

## ASSESSING THE SOCIO-ECONOMIC IMPLICATIONS OF CLIMATE CHANGE ON BETEL LEAF CULTIVATION IN MOHANPUR UPAZILA, RAJSHAHI

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### ABSTRACT

Climate change represents a significant threat to agricultural systems worldwide, particularly affecting vulnerable communities dependent on specific crops for their livelihoods. In Mohanpur Upazila, Rajshahi, betel leaf cultivation is a critical source of income for numerous households. This research aims to comprehensively assess the socio-economic implications of climate change on betel leaf cultivators in the region, with a specific focus on understanding their vulnerabilities and adaptation strategies. To achieve this objective, Participatory Rural Appraisal (PRA) methods were applied as a research approach. Through PRA techniques, including community consultations, Focus Group Discussions (FGD), and individual interviews, this study engaged directly with betel leaf cultivators, traders, and other stakeholders in the betel leaf value chain. These interactions provided insights into the evolving challenges posed by climate change, including shifts in temperature, rainfall patterns, and increased occurrences of extreme weather events, affecting crop quality and yield. In addition to assessing the direct impacts on betel leaf cultivation, the study evaluates the broader socio-economic implications on the livelihoods of cultivators. It examines income stability, employment opportunities, and food security within the community, shedding light on the interplay between climate change and the well-being of betel leaf-dependent households. The findings of this research will contribute valuable insights into the vulnerabilities and resilience of betel leaf cultivators in Mohanpur Upazila, Rajshahi, in the face of climate change. Furthermore, this study underscores the importance of incorporating local knowledge and perspectives through the application of PRA methods, enabling the development of targeted policies and adaptation strategies that can bolster the socio-economic resilience of betel leaf cultivators in a changing climate.

**Keywords:** *Betel Leaf, Climate Change, PRA, Socio-Economic Implications, FGD*

## 1. INTRODUCTION

People in the competitive 21st-century society are always looking to increase their income in order to afford better living conditions. Particularly in rural areas, people rely on various forms of agriculture for their living. Betel nut farming is one such agricultural crop. In many parts of the region, betel-leaf production is crucial for improving the socioeconomic position of people because of the product's fame and marketing. Growing in popularity and acreage every day is this crop since farmers find it to be more profitable than many other crops. The recent increase in revenues has piqued the attention of many farmers in betel leaf farming. The majority of the population (95%) in the villages of Saipara and Gangapara under Bakshimail Union of Mohanpur Upazila in Rajshahi District makes their living from betel cultivation.

Unfortunately, the district's betel vines have suffered significant damage from this year's flood, storm, and rain. The strong winds have harmed thousands of betel vines. Additionally, a thousand hectares of the district's farmland were damaged by Cyclone Amphan. For thousands of individuals in the upazilas of Mohanpur, Durgapur, