Riding a motorcycle	Yes	10 (27.8)	1 (6.2)	1 (25.0)	0 (0.0)	0 (0.0)	0 (0.0)	22 (25.3)	
	No	26 (72.2)	15 (93.8)	3 (75.0)	2 (100.0)	1 (100.0)	5 (100.0)	65 (74.7)	0.076
Collection of honey	Yes	11 (30.6)	5 (31.2)	0 (0.0)	0 (0.0)	0 (0.0)	2 (40.0)	18 (20.7)	
	No	25 (69.4)	11 (68.8)	4 (100.0)	2 (100.0)	1 (100.0)	3 (60.0)	69 (79.3)	0.431
Timber business	Yes	10 (27.8)	1 (6.2)	0 (0.0)	0 (0.0)	0 (0.0)	1 (20.0)	14 (16.1)	
	No	26 (72.2)	15 (93.8)	4 (100.0)	2 (100.0)	1 (100.0)	4 (80.0)	73 (83.9)	0.257
Poultry rearing	Yes	20 (55.6)	4 (25.0)	1 (25.0)	0 (0.0)	0 (0.0)	2 (40.0)	30 (34.5)	
	No	16 (44.4)	12 (75.0)	3 (75.0)	2 (100.0)	1 (100.0)	3 (60.0)	57 (65.5)	0.123
Cow fattening	Yes	26 (72.2)	2 (12.5)	1 (25.0)	0 (0.0)	0 (0.0)	2 (40.0)	32 (36.8)	
	No	10 (27.8)	14 (87.5)	3 (75.0)	2 (100.0)	1 (100.0)	3 (60.0)	55 (63.2)	<0.001
Agroforestry	Yes	9 (25.0)	4 (25.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	16 (18.4)	
	No	27 (75.0)	12 (75.0)	4 (100.0)	2 (100.0)	0 (0.0)	5 (100.0)	71 (81.6)	0.222

Beekeeping	Yes	5 (13.9)	4 (25.0)	2 (50.0)	0 (0.0)	0 (0.0)	3 (60.0)	19 (21.8)	
	No	31 (86.1)	12 (75.0)	2 (50.0)	2 (100.0)	1 (100.0)	2 (40.0)	68 (78.2)	0.121
Handicrafts	Yes	2 (5.6)	2 (12.5)	0 (0.0)	2 (100.0)	0 (0.0)	1 (20.0)	7 (8.0)	
	No	34 (94.4)	14 (87.5)	4 (100.0)	0 (0.0)	1 (100.0)	4 (80.0)	80 (92.0)	0.008
Integrated rice fish farming	Yes	1 (2.8)	1 (6.2)	0 (0.0)	0 (0.0)	0 (0.0)	1 (20.0)	3 (3.4)	
	No	35 (97.2)	15 (93.8)	4 (100.0)	2 (100.0)	1 (100.0)	4 (80.0)	84 (96.6)	0.934

The analyze data from the table 4.1.22 cross tabulation exploring the association between self-occupational sources of the respondents with family monthly income. Based on these variables, occupation included agriculture, farmers' and fishermen up to farmers and small business, farmers, and handicrafts, farmers, cattle rearing, farmers, and honey collection with its final number of respondents totaled up to 104. Out of several occupations studied, a number were found to have a significant association with family income. Of notable mention is the fisheries with a highly significant association ($P < 0.001$) with 54.0% of the respondents engaged in this activity, while similar patterns were observed in the case of shrimp farming ($P < 0.001$) and rice cultivation ($P < 0.001$), with a proportion of respondents engaged being 56.3% and 41.4%, respectively. Another with significant association, again under cow fattening ($P < 0.001$), was also observed in handicrafts ($P=0.008$), although it was of less frequency.

Jute cultivation ($P = 0.073$), ecotourism ($P = 0.097$), and motorcycle riding ($P = 0.076$) were not associated with family income, although apparently, these occupations yielded P values less than 0.1. Goat rearing ($P = 0.523$), agroforestry ($P = 0.222$), beekeeping ($P = 0.121$), and rice-fish farming integrated farming systems, $P = 0.934$ were also unassociated with family monthly income. Findings here therefore mean that certain occupational sources have, among other activities, fisheries, shrimp farming, rice cultivation, cow fattening, and tiny crafts, and were associated more with family income than others.

Table-4.1.23: Association between respondent's alternative occupation sources with family monthly income (Cont'd)

Dependent: Q10 Occupation	Coding category	Work of farmers and bricklayers	Farmers and rickshaw driving	Farmers and CNG Driving	Farmers and tea shops	Farmers and wood collection	Total	P value
Total N (%)		N(%)=5 (4.8)	N(%)=5 (4.8)	N(%)=1 (1.0)	N(%)=5 (4.8)	N(%)=1 (1.0)	N(%)=104	
Fisheries	Yes	0 (0.0)	0 (0.0)	0 (0.0)	1 (25.0)	0 (0.0)	47 (54.0)	
	No	5 (100.0)	5 (100.0)	1 (100.0)	3 (75.0)	1 (100.0)	40 (46.0)	<0.001
Shrimp farming	Yes	0 (0.0)	1 (20.0)	0 (0.0)	1 (25.0)	0 (0.0)	49 (56.3)	
	No	5 (100.0)	4 (80.0)	1 (100.0)	3 (75.0)	1 (100.0)	38 (43.7)	<0.001
Cultivation of rice	Yes	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	36 (41.4)	
	No	5 (100.0)	5 (100.0)	1 (100.0)	4 (100.0)	1 (100.0)	51 (58.6)	<0.001
Jute Cultivation	Yes	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	12 (13.8)	
	No	5 (100.0)	5 (100.0)	1 (100.0)	4 (100.0)	1 (100.0)	75 (86.2)	0.073
Ecotourism	Yes	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	6 (6.9)	
	No	5 (100.0)	5 (100.0)	0 (0.0)	4 (100.0)	1 (100.0)	81 (93.1)	0.097
Goat rearing	Yes	1 (20.0)	0 (0.0)	0 (0.0)	1 (25.0)	1 (100.0)	30 (34.5)	
	No	4 (80.0)	5 (100.0)	1 (100.0)	3 (75.0)	0 (0.0)	57 (65.5)	0.523
Riding a motorcycle	Yes	4 (80.0)	3 (60.0)	0 (0.0)	2 (50.0)	0 (0.0)	22 (25.3)	
	No	1 (20.0)	2 (40.0)	1 (100.0)	2 (50.0)	1 (100.0)	65 (74.7)	0.076
Collection of honey	Yes	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	18 (20.7)	
	No	5 (100.0)	5 (100.0)	1 (100.0)	4 (100.0)	1 (100.0)	69 (79.3)	0.431
Timber business	Yes	1 (20.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	14 (16.1)	
	No	4 (80.0)	5 (100.0)	1 (100.0)	4 (100.0)	0 (0.0)	73 (83.9)	0.257
Poultry rearing	Yes	0 (0.0)	1 (20.0)	0 (0.0)	2 (50.0)	0 (0.0)	30 (34.5)	
	No	5 (100.0)	4 (80.0)	1 (100.0)	2 (50.0)	1 (100.0)	57 (65.5)	0.123
Cow fattening	Yes	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	32 (36.8)	
	No	5 (100.0)	5 (100.0)	1 (100.0)	4 (100.0)	1 (100.0)	55 (63.2)	<0.001
Agro forestry	Yes	0 (0.0)	0 (0.0)	0 (0.0)	2 (50.0)	0 (0.0)	16 (18.4)	
	No	5 (100.0)	5 (100.0)	1 (100.0)	2 (50.0)	1 (100.0)	71 (81.6)	0.222
Beekeeping	Yes	0 (0.0)	1 (20.0)	0 (0.0)	0 (0.0)	0 (0.0)	19 (21.8)	
	No	5 (100.0)	4 (80.0)	1 (100.0)	4 (100.0)	1 (100.0)	68 (78.2)	0.121
Handicrafts	Yes	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	7 (8.0)	

	No	5 (100.0)	5 (100.0)	1 (100.0)	4 (100.0)	1 (100.0)	80 (92.0)	0.008
Integrated rice fish farming	Yes	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (3.4)	
	No	5 (100.0)	5 (100.0)	1 (100.0)	4 (100.0)	1 (100.0)	84 (96.6)	0.934

Table 4.1.23 shows the statistical relationship of the respondents' occupations with their monthly household income under all combined activities such as farmer and brick kiln worker, farmer and rickshaw worker, farmer and CNG worker, farmer and tea shop worker, farmer and wood collector. The analysis revealed a very high and significant relationship of household income with fishery ($P < 0.001$), as well as the related shrimp farming ($P < 0.001$) and no member of these two occupation categories participated in this activity, only a small percentage were employed in tea shop (25.0% for fishery and shrimp farming).

Similarly, respondents from all households were significantly associated with paddy farming ($P < 0.001$) and cattle fattening ($P < 0.001$) as they were not previously engaged in the activities. On the other hand, there was no significant association between household income and occupations such as jute cultivation ($P=0.073$), ecotourism ($P=0.097$), and motorcycling ($P=0.076$), although slight differences were observed across groups. Other activities such as timber business ($P=0.257$), poultry farming ($P=0.123$), goat farming ($P=0.523$), agroforestry ($P=0.222$), beekeeping ($P=0.121$), and integrated rice-fish farming ($P=0.934$) did not show any statistical association.

In addition, the analysis indicated that handicrafts ($P=0.008$) were significantly associated with household income. These, overall, show stronger relationships with household income for fisheries, shrimp farming, rice farming, and cattle fattening than for other occupations, although a good number of cases show very limited, if any, significant relationships.

Table-4.1.24: Association between respondent's alternative occupation sources with family monthly income (Cont'd)

Dependent: Q10 Occupation	Coding category	Farmers and Day Laborers	Farmers and Apiculture	Farmers and Golpata collection	Farmers and pea workers	Farmers and working in garments in cities	Farmers and oil fryers	Farmers and small businesses_duplicated_16	Total	P value
Fisheries	Yes	1 (16.7)	0 (0.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	47 (54.0)	
	No	5 (83.3)	1 (100.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	40 (46.0)	<0.001
Shrimp farming	Yes	1 (16.7)	0 (0.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	49 (56.3)	
	No	5 (83.3)	1 (100.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	38 (43.7)	<0.001
Cultivation of rice	Yes	1 (16.7)	0 (0.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	36 (41.4)	
	No	5 (83.3)	1 (100.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	51 (58.6)	<0.001
Jute Cultivation	Yes	0 (0.0)	0 (0.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	12 (13.8)	
	No	6 (100.0)	1 (100.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	75 (86.2)	0.073
Ecotourism	Yes	1 (16.7)	0 (0.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	6 (6.9)	
	No	5 (83.3)	1 (100.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	81 (93.1)	0.097
Goat rearing	Yes	3 (50.0)	0 (0.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	30 (34.5)	
	No	3 (50.0)	1 (100.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	57 (65.5)	0.523
Riding a motorcycle	Yes	1 (16.7)	0 (0.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	22 (25.3)	
	No	5 (83.3)	1 (100.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	65 (74.7)	0.076
Collection of honey	Yes	0 (0.0)	0 (0.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	18 (20.7)	
	No	6 (100.0)	1 (100.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	69 (79.3)	0.431
Timber business	Yes	0 (0.0)	0 (0.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	14 (16.1)	
	No	6 (100.0)	1 (100.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	73 (83.9)	0.257
Poultry rearing	Yes	0 (0.0)	0 (0.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	30 (34.5)	
	No	6 (100.0)	1 (100.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	57 (65.5)	0.123
Cow fattening	Yes	1 (16.7)	0 (0.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	32 (36.8)	
	No	5 (83.3)	1 (100.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	55 (63.2)	<0.001

Agro forestry	Yes	0 (0.0)	0 (0.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	16 (18.4)	
	No	6 (100.0)	1 (100.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	71 (81.6)	0.222
Beekeeping	Yes	3 (50.0)	1 (100.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	19 (21.8)	
	No	3 (50.0)	0 (0.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	68 (78.2)	0.121
Handicrafts	Yes	0 (0.0)	0 (0.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	7 (8.0)	
	No	6 (100.0)	1 (100.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	80 (92.0)	0.008
Integrated rice fish farming	Yes	0 (0.0)	0 (0.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	3 (3.4)	
	No	6 (100.0)	1 (100.0)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	0 (NaN)	84 (96.6)	0.934

According to table 4.1.24 cross tabulation data shows the association between respondent's occupation sources with family monthly income. From the findings, it has been observed that the occupations of the respondents reveal that statistically significant associations, regarding fisheries (P<0.001), are available for shrimp farming (P<0.001), rice cultivation (P<0.001) and cow fattening (P<0.001). Very few respondents such as farmers and day laborers involve some in fisheries, shrimp farming or cow fattening, whereas others were not involved.

Other income-generating activities such as jute cultivation (P=0.073), ecotourism (P=0.097) and motorcycling (P=0.076) did not have any significance associated with occupations. As well, occupations such as goat rearing (P=0.523), timber business (P=0.257), poultry rearing (P=0.123), agroforestry (P=0.222) and beekeeping (P=0.121) also did not show any significant associations.

Handicrafts (P=0.008) has a significant association with occupational but demonstrates apparently limited participation by the farmers in this activity. On the contrary, integrated rice-fish farming (P=0.934) showed no significant relationship. In general, results showed that fisheries, shrimp farming, rice cultivation, cow fattening and handicraft activities have strong significant associations with respective occupational groupings meanwhile many other economic activities have non, or marginal relationships associated probably because of their confined or specific positions.

Table-4.1.25: Association between respondents' influences traditional professions with family monthly income

Dependent: Influences traditional professions	Coding category	No	Yes	Total	P value
Total N (%)		N(%)=29 (27.9)	N(%)=75 (72.1)	N(%)=104	
Fisheries	Yes	5 (20.8)	42 (66.7)	47 (54.0)	
	No	19 (79.2)	21 (33.3)	40 (46.0)	<0.001
Shrimp farming	Yes	3 (12.5)	46 (73.0)	49 (56.3)	
	No	21 (87.5)	17 (27.0)	38 (43.7)	<0.001
Cultivation of rice	Yes	2 (8.3)	34 (54.0)	36 (41.4)	
	No	22 (91.7)	29 (46.0)	51 (58.6)	<0.001
Jute Cultivation	Yes	1 (4.2)	11 (17.5)	12 (13.8)	
	No	23 (95.8)	52 (82.5)	75 (86.2)	0.208
Ecotourism	Yes	2 (8.3)	4 (6.3)	6 (6.9)	
	No	22 (91.7)	59 (93.7)	81 (93.1)	1.000
Goat rearing	Yes	7 (29.2)	23 (36.5)	30 (34.5)	
	No	17 (70.8)	40 (63.5)	57 (65.5)	0.695
Riding a motorcycle	Yes	5 (20.8)	17 (27.0)	22 (25.3)	
	No	19 (79.2)	46 (73.0)	65 (74.7)	0.754
Collection of honey	Yes	1 (4.2)	17 (27.0)	18 (20.7)	
	No	23 (95.8)	46 (73.0)	69 (79.3)	0.040
Timber business	Yes	2 (8.3)	12 (19.0)	14 (16.1)	
	No	22 (91.7)	51 (81.0)	73 (83.9)	0.374
Poultry rearing	Yes	5 (20.8)	25 (39.7)	30 (34.5)	
	No	19 (79.2)	38 (60.3)	57 (65.5)	0.161
Cow fattening	Yes	2 (8.3)	30 (47.6)	32 (36.8)	
	No	22 (91.7)	33 (52.4)	55 (63.2)	0.002
Agro forestry	Yes	1 (4.2)	15 (23.8)	16 (18.4)	
	No	23 (95.8)	48 (76.2)	71 (81.6)	0.071
Beekeeping	Yes	3 (12.5)	16 (25.4)	19 (21.8)	
	No	21 (87.5)	47 (74.6)	68 (78.2)	0.312
Handicrafts	Yes	2 (8.3)	5 (7.9)	7 (8.0)	
	No	22 (91.7)	58 (92.1)	80 (92.0)	1.000
Integrated rice fish farming	Yes	1 (4.2)	2 (3.2)	3 (3.4)	
	No	23 (95.8)	61 (96.8)	84 (96.6)	1.000

Data cross tabulation (Table-4.1.25) presents the correlation between practices of traditional occupations like fisheries, shrimp farming, and rice cultivation, and whether these have influenced traditional professions. Responses Distribution: 'No Influence on Traditional Occupations, ' 27.9% of respondents. Altogether, 72.1% of the respondents. Out of which 46.0% are those who do not get entangled in fisheries, such people are those (79.2%) that do not think their involvement in fisheries increases their traditional occupations. An approximate amount of (54.0%) involves the overall population of respondents that practiced fisheries.

Out of that, (66.7%) perceived that fisheries do have influence over traditional occupations that pinpoints that very relevant co-relation exists between fishes and perceived influence on traditional occupations. 43.7% of total respondents do not participate in shrimp farming, 87.5% of whom say that it does not influence their traditional professions. The p-values for fisheries ($p < 0.001$), shrimp farming ($p < 0.001$), and rice cultivation ($p < 0.001$) all indicate statistically significant relationship. The other 56.3% of respondents are involved in shrimp farming, with 73.0% of these respondents claiming that shrimp farming affects their traditional professions- this implies that shrimp farming is considerable in terms of practice to traditional professions.

Cultivation of Rice 58.6% of respondents do not cultivate rice, with 91.7% declaring that it does not affect their traditional occupations. What this implies is that 41.4% of respondents cultivate rice, and 54.0% believe that it influences traditional occupations. Thus, it seems fair to conclude that rice cultivation does have a moderate effect on traditional occupations.

Table-4.1.26: Association between drip irrigation with family monthly income source

Dependent: Drip irrigation	Coding category	No	Yes	Total	P value
Total N (%)		N(%)=36 (34.6)	N(%)=68 (65.4)	N(%)=104	
Fisheries	Yes	10 (33.3)	37 (64.9)	47 (54.0)	
	No	20 (66.7)	20 (35.1)	40 (46.0)	0.010
Shrimp farming	Yes	9 (30.0)	40 (70.2)	49 (56.3)	
	No	21 (70.0)	17 (29.8)	38 (43.7)	0.001
Cultivation of rice	Yes	2 (6.7)	34 (59.6)	36 (41.4)	
	No	28 (93.3)	23 (40.4)	51 (58.6)	<0.001
Jute Cultivation	Yes	0 (0.0)	12 (21.1)	12 (13.8)	
	No	30 (100.0)	45 (78.9)	75 (86.2)	0.017
Ecotourism	Yes	1 (3.3)	5 (8.8)	6 (6.9)	
	No	29 (96.7)	52 (91.2)	81 (93.1)	0.613
Goat rearing	Yes	6 (20.0)	24 (42.1)	30 (34.5)	
	No	24 (80.0)	33 (57.9)	57 (65.5)	0.068
Riding a motorcycle	Yes	10 (33.3)	12 (21.1)	22 (25.3)	
	No	20 (66.7)	45 (78.9)	65 (74.7)	0.321
Collection of honey	Yes	6 (20.0)	12 (21.1)	18 (20.7)	
	No	24 (80.0)	45 (78.9)	69 (79.3)	1.000
Timber business	Yes	3 (10.0)	11 (19.3)	14 (16.1)	
	No	27 (90.0)	46 (80.7)	73 (83.9)	0.415
Poultry rearing	Yes	5 (16.7)	25 (43.9)	30 (34.5)	
	No	25 (83.3)	32 (56.1)	57 (65.5)	0.021
Cow fattening	Yes	4 (13.3)	28 (49.1)	32 (36.8)	
	No	26 (86.7)	29 (50.9)	55 (63.2)	0.002
Agro forestry	Yes	4 (13.3)	12 (21.1)	16 (18.4)	
	No	26 (86.7)	45 (78.9)	71 (81.6)	0.554
Beekeeping	Yes	11 (36.7)	8 (14.0)	19 (21.8)	
	No	19 (63.3)	49 (86.0)	68 (78.2)	0.031
Handicrafts	Yes	4 (13.3)	3 (5.3)	7 (8.0)	
	No	26 (86.7)	54 (94.7)	80 (92.0)	0.368
Integrated rice fish farming	Yes	1 (3.3)	2 (3.5)	3 (3.4)	
	No	29 (96.7)	55 (96.5)	84 (96.6)	1.000

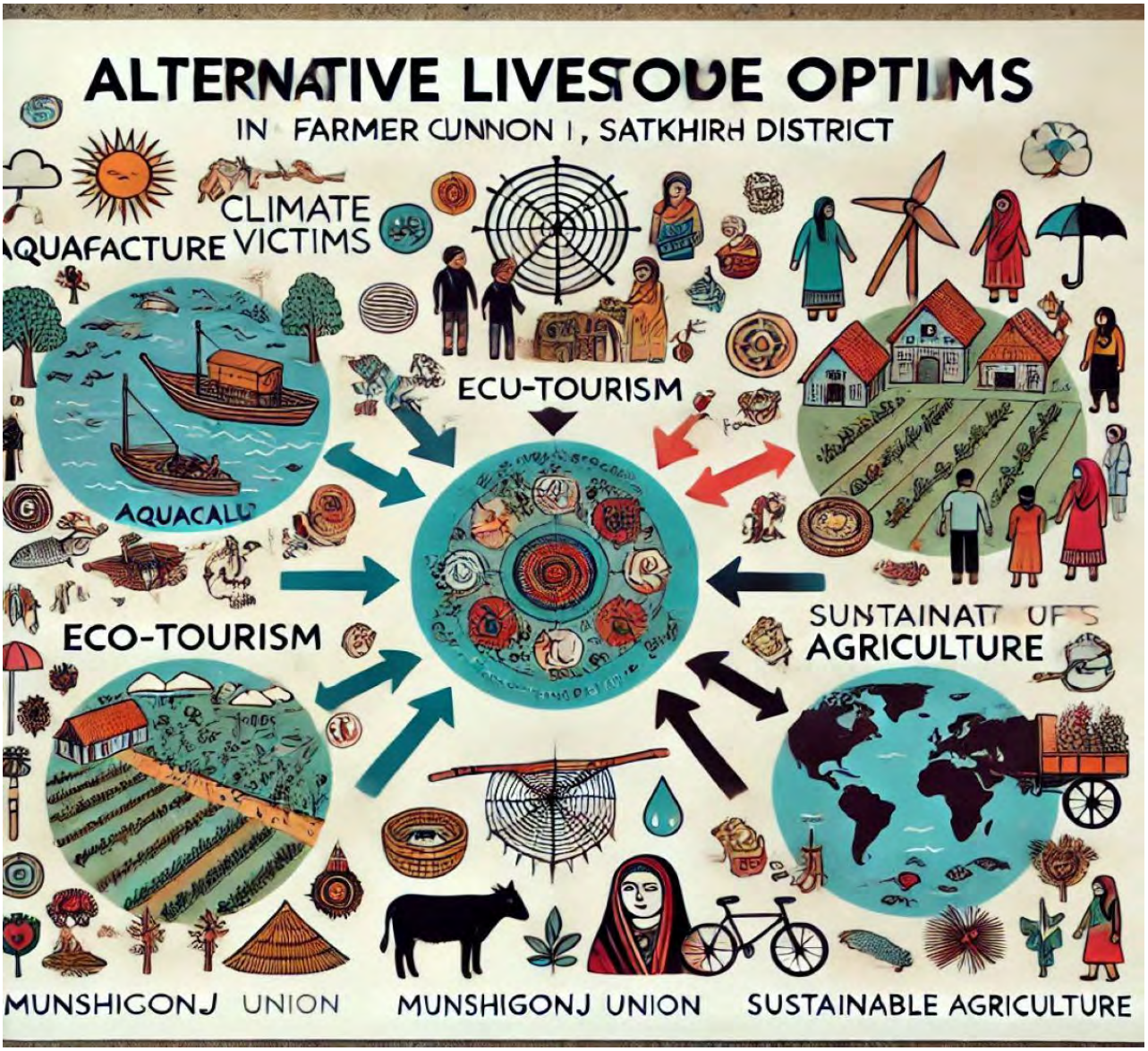
The cross-tabulation data in Table-4.1.26 examines the relationship between the use of drip irrigation and participation in some agricultural activities such as fisheries, shrimp farming and paddy farming. It contains information on 104 respondents who are drip irrigation users and non-drip irrigation users. According to the drip irrigation usage survey, more than three-fifths of the respondents (65.4%) use drip irrigation while others (34.6%) do not use it.

Overall (46.0%) are not involved in fisheries. Out of these (66.7%) do not use drip irrigation while (35.1%) do use it. Out of the total respondents involved in fisheries, 54.0% (64.9%) use drip irrigation. This indicates an established link between fisheries and the use of drip irrigation facilities. Out of these (70.0%) respondents who are not involved in shrimp farming do not use drip irrigation. A total of (56.3%) respondents are engaged in shrimp farming and (70.2%) use drip irrigation. This indicates a strong relationship between shrimp farming and the adoption of drip irrigation methods.

A total of (58.6%) respondents do not cultivate rice, an impressive (93.3%) of them do not use drip irrigation. A total of (41.4%) respondents cultivate rice and (59.6%) of these users use drip irrigation. Thus, the contribution of rice farming between using and not using drip irrigation is great. In fish farming ($p = 0.010$), shrimp farming ($p = 0.001$) and rice farming ($p < 0.001$) again all indicate statistically significant relationships between this activity and the use of drip irrigation.

4.2. Qualitative Findings

Alternative livelihood options for climate victims of farmer community of Munshiganj Union at Satkhira district.



Source: *Field data collection*

4.2.1 Perceptions of the Community Regarding Adoption of Aquaculture

FGD -1: Perceptions on Adoption of Aquaculture

According to the FGD participants from the Harinagar area, 'The transformation from rice farming to shrimp farming is a drastic change in our sources of livelihood. Apart from the increased income compared to traditional farming, shrimp farming is high in upfront investment, which not all of us can afford. Some people have experienced the problems that arise from a lack of technical knowledge, and without proper training, it's hard to be successful in this business. However, we believe that with more support and training, shrimp farming can be a sustainable option for our community. The salinity in our land makes it difficult to grow crops, so shrimp farming seems like a good alternative."

According to a key informant in this context, "Most profitable shrimp farming also has some risks. The risk comes mostly when diseases spread among the shrimps. There should be adequate information and resources made available for managing these risks."

Case-1: A Story of Transformation through Aquaculture

"My name is Rafiq. I am a farmer. We, too, suffer a lot from increased salinity in the soil and heavy inundations at periodic intervals like most farmers in the Munshiganj district. Cultivation of paddy, which my family had relied upon, has become impossible now due to salinity, and so the once-thriving rice fields are no longer generating enough production. This has left most of us with no source of income. Currently, I must rely on aquaculture to survive." (Case-1: from Jelekhali area)

Case-2: Shifting to shrimp farming

"My name is Subal. Due to natural disasters for climate change, most of the farmers in our area have now chosen shrimp farming as an alternative profession. I am currently engaged in this profession. I think shrimp farming can bring in more income than conventional farming. I believe that shrimp farming can be a stable source of income if provided with necessary support, training and resources." (Case-2 from Kachukhali area)

4.2.2 FGD -2: Challenges and Opportunities in Agroforestry

According to the FGD participants from Garaze Bazar**,** "Agroforestry has been a good way for us to use our land more effectively. By planting fruit trees and collecting timber alongside our crops, we have seen improvements and additional income. However, it takes time to see the benefits, and not everyone has the patience or resources to wait.

According to one key informant, “We need more training on which trees to plant and how to manage them properly. Also, getting the right market for our fruits and timber is still a challenge.

Another key informant stated that, "Agroforestry is good, but it added value to income diversification. The high initial costs of doing this have become roadblocks for most of us in establishing systems on their farms and the necessary seedlings and tools. If the government increases its support in this area, many farmers would readily adopt the practice."

4.2.3 KII -1: Observations on the Shift to Handicrafts and Small-Scale Industries (KII-1 from Harinagar location)

According to the observation on the trend towards handicrafts and small-scale industries, the small-scale industry entrepreneur informants revealed that, “Handicrafts and small-scale industries will provide an alternative for people who cannot farm themselves; most importantly, women, who have the potential to earn income by working from the comfort of their homes. A major challenge faced is limited market access. Many of the products we produce do not reach the big markets and we sell them locally at lower prices. This will bring better exposure to the market – then we can make a better living from it.”

The key informants further added, “The growth potential of small-scale industries is huge, but to reach the bigger markets, better infrastructure like transportation and communication is needed. Also, training in modern techniques can help us improve the quality of our products and make them competitive.”

4.2.4: Challenges in implementing alternative livelihoods for climate victims

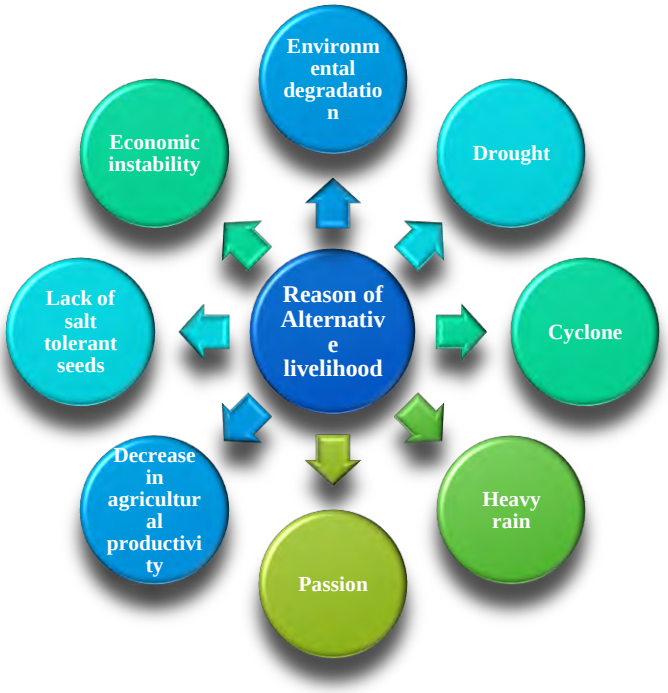


Figure-20: Reason behind Alternative livelihood

FGD-3: Impact of environmental degradation on agricultural productivity

According to the FGD of the farming community as well as local traders, "Increasing salinity and soil erosion have severely reduced our agricultural productivity. In the past, we used to produce enough crops to use for our families and sell the rest. Now, we cannot produce enough crops for ourselves. The soil has deteriorated so much that even a genetic agricultural tradition is no longer viable. It is scary for us because everything is becoming more barren every year. Local traders emphasize the need for pilot programs and international funding such as Green Climate Fund, ADB fund for climate adaptation and resilience projects, focusing primarily on agriculture and community-based interventions.

They suggest for essential need of collaboration with governments and development banks to take and implement projects targeting vulnerable populations by making these funds available to farmers through policy development. According to a key informant, "The government should really do something for our livelihood". Despite some government assistance, it takes us a long time to get it. But we need immediate alternatives to survive.

Case-03: Ideas about Alternative Sources of Income

"My name is Jahangir Hossain. The thought of not working in agriculture anymore has been on my mind for quite some time now because farming is getting harder every year. I have heard some people talking about starting fish farming or small businesses. Although acquiring new skills is difficult for us, there is no alternative to it to face the climate change potential." (Case-3 from Harinagar area)

FGD -4: Drought and Water Scarcity

According to FGD participants from Kultoli, 'Drought has turned into a big enemy for us in the last few years. It hasn't rained well and thus made the impossibility to cultivate our traditional crops. The rivers have all become at the brink of getting dried up. Wells are dug, but the water level is very low. The failure of crops leaves us with nothing even to sell much less than what to eat. Some of us look for alternative livelihoods but, we don't have the necessary skills and resources to make a successful transition."

According to a key informant illustrated that, "We need more government and NGO support to build irrigation systems that can withstand these droughts. Otherwise, we will have to leave farming altogether."

KII-2: Coping with frequent cyclones

(KII-2 from Jelekhali location)

According to Key Informant Interviews of farmer's community, "The frequent cyclones that come ashore have caused extensive damage to our homes and crops. Every time a cyclone hits, we lose everything and start anew. Cyclone compensation from the government is never enough to bring our lives back to normal. Farmers are gradually giving up farming because they cannot bear the repeated losses. Those who remain urgently need alternative livelihoods, which are disaster resilient."

According to a key informant in this regard, "We need better cyclone shelters and early warning systems, but more importantly, we need new ways of making a living that are not so dependent on land and weather."

KII-3: Economic instability due to lack of salt-tolerant seeds

(KII-3 from Dhankhali location)

Regarding the economic instability due to lack of salt-tolerant seeds, key informants from the farming community mentioned, “The way things have turned out, the shortage of salt-tolerant seeds has weakened our economy. Whereas earlier we had to rely on traditional crops for our crop income, the increasing salinity of the soil has rendered conventional seeds ineffective. Without suitable seeds, our crops fail massively, creating economic instability for many families. We need salt-tolerant seeds as well as training in their use, but it is very difficult to get.”

In this context a key informant stated that, “If the government and NGOs can provide more support in distributing salt-tolerant seeds, it will help a lot in the economic stability of our farmers.”

KII -4: Decreasing Agricultural Productivity and the Need for Economic Diversification

(KII-4 from Kachukhali location)

According to a key informant, “Agricultural productivity is declining due to challenges such as environmental degradation and water scarcity. Many in our community have started looking at non-farm activities such as small businesses or labor, but many do not know much about this. As a result, many faces various obstacles in maintaining alternative occupations. To make these options viable, we need proper training, access to capital and market linkages.”

Another informant stated that, “We can no longer rely on agriculture. The government should create effective programs for farmers to move to other sectors, so that a stable income can be ensured.”

Case-04: Reason for Searching Alternative Livelihoods

My name is Rahima Khatun. I started looking for a job after many crops were destroyed due to floods and drought. Currently, agricultural income has become insufficient, so I am looking for a more stable alternative source of income to support my family.” (Case-4 from Dhankhali area)

4.2.5: Impact of Climate Change on Agriculture, Water, and Livelihoods

(KII-5: local community leaders from Kodomtola location)

Key informants illustrated that, due to climate change, the demand for clean water is constantly increasing and due to the lack of safe water, people in the area are constantly increasing the incidence of diseases like cholera, diarrhea and dysentery. In addition, soil salinity is hampering agricultural productivity. Due to the increase in soil salinity, freshwater fish farming is being hampered, and the food crisis is getting worse day by day. Due to the increase in salinity, the amount of cultivable land of farmers is decreasing day by day. In addition, various natural disasters cause extensive damage to crop and many times it leaves farmers destitute.

Picture-22: Flash Flood

Picture-23: Scarcity of fresh water

(**Source:** Field data collection)

According to a farmer's key informant, "we have been living here since the time of our forefathers. In recent times, we are witnessing more natural disasters than in the past. Earlier, almost all the crops used to grow on our own, but today we cannot cultivate anything more than two or three crops. Moreover, growing crops on agricultural land is very expensive and challenging due to the saltwater entering the river every year. Fresh water sources are on the verge of extinction due to increased salinity in the soil. The scarcity of fresh drinking water is increasing day by day. Climate change is threatening our quality of life. Yet, we are struggling to sustain our existence amidst hundreds of adversities here with the bricks and soil of our forefathers."

Picture-24: Water logging

Picture-25: Riverbank erosion

(**Source:** Field data collection)

Case-05: Negative Impact of Climate Change on Agriculture

"My name is Abdul Karim, and I have been a rice farmer for 20 years. In recent years, I've noticed that the weather is changing, and it's affecting my crops. Heavy rains are flooding my fields, and droughts are making it hard to grow anything. Yields have dropped, and I'm worried about the future of farming in my area". (Case-5 from Garaze Bazar area)

4.2.6: KII -6: Adaptive Agricultural Practices in Saline-Affected Regions

(KII-6 from Garaze Bazar location)

To protect crops, farmers adopt various methods such as mulching methods, drought resistant crops, salt tolerant sowing and soil amendment methods. Moreover, they use different methods, including underground fresh water, to irrigate the croplands.

According to an informant, "farming has become a little difficult for our farmers due to the salinity of our region. Since the soil of the field is saline, we apply gypsum fertilizer in the field after cultivation and leave it for about 5-6 days, due to which the amount of saline in the field decreases. Gypsum removes the salinity of the soil and makes the land suitable for growing crops. There is no need to irrigate Aman paddy in the rainy season, but in the summer, we use underground fresh water to irrigate the Boro paddy fields.

Case-06: Livelihoods Adopted by Farmers in Response to Climate Change

"My name is Ripon Kumar Kundo. I have stopped growing rice and started raising goats and chickens. The weather is making farming difficult, but with livestock, I have a better chance of earning money. I got the idea from other farmers who have already made the switch." (Case-6 from Kodomtola area)

Picture-26: Effect of soil salinity

Picture-27: Effect of soil salinity

(**Source:** Field data collection)

4.2.7: KII -7: Impact of Climate Change on Agriculture Challenges of Heat waves, Water Scarcity, and Rising Costs

(KII-7 from Dhankhali location)

The dangerous negative impacts of climate change on agriculture are severe heat waves, changes in rainfall patterns, increased pest and disease pressures, lack of fresh water, loss of soil fertility, and reduced soil nutrient quality. Lack of water and irrigation becomes difficult.

According to an informant, "due to climate change, the cultivation process in the field is slow due to lack of timely rainfall. Due to the late rains in the rainy season, we must depend on rain for cultivation in the field. That is why we must start the cultivation process late along with the rain. After sowing the seeds in the field, the rice plants die due to drought and lack of rain during the rainy season. This causes huge loss to the farmers. The price of everything in the market, such as seeds, fertilizers, diesel for farming and irrigation, is also increasing."

Picture-28: Supply water used by Community

Picture-29: Safe drinking Water Collection

Picture-30: Drought

Picture-31: Drought

Drought and lack of fresh water (**Source:** Field data collection)

4.2.8: KII -8: Shrimp Farming in Crisis the Shift to Alternative Livelihoods Amidst Viral Outbreaks in Munshiganj Union at Satkhira district

(KII-8 from Jelekhali location)

Being a coastal area, shrimp farming is very profitable in saline water, but at present, coastal fish farmers are calm in the face of the virus. The attack of virus is maximum in Bagda shrimp farming. In the farming of Bagda shrimp everything becomes white because of the virus infection. There is nothing left in the enclosure, the shrimp and cucumbers die and mix with the soil under the water like dust (when the shrimp and cucumbers die, they do not decompose and float on the water, so the shrimp farmers do not realize at first that the virus is infected). Due to continuous loss in shrimp farming, they have started looking for alternative livelihoods.

According to an informant, "we have been cultivating shrimp in saline water for generations. But in recent times, there has been a loss of crops. Because of the virus, all the fish are dying. When the Bagda prawns die, they do not decompose and float on the water, so we do not easily understand that the virus has been transmitted in the nest. After buying Bagda's pony and releasing it in the enclosure, I sold only 18 thousand takas. I left a total of one to one and a half lakh taka in my enclosure but sold only 18 thousand takas. I don't know how to deal with this loss. At present, I have given a tea shop in the market along with the enclosure, I am happy with the money I earn from that shop. Due to the continuous loss in shrimp farming, I have chosen tea shop or small business as an alternative occupation. At least everyone has to eat to survive."

Picture-32: Shrimp farming

Picture-33: Bed of Shrimp farming

(**Source:** Field data collection)

Case-07: Professions Farmers Take Up Instead of Crab Farming

I am Shafiqur Rahman. I used to farm crabs, but storms destroyed my ponds. Now, I'm working as a laborer in construction. It's not what I planned, but crab farming was no longer possible with the changing weather. (Case-7 from Jelekhali area)

4.2.9: KII -9: Adapting to Adversity the Shift from Shrimp Farming to Agriculture in Coastal Areas over the Last 10 years. (KII-9 from Jelekhali location)

Saltwater shrimp farming is very popular in coastal areas. Besides, farming is a very profitable business. But for several years, shrimp farming has been facing continuous losses due to natural disasters and virus infections. Because of this, shrimp farmers and nest owners in the region are showing more interest in agriculture as an alternative occupation. These farmers are investing more

money and labor in the cultivation of Boro paddy, because of which they have been able to take home 20-25 maunds of paddy per bigha in the Boro season this year. Many people are also providing passenger services in various small businesses and motorized vans.

According to an informant, "I have four enclosures where I used to grow prawns. Initially, shrimp farming was very profitable, but now it has become a matter of time for us. For the last 6-7 years, as there was no expected profit in shrimp farming, I cultivated Boro paddy on shrimp farming land, and cultivated potatoes in winter on the fence of the enclosure. I cultivated Boro paddy on 15 katha of land this year and got about 20 maunds of paddy from there. I'm going to plant all my corn next year."

Picture-34: Crop damage by flood

Picture-35: Cultivation of salinity tolerant rice

Source: Field data collection

Case-08: Changes in Farming Profession over the Last 10 Years

"I am Rehana Begum, and I used to only grow rice. But in the past 10 years, I have started to grow vegetables and fruits. The weather is less predictable, so I had to change what I grew. It's been hard, but growing different crops has helped me support my family." (Case-8 from Kultoli area)

4.2.10: KII -10: Emergence of Salt-Tolerant Rice Cultivation of a New Agricultural Horizon for Coastal Farmers

(KII-10 from Harinagar location)

Being a coastal area, the farmers here cultivate salt-tolerant rice due to the high salt content in the soil. For example, BRRI-47, BRRI-61, BINA-8, BRRI-28, BRRI-55, BINA-11, BINA-10, BINA-47. Each of these varieties is salt-tolerant and high yielding.

According to an informant, "since the introduction of salt-tolerant rice seeds, the amount of rice planted in the Boro season in our area has increased at a comparable rate. The farmers who used to cultivate shrimp throughout the year now cultivate shrimp for nine months of the year and Boro paddy for the remaining three months. We used to buy rice throughout the year before cultivating rice. But now that most of the farmers in the area are cultivating rice, they no longer must buy rice to eat, so they can save some money. Moreover, farmers in areas where the salt content is relatively high cultivate salt-tolerant Aman paddy in the season of Aman paddy cultivation. At present, the cultivation of salt-tolerant rice has been described as the beginning of a new horizon of agricultural revolution in our coastal people.

Picture-36: Cultivation of salinity tolerant rice

Picture-37: Cultivation of salinity tolerant rice

Picture-17: Salt-Tolerant Rice Cultivation (**Source:** Field data collection)

4.2.11: KII -11: Diversification in Coastal Farming the Rise of Watermelon Cultivation as an Alternative to Traditional Crops

(KII-11 from Kultoli location)

As an alternative to rice, coastal farmers cultivate a variety of crops, including tomatoes and watermelons. Usually, in the month of Magh-Falgun, they cultivate the land, plant watermelon seedlings and regularly irrigate it with fertilizer and water. They apply insecticide after 3-4 days

to control insects. Some people say that each watermelon here is about 5-6 kg, sometimes even more. There are many farmers who cultivate watermelon and other vegetables like sweet pumpkin, gourd, cucumber etc throughout the year using mulching methods.

According to an informant, "after cultivating paddy this year, I cultivated watermelon on 2 bigha as of land. The cultivation of watermelon is a little more laborious and the cost of fertilizers and pesticides has increased a little. But the good news is that I was able to sell about 700-800 pieces of watermelon at the grazing price and I got a profit of 50000 taka excluding expenses. Then I sold the remaining fruits at a low price and made a profit of 20,000 taka. This year I cultivated watermelon and got a total profit of about 70000 takas. I have chosen watermelon cultivation as an alternative to paddy cultivation."

Picture-38: Cultivation of traditional crops

Picture-39: Cultivation of Watermelon

Source: Field data collection

Case-09: Alternative Crops to Rice Farming

"I am Jahanara Begum, a farmer for 15 years. With the changing weather, growing rice has become difficult. So, I started planting vegetables like tomatoes and pumpkins. These crops are less affected by the weather, and I can still earn a living from them. (Case-9 from Kodomtola area)

4.2.12: KII -12: Transforming Coastal Agriculture the Shift from Rice to White Fish Farming for Enhanced Profitability

(KII-12 from Jelekhali location)

As an alternative to rice farming, coastal farmers are cultivating white fish in ponds and enclosures. Among the white fish, Rui, Katla, Mrigel, Mirror Carp, Pangas and Telapia fish are majorly cultivated. There is no end to the interest of the farmers in this profession as they can get more profit with less cost and less hard work.

Picture-40: Fish farming supported by NGO

According to an informant, after cultivating paddy, I mixed dung and dung in the field and mixed it with the soil and left it for about 1 month. After a month, the water is removed from the enclosure with the help of boring to make it suitable for plankton so that after the release of fish droppings, they can eat these plankton as food. By using this method, the cost of farming white fish is less. Last year, using the same method, I released 30 kg of Rui, Katla, Kalibaush fish fillets. A year later, I had 800-900 grams per kilogram. Last year, I made a profit of 1 lac taka. This year I'm using the same method. Not only me, but there are also many farmers like me who are benefiting from white fish farming as an alternative to rice farming.

4.2.13 FGDs-5: Diversifying Income the Rise of Poultry Farming as a Profitable Alternative to Fish Farming

According to the FGD participants from Dhankhali, "As an alternative to fish farming, farmers are setting up poultry farms at home. Poultry chicken can be marketed only if reared for a few days. After just one to two months of rearing, the chick weighs 1.5-2 kg, which is fully marketable."

Picture-41: Poultry farming as alternative support

The owners of these poultry farms say that "at present the demand for poultry chicken meat is very good in the market and the price is also very high. This will double the farmers "income."

According to an informant, I have two big ponds where I cultivate fish commercially. I get a good income from fish farming. However, fish farming takes more time, for example, it takes at least 8-9 months to market a fish bigger than a chicken, but on the other hand, it takes only 2-3 months to market a chicken in a poultry farm. So even if I can grow fish once a year, I can raise and market chickens in the poultry farm 3 times at the same time. The profit I get from fish farming is two to three times that of poultry farming. Therefore, I am giving more importance to poultry farming as an alternative to fish farming.

Picture-42: Poultry farming

As an alternative to crab cultivation, some are cultivating high-yielding rice, some are doing plain farming, and some are doing different businesses. Success in farming can be achieved in a few days. However, farmers are suffering losses due to the infection. At present, most of Bangladesh's crab is exported to China. Cotton prices have also skyrocketed. As a result, the profit of the farmers is very high. Still, some people are choosing different business professions as an alternative to cucumber farming.

Picture-43: Fisheries

According to an informant, "I am a crab farmer. Those cucumbers which are soft and relatively less in weight, if they are bought and kept in my farm pond for 3-4 weeks, they become very big in weight and size. At that time, I used to sell each kakra for Tk 400-1000. I have opened a shop in the market. It's good in my shop. Instead of relying solely on cucumber farming, I chose small business as an alternative occupation."

Case-10: Alternative Professions to Fish Farming

"My name is Sukumar Maji, and I used to be a fish farmer. But floods and diseases made it hard to continue. I switched to running a small grocery shop, which has been more reliable. Many other fish farmers are also looking for safer jobs." (Case-10 from Jelekhali area)

4.2.14: KII -13: From Crisis to Prosperity the Transformative Impact of Sunflower Farming as an Alternative to Traditional Crops

(KII-13 from Kodomtola location)

As an alternative to crab cultivation, many farmers here are cultivating sunflower oilseeds and mustard. They said that the profit in the cultivation of sunflower oil seeds is very high. Due to the high market price of sunflower seeds, many farmers are now interested in sunflower cultivation. Many farmers are also cultivating mustard. Farmers are more interested in cultivating salt-tolerant high-yielding mustard and high-yielding sunflower.

According to an informant, "earlier I used to cultivate cucumbers, and then I used to get good profit. But in the last flood, everything got submerged in water and I became completely homeless. At the time of the flood, a foreign company gave 10 kg of sunflower seeds to our affected families, and they recorded them on the exhibition farm. Three months later, when the sunflower seed matured, I took home about 22 tons of sunflower oilseeds. Its market price is Rs 88000. I didn't expect to make so much money in three months. Sunflower farming has changed my life. That is why I am giving more importance to sunflower farming as an alternative to crab farming and advising other farmers to start sunflower farming."

CHAPTER FIVE
Discussion and Recommendation

5.1 Discussion

In this discussion, the impacts of climate change in coastal Bangladesh are discussed with specific reference to Munshiganj Union in the Satkhira district. Climate change has posed some very serious challenges to the communities in this area. The rising salinity in the region, recurrent floods, and erratically changed weather patterns have hampered agricultural productivity, predominantly affecting the rice-dependent farmers of the community. The agro-ecological changes induced by climate further aggravate the economic hardship and food insecurity. From the findings of the study, it was found that 67.3% of respondents regarded water scarcity as a very crucial issue.

Alterations in rainfall patterns were mentioned by 58.7% of respondents as being highly disruptive regarding the natural water cycle that is vital for farming. Freshwater shortages are affecting 50% of those interviewed, while 46.2% speak of decreasing fertility of the soils and 23.1% of nutrient depletion as complicating agriculture further. In addition, 40.4% claimed their yields and losses resulted from increased pest and disease pressures. In a similar recent publication by Roy (2024), it was reported, however, that 40.9% of farmers and fishermen noted a considerable reduction in rainfall, whereas 63.64% said temperature increased.

A minority noticed increased rainfall (4.55%) or decreased temperature (5.84%), which is indicative of the variability on perceptions of climate. Interestingly, 44.16% observed reduced levels of water in their local rivers. Group discussions recorded a consensus on reduced rainfall while individual interviews provided richer and more diverse views. Even though 47.1% said they work with other people of the same sex while in a place of employment, 51.9% said their number has increased. That is Terry (2009), Leduc et al. (2008) who assertion climate change has a disparate effect in women because they have less access to resources, training, and decision-making opportunities.

Women are elevated by Crenshaw's (1989) concept of intersectionality in understanding how their gender cuts across other social factors to heighten their vulnerability. Major research was done by Asaduzzaman et al. (2016) that shows how women in poorer households do not have enough resources to explore other livelihoods, which increases their dependence on male relatives. Alternative livelihoods are affected by climate change.

About 30.8% of respondents believe that climate change has a negative impact on tourist-based farmers while 15.4% state that fishing opportunities have reduced. Mistry (2022) also reported that this was seen in Sreeramkati Union where agricultural production reduced by 45%, fisheries by 36% and the livestock sector by 19%. Rising temperatures and erratic rainfall have exacerbated these disruptions to 43% of respondents who knew there has been an impact of climate on the seasons yet 66% find it difficult to comprehend the year changes.

From the study findings, it has been seen that a large proportion of the respondents (77%) are aware of climate change and are concerned about food security, which worries 82% of respondents. Unavailability of training and lack of infrastructure are barriers to adaptation of climate change. Adaptations include the switch to hybrid varieties like Boro rice which is being planted by 66% of farmers and adoption of fish farming which has been implemented by 68% of farmers as opposed to traditional fishing practices. Still, 81% of respondents believe that the quality of their living areas is becoming poorer. Likewise, the research undertaken by mistry et al., shows a lowering output (56%) due to climate change, which drives higher prices for food, less affordability, and an even lesser amount of food available all contributing towards the established food shortage. (Mistry et al., 2022).

Some avenues of making these impacts better will include climate-resilient agricultural practices, improving access to freshwater, and adaptive livelihood strategies. Advanced hybrid crop and fish culture methods with increased awareness and infrastructure up-gradation would be handy for long-term adaptation and sustainability in Munshiganj Unions. The communities will, through training and resources, be prepared to realize food security as well as strengthen their economy over time against climate change.

5.2 Recommendations

Climate change poses major challenges to farm households, affecting both livelihoods and livelihoods, agricultural activities and overall income stability. This report makes important recommendations to governments as well as various agencies and NGOs to address such impacts and provide effective guidance for sustainable supportive practices in agriculture.

5.2.1 multi-media platforms for public awareness campaigns:

Public awareness campaigns on the value and potential of alternative livelihoods will catalyze the wider community towards alternative livelihoods. Targeted public awareness campaigns need to be created and distributed through multiple media sources such as social media, radio, television and local newspapers. These should be action-oriented and provide clear messages about climate change and its local impacts, as well as encourage action at the individual and community level. Storytelling, combined with infographics and testimonials from residents, can make it more relevant and impactful. Additionally, social events such as climate action fairs or informational events can attract, amplify and focus the message on common issues in climate adaptation and mitigation efforts.

5.2.2 Provide additional access to technical training:

It is important to prepare and train farmers to use alternative livelihood activities such as aquaculture, salt-tolerant crops and small-scale enterprises. These training activities should be geared towards best practices, disease management and technical support for farmers to adapt to climate change.

5.2.3 Increase financial support:

Establishing financial support mechanisms such as low-interest loans and grants can play a crucial role in helping farmers meet their initial investment in alternative livelihoods. In this context, access to microfinance institutions and government subsidies should be facilitated to reduce the financial burden on small farmers.

5.2.4 Strengthen transport and marketing infrastructure Improve market access:

Establishment of infrastructure such as improved irrigation systems, transport networks and market facilities that enable production and distribution of alternative livelihood products is

essential. Increasing market access by establishing farmers' cooperatives or marketing platforms for larger markets can play an effective role in advancing alternative livelihoods for farmers.

5.2.5 Encourage community-based support networks:

Establishment of local cooperatives is another very important step to help farmers build mutual support, knowledge sharing and collaboration in alternative livelihood practices. Such networks can also provide opportunities for collective bargaining and access to resources for others.

5.2.6 Develop risk management strategies:

In extreme pandemic situations, there is a need to formulate and disseminate risk management strategies for climate-resilient livelihoods that include programmatic strategies to reduce disease risks in aquaculture and other adverse weather events. Providing farmers with the right tools and resources on how to manage or mitigate them can play an effective role.

5.2.7 Implement comprehensive climate education programs:

It is important to set up community-level education programs on climate issues to raise awareness about what climate change is and how adaptation can be made. In this regard, local curricula should be found, interactive workshops, instructional materials that will be brought to schools, and the like, bringing everyone from young children to the elderly together in fun home-based activities, simulations, and real-time study scenarios to maximize learning. Such partnerships with local schools, NGOs, and community leaders can facilitate such programs in the area.

5.2.8 Encourage progress in research and development:

Investment in research and development is crucial to making alternative livelihood options viable. New varieties - Government as well as non-governmental organizations can play an effective role in developing new, more resilient crop varieties, including improved aquaculture technologies adapted to the salinity conditions prevailing in the region.

5.2.9 Promote policy support and advocacy:

Finally, it is essential to advocate for supportive policies and programs at the local and national levels that prioritize climate adaptation and alternative livelihood options for affected communities. Policymakers can play an effective role in ensuring that the needs and challenges of climate-affected farmers are addressed in development plans.

5.3 Policy Recommendations

All these stakeholders – including government agencies, NGOs, financial institutions and local communities – have distinct and complementary roles to play in developing effective strategies for climate resilience. These Policy Recommendations reviews their individual contributions to successful adaptation initiatives undertaken by these stakeholder groups.

5.3.1 Role of government agencies

Awareness campaigns: Governments can capitalize on national media channels to highlight success stories of adaptation and resilience, along with climate adaptation and alternative livelihood practices, through public awareness campaigns. The Ministry of Environment, Forests and Climate Change, as well as the Ministry of Agriculture, Posts, Telecommunications and Information Technology (ICT) and the Ministry of Social Welfare can play an effective role in this regard.

Infrastructure development: The role of the government is crucial in building and financing critical infrastructure such as improved irrigation systems, weather-resistant roads and market facilities. These effective measures will help sustain production and facilitate livelihood practices in affected areas. In this context, the Ministry of Finance, as well as the Ministry of Planning, the Ministry of Environment, Forests and Climate Change, the Ministry of Social Welfare and the Ministry of Posts, Telecommunication and Information Technology (ICT) can play an important role in this regard.

Capacity Building and Training Programs: The government can scale up training programs in alternative occupations on a larger scale through partnerships with other educational institutions and technical experts. Moreover, it is imperative that all such programs are inclusive and open. In this context, the Ministry of Finance, as well as the Ministry of Planning, the Ministry of Social Welfare and the Ministry of Posts, Telecommunication and Information Technology (ICT) can play an important role in this regard.

Policy Development and Support: It is imperative to establish policies that ensure sustainable agricultural occupations in climate-affected areas, ensure land rights and ensure gender equality. This will include subsidies for climate-resilient seeds, insurance policies and other alternative livelihoods for climate-displaced communities. In this context, the Ministry of Finance, as well as the Ministry of Planning, and the Ministry of Social Welfare can play an important role in this regard.

5.3.2 Local Government and National Climate Funds

Bangladesh Climate Change Trust Fund (BCCTF): The Bangladesh Climate Change Trust Fund (BCCTF) is implementing various initiatives to support sustainable agriculture, water management and community-level livelihood adaptation. Funded from the national treasury, community groups and local governments can apply financing support for adaptation and resilience in Bangladesh.

Local Municipality Grants and Subsidies: Local municipalities can take measures to reach farmers through local agricultural extension offices, such as subsidies for salinity-tolerant crops or irrigation infrastructure grants. These steps can greatly support the successful implementation of national policies and sustainable agriculture, water management and community-level livelihood adaptation. By adopting this policy provision, government agencies can play an effective role in making these funds available to farmers.

5.3.3 International Climate Adaptation Funds

Green Climate Fund (GCF): The GCF is the most comprehensive financing mechanism for climate change, providing grants and loans for adaptation and resilience projects. The fund specifically finances adaptation projects for low-income, climate-vulnerable communities, involving agriculture-focused projects, water management and sustainable livelihoods. Government agencies can play an effective role in extending this funding to farmers.

Adaptation Fund: This funding is allocated to adaptation projects for developing countries facing the severe impacts of climate change. The grants are expected to support local projects, primarily aimed at increasing food security, developing community water resources and improving resilience among people. Governments can help channel this funding to farmers through enabling policies.

Global Environment Facility (GEF) Fund: The Global Environment Facility (GEF) funds a range of projects related to biodiversity, climate adaptation and land degradation. Under the "Small Grants Program" (SGP), the GEF finances community-based projects focused on sustainable resource management and alternative livelihoods. Government agencies can play a key role in making these funds available to farmers through policy adoption.

International Fund for Agricultural Development (IFAD) Smallholder Adaptation Program: The International Fund for Agricultural Development (IFAD) improves the agricultural systems of smallholders through projects that provide opportunities for climate-resilient crops, water resources and alternative livelihoods. It provides grants and technical assistance in partnership with local governments. Government agencies can play a key role in making these funds available to farmers.

Climate Investment Fund (CIF): The possibilities offered by the CIF's Pilot Program for Climate Resilience (PPCR) are to provide funding for climate adaptation and resilience projects, focusing primarily on agriculture and community-based interventions. Working in partnership with governments and development banks, it implements projects targeting vulnerable populations. Governments can play a key role in making these funds available to farmers through policy development.

5.3.4 Role of Non-Governmental Organizations (NGOs)

Community Mobilization and Training: NGOs are powerful instruments in communities for mobilization for capacity building and for adaptive practices. They can provide hands-on technical assistance and train in climate-resilient agriculture, most small-intensity aquaculture and small business management.

Gender-Sensitive Initiatives: NGOs intervention programs have proven successful in adding gender dimensions in resource accessibility, making spaces for decision-making, as well as providing education and extension opportunities. It could organize childcare during training or make safe spaces for encouraging women's participation.

Pilot Projects and Innovations: NGOs can design pilot projects, like saline-tolerant crop production, fish culture, etc., to test innovative alternative livelihood generation initiatives. Any successful such venture becomes a model that can be scaled up by governments or communities later.

Advocacy and Policy Influence: NGOs can play a significant role to develop policies through evidence-based references along with government bodies and advocacy to community needs and priorities, at least as far as climate adaptation, gender inclusion, and support to smallholder farmers are concerned.

5.3.5 Role in financing local and regional microfinance institutions

Shushilan, Care Bangladesh: Shushilan and Care Bangladesh are ways to advocate farmers who have been affected by climate change with climate-smart, sustainable agriculture, and rural development projects.

Grameen Bank (Bangladesh): Grameen Bank, for example, can provide such kinds of microfinancing for smallholder farmers or rural micro-entrepreneurs so that they can invest in sustainable practices. The loan products are tailored in such a way that quite low-income households, particularly women, can avail of them.

BRAC Microfinance: BRAC can also provide microloans to rural people for their investment in agriculture and small enterprises; they also provide financial training to improve loan use for sustainability.

ASA (Association for Social Advancement): ASA is micro-financed in funding small business and agricultural projects. Since they are initiated with rural communities in mind, they can really have contributed through low-cost loans to farmers making their production activities, climate resilient agriculture and aquaculture.

Village Savings and Loan Associations: Usually, such community-based saving and loan schemes are encouraged by NGOs in rural areas; they can be significant in the life of many people because they allow members to save, take loans and invest in local enterprises including climate-resilient livelihoods.

5.3.6 Role of Financial Institutions

Provision of low-interest loans and grants: Cooperatives, micro finance institutions, and banks can deliver very low-interest loans, grants, or flexible repayment terms to farmers willing to invest in alternative livelihoods. Financial inclusion might also help farmers to meet upfront investments by adopting newer farming methods.

Microfinance Services for the Underprivileged: Partnerships between financial institutions and NGOs could make it possible to use microfinance products for smallholder farmers, women and other marginalized groups.

Insurance Products for Climate Risk: Financial institutions can come together all in the bid to create affordable insurance products that will reduce the financial risk associated with climate change, whether that is in terms of crop failure or losses in aquaculture. With insurance, farmers would have reduced risks to sudden financial shocks.

Investment in research and development: Financial institutions can fund research on the resilience of crops to climate change and new technologies, in partnership with academic and agricultural research institutions.

5.3.7 Role of Local Communities

Participation in Training and Capacity Building: Regarding Participation in Training and Capacity Building, the participants are also the members of the community who attend the adaptive practices training and will put them into practice. This keeps their participation relevant as well as sustainable to interventions.

Formation of Cooperatives and Support Networks: Local communities can form cooperatives or support groups, which provide a platform for collective contributions, sharing of tacit knowledge, and acknowledging mutual benefits. Cooperatives can enhance negotiation power and market access for smallholder farmers.

Peer Education: Community members who are adopters of some best new practices can share their experiences of using these techniques with peers. Such a peer-to-peer approach builds greater confidence and helps accelerate the use of new ideas.

Local Advocacy and Feedback: Communities can address their needs through feedback mechanisms to various NGOs and government agencies on the effectiveness of the adaptation efforts. Local leaders can present the community case with external organizations in discussions regarding the programs so they can remain relevant and responsive.

CHAPTER SIX
Conclusion

Conclusion

This research brings into focus the huge and multi-faceted aspects that climate change has on the agricultural livelihoods and alternative employment activities in coastal Bangladesh. Though it is primarily through agriculture, many productivity challenges due to climate-affiliated hazards-salinity, water scarcity, erratic rains, etc.-also face the industry. Farmers, as a possible adaptation strategy, are now in for mulching, drip irrigation, and drought-resistant crops.

However, this adoption is not high because of lack of knowledge, infrastructure, and financial limitation. NGOs like Shushilan, Care Bangladesh, BRAC, and many others come as support providers to help even more farmers work out some of these issues. However, greater effort has to be made for more effective and wider-reaching improvements to these interventions. Although these include emerging alternatives like aquaculture, shrimp farming, and livestock rearing, today, there is little adoption among the farmers. This is attributed to a lack of awareness, education, and funds needed to support the practice.

Access to resources and opportunities becomes even more difficult for women due to gender differences that are indeed insurmountable obstacles, which further increases women's condition of vulnerability and decreases the adaptive capacity of communities. A mix of strategies toward better education and financial resources and targeted social support for traditional and alternative livelihoods would be essential for sustained benefits from the efforts in the long run. Those would help communities adapt to the impacts of climate change and ensure a safer and more resilient future.

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Annexure-1

Survey Questionnaire

Research Title

Alternative Livelihood Options for Climate Victims: A Case Study of Farmer Community of Munshiganj Union at Satkhira District

Section 1: Demographic and socio-economic conditions

Serial no	**V**ariable	Coding category		Code no
1.	Name			
2.	Mobile number			
3.	Address			
4.	Age			
5.	Gender	1. Men 2. Woman	99.Other …(Please Specify)	
6.	Number of earners in the household	1 . Less than 2 people 2 . 2 - 3 person 3 . More than 4		
7.	Family monthly income	1 . less than 5,000 2 . 5001 - 10,000 3 . 10 ,001 - 15,000 4 . 15,001 – 20,000	5 . 20,001 - 25,000 6 . More than 25,000 99 . Other …(Please Specify)	
8.	Educational qualification	1. Illiterate 2. Primary 3. Secondary	4. High school 5. Graduate 6. Ppostgraduate	
9.	Religion	1. Muslim 2. Hindu 3. Buddhist	4. Christian 99. Other …(Please Specify)	

10.	Occupation	1.Agriculture 2. Farmers and Fishermen 3. Farmers and small businesses 4. Farmers and Handicrafts 5. Farmers and cattle rearing 6. Farmers and honey collection 7. Farmers and Golpata collection 8. Farmers and pea workers 9. Work of farmers and bricklayers 10. Farmers and working in garments in cities	11. Farmers and Rickshaw Driving 12. Farmers and CNG Driving 13. Farmers and tea shops 14. Farmers and oil fryers 15. Farmers and wood collection 16. Farmers and small businesses 17. Farmers and Day Laborers 18. Farmers and Apiculture 99. Other …(Please Specify)	
11.	Marital condition	1 . Unmarried 2 . Married	3 . Dervosi 4 . Widow	

Section 2: Impact of climate change on farmers' livelihoods

Serial no	Variable	Coding category		Code no
12.	In your opinion, what is the impact of climate change on farmers? (Multiple answers are acceptable)	1. Increases the salinity level in the soil 2. There is a shortage of fresh water for irrigation of land	7. Food insecurity develops among poor farmers 8. Water scarcity occurs	

		3. Impairs fish productivity 4. Damages farmers' crops 5. Livestock fodder becomes scarce 6. Displacement and migration of farmers increases	9. Housing and infrastructure destroyed 10. Effects on health occur 11. Economic weakness arises 99. Other (Please Specify)	
13.	In your opinion, what is the impact of climate change on the livelihood of farmers? (Multiple answers are acceptable)	1. Influences on traditional professions 2. Farmers face employment crisis 3. Increases gender segregation in the workplace	4. Impacts on the livelihood of farmers involved in tourism activities 5. Reduces fishing opportunities for farmers 99. Other (Please Specify)	

Section 3: Crop protection practices adopted by farmers due to climate change

Serial no	Variable	Coding category	Code no
14.	In your opinion, what methods do farmers adopt to protect crops? (Multiple answers are acceptable)	1. Drip irrigation 2. Mulching 3. Shade net 4. Drought-resistant crops 5. Soil amendment 6. Agro forestry 7. Protective cover 8. Efficient water use 9. Ground water management	

		99. Other …(Please Specify)	
15.	According to you, which NGOs are actively engaged in helping farmers affected by climate change? (Multiple answers are acceptable)	1.Brac 2.World fish 3.Care Bangladesh 4.Shushilan 99 . Other …(Please Specify)	

Section 4: Negative Impact of Climate Change on Agriculture

Serial no	Variable	Coding category	Code no
16.	In your opinion, what are the dangerous negative impacts of climate change on agriculture? (Multiple answers are acceptable)	1. Changes in rainfall patterns 2. Increases pest and disease pressure 3. Scarcity of fresh water occurs 4. Soil fertility is lost 5. Soil nutrients decrease 6. Water scarcity and irrigation challenges 99. Other …(Please Specify)	

Section 5: Ideas about alternative livelihoods

Serial no	Variable	Coding category		Code no
17.	Do you have any ideas about alternative livelihoods?	1 . Yes	2 . No	
18.	If yes, what alternative livelihoods apply to you?	1. Fisheries 2. Shrimp farming	9. Timber business 10. Poultry rearing 11. Cow fattening	

	(Multiple answers are acceptable)	3. Cultivation of rice 4. Jute Cultivation 5. Eco-tourism 6. Goat rearing 7. Riding a motorcycle 8. Collection of honey	12. Agroforestry 13. Beekeeping 14. Handicrafts 15. Integrated rice-fish farming 16. Mango orchard 99. Other …(Please Specify)	
19.	What kind of changes have taken place in the profession in the last 10 years? (Multiple answer are acceptable)	1. Cultivation of salt-tolerant crops from conventional crops 2. Conversion from crop farming to aquaculture 3. Mushroom Cultivation 4. Vegetable Gardening 5. Animal husbandry 6. Rearing of cows and goats 7. Poultry Farming	9. Handicrafts 10. Small Transactions 11. Horticulture and Agro forestry 12. Integrated farming from fishing 13. Adoption of renewable energy solutions 14. Vocational training and skill development 99. Other …(Please Specify)	
20.	Have you ever looked for an alternative livelihood?	1 . Yes	2 . No	

21.	If yes, please tell why you are looking for alternative livelihood? (Multiple answers are acceptable)	1. Environmental degradation 2. Drought 3. Cyclone 4. Heavy rain 5. Passion 6. Decrease in agricultural productivity 7. Lack of salt tolerant seeds 8. Economic instability 9. Effects of climate change	10. Limited job opportunities 11. Health hazards 12. Damage to infrastructure 13. Food insecurity 14. Lack of livelihood diversity 15. Lack of educational opportunities 16. Difficulties in accessing health care 99. Other …(Please Specify)	
22.	What kind of crops do you grow as an alternative livelihood?	1. Cultivation of rice 2. Organic farming 3. Floating bed	4. Integrated rice-fish farming 99. Other …(Please Specify)	
23.	How many kilometers do you work every day in need of alternative livelihood?	1. Less than 2 km 2. 2-3 km		
24.	How many years have you been practicing alternative livelihoods?	1. Less than one year 2. Two years 3. Three years 4. Four years 5. Five years 6. More than six years		

Section 6 : Climate of change because of Farmers alternative Livelihood the source search

Serial no	Variable	Coding category		Code no
25.	Farmers cultivate salt tolerant rice cultivation. (Multiple answers are acceptable)	1. BRRI-47 2. BRRI-61 3. BINA -8 4. BRRI-28 5. BRRI-55 6. BINA Rice 11 7. BINA 10 8. BINA-47 99. Other …(Please Specify)		
26.	Do farmers have an idea about the livelihood options?	1 . Yes	2 . No	
27.	If yes, what crops can farmers cultivate as an alternative to rice cultivation? (Multiple answers are acceptable)	1. Salt-tolerant rice 2. Cultivation of corn 3. Salt-tolerant rice varieties 4. Beans 5. Sesame 6. Sunflower 7. Spinach 8. Carrots 9. Tomatoes 10. Sweet potatoes 11. Pumpkin 12. Watermelon		

		13. Cabbage 14. Cauliflower 15. Integrated rice-fish farming 16. Eco-friendly jute cultivation 99. Other …(Please Specify)	
28.	What can farmers do as an alternative to rice cultivation? (Multiple answers are acceptable)	1. Indigenous fish farming 2. Foreign fish (Rui, katla, monosex tilapia, pangas, hybrid Magurr fish farming in Thailand) 3. Shrimp Farming (Bagda, Venom, Harna Shrimp) 4. Eco-tourism 5. Tourist Guidelines 6. Cattle rearing 7. Goat rearing 8. Poultry farming 99. Other …(Please Specify)	
29.	As an alternative to fish farming, can farmers take any profession? (Multiple answers are acceptable)	1. Cow fattening 2. Agroforestry 3. Floating bed cultivation 4. Beekeeping 5. Organic farming 6. Handicrafts 7. Manufacture of artisan products 8. Cultivation of herbal medicine 99. Other …(Please Specify)	

30.	What profession can farmers take as an alternative to crab farming? (Multiple answers are acceptable)	1. Mango orchard gardener 2. Honey collection 3. Timber business 4. Collection of bay leaves 5. Traveling business 6. Daily labor 7. Sewing 8. Boat building 9. Boat business 99. Other …(Please Specify)	
31.	Can farmers grow crops as an alternative to crab farming? (Multiple answers are acceptable)	1. Dal 2. Salt tolerant orange oilseeds 3. Cultivation of Mustard 4. Coconut production 99. Other …(Please Specify)	

Section 7: Actions to be taken to introduce sustainable and alternative livelihoods of farmers

Serial no	Variable	Strongly agree	Agree	Neutral	Disagree	Totally disagree
		1	2	3	4	5
32.	Farmers need to learn techniques to use efficient irrigation techniques					
33.	Training and capacity-building programs need to be implemented to increase the capacity of farmers					
34.	Technical training should be provided to the farmers					
35.	Farmers need to be financially supported to adopt new livelihoods					
36.	Farmers need to provide small loans or loans					

37.	Market linkages are needed for farmers to sell alternative occupation products					
38.	Farmers need to arrange fair market prices for alternative livelihood products					
39.	Farmers need to be given an early idea about the climate of alternative livelihoods					
40.	Government needs to subsidize farmers for alternative livelihoods					

Section 8: Impact of Gender Dimension on Livelihoods

Serial no	Variable	Coding category	Code no
41.	In your opinion, what are the gender-based impacts of climate change on farmers' livelihoods?	1. Women's opportunities in agriculture are reduced 2. Occupational migration of men and women decreases 3. Female and male entrepreneurship declines 4. Training opportunities for both men and women are reduced 99. Other …(Please Specify)	

Section 9: Means of early warning or means of communication

Serial no	Variable	Coding category		Code no
42.	Television	1 = Yes	2 = No	
43.	Newspaper	1 = Yes	2 = No	
44.	Radio	1 = Yes	2 = No	
45.	Facebook	1 = Yes	2 = No	
46.	Online	1 = Yes	2 = No	
47.	Miking (Declaration)	1 = Yes	2 = No	
48.	CPR volunteer	1 = Yes	2 = No	

Interviewer Name:

Time : Start ……. End ……..

Annexure-2

Alternative livelihood options for climate victims: a case study of farmer community of Munshiganj Union in Satkhira districts

KII Checklist

These questions will be asked by key stakeholders during interviews related to alternative livelihoods for climate-impacted communities. This is not an exhaustive list, but it includes some fundamental questions. Additional important follow-up questions related to the discussion and assessment will be asked.

Respondent's Name:
Title:
Duration in Current Position:
Department:
Interviewer:
Date:

1. How long have you been living in this area?
2. Why do you think the people here have sought alternative livelihoods?
3. Could you please share your thoughts on alternative livelihoods in this area?
4. What alternative livelihoods have you explored in the past five years?
5. In your opinion, what types of crops do the people here cultivate as an alternative livelihood?
6. As far as you can remember, what crops do farmers cultivate as an alternative to rice farming?
7. In your opinion, what crops do farmers cultivate as an alternative to fish farming?
8. In your opinion, what crops do farmers cultivate as an alternative to crab farming?
9. In your opinion, what are the impacts of climate change on farmers in this area?
10. In your opinion, what factors have contributed to the successful implementation of the project?
11. In your opinion, what are the impacts of climate change on farmers' livelihoods?
12. Based on your experience, what risks are farmers facing due to climate change?
13. In your opinion, what are the negative impacts of climate change on agriculture?
14. Based on your experience, could you kindly provide advice on what actions should be taken to promote sustainable and alternative livelihoods for farmers?

Annexure-3

Alternative livelihood options for climate victims: a case study of farmer community of Munshiganj Union in Satkhira districts

Focus Group Discussion Guidelines

Instructions: You are invited to participate in a group discussion about a long-standing local issue, and we greatly appreciate the effort you've made to be here. I am conducting an academic thesis focused on "Alternative Livelihood Options for Climate Victims: A Case Study of the Farmer Community in Munshiganj Union, Satkhira District." We will discuss solutions to this issue.

1. You have been selected randomly as members of this area who have been residing here for many years. You are invited to share your opinions about the activities and outcomes of this project.
2. You have the right to opt out of the discussion or leave at any time during the conversation.
3. Your participation is entirely voluntary. As this is a government project evaluation, there is no provision for remuneration for your time and opinions.
4. Your personal identity will not be disclosed to anyone in the evaluation report.
5. This discussion is expected to take about one hour. If you are unable to stay for this duration, please inform us in advance. However, we encourage you to freely express your opinions or choose not to, and to ensure equal participation with mutual respect.
6. Please refrain from engaging in debates, as our principle is "we agree to disagree."
7. Kindly avoid talking all at once; instead, share your views individually and help others express theirs as well.
8. Remember: This is not a test, and there are no right or wrong answers. Please share what you truly feel from the heart.

Focus Group Discussion Checklist

Section-1		
	Subject	**Instructions**
1.	How long have you been living in this area?	
2.	Why is this area famous? Could you share some notable aspects of this area?	Probe
3.	What major challenges have you been facing in the agricultural sector over the years, and what are those challenges?	
4.	What initiatives have you noticed aimed at solving these mentioned problems?	Identify and record the names of the mentioned initiatives.
5.	What initiatives have you observed from government and non-government organizations?	Probe
Section-2		
	Subject	**Instructions**
1	Could you tell us about the impact of climate change on your life and livelihood?	
2	How is climate change affecting the livelihoods of people in your area?	Probe
3	In recent times, how have you been most affected by climate change?	
4	What alternative livelihood options have you explored due to climate change?	
5	What alternative livelihoods have you explored in the past five years?	
6	Why have you been seeking alternative livelihood options recently because of climate change?	Probe; Try to identify the problems they have faced due to climate
7	Considering the effects of climate change, what measures should be taken to ensure alternative livelihoods?	

Section-3	Alternative Livelihood Sources for Farmers Due to Climate Change	
	Subject	**Instructions**
1	Do you believe that the effects of climate change have impacted farmers' rice cultivation and social security systems in your area? If so, how?	
2	How have challenges like the lack of salt-tolerant seeds, reduced agricultural productivity, environmental degradation, health risks, food insecurity, and lack of livelihood diversity helped to explore alternative livelihood options in your area? In what ways?	
3a	Have you seen farmers cultivating crops with improved seeds on saline land, which typically remains saline over the years? What types of crops have you observed?	Probe
3b	Have you heard of any government or non-government initiatives aimed at addressing issues such as the lack of salt-tolerant seeds, reduced agricultural productivity, environmental degradation, health risks, food insecurity, and lack of livelihood diversity? If so, what initiatives were taken?	Probe
3c	Do you have any ideas on what alternative livelihoods might be suitable for farmers?	Probe
	As an alternative to rice farming, what other crops can farmers cultivate? Could you provide details on these crops?	
	As an alternative to fish farming, what other crops can farmers cultivate? Could you provide details on these crops?	
	What crops have been produced through floating bed farming?	Probe
	Have you observed floating bed farming methods in your area? How effective has this technology been in waterlogged areas?	
3d	How important has canal re-excavation been for farmers in your area?	Probe
	How has this activity helped to reduce waterlogging and salinity? If you have insights, please explain in detail.	
	Has this activity helped improve irrigation facilities to boost agricultural production in your area?	

Section-4	The Impact of Climate Change on Farmers' Livelihoods	
	Subject	**Instructions**
1	Could you describe the impacts of climate change on farmers' livelihoods in your area?	Probe and list down
2	How has climate change impacted your household's economic stability?	
3	Have you heard of any government or non-government initiatives to reduce the impacts of climate change on farmers' livelihoods in your area? If so, what initiatives were taken?	
4	In your opinion, if government or non-government initiatives have been taken, which group of people has benefited the most?	
Section-5		
	Subject	**Instructions**
1	Do you think climate change is having a negative impact on agriculture? If so, what are the negative impacts?	Probe
2	What measures should be taken to introduce sustainable and alternative livelihoods for farmers?	

Thanks to all for valuable comments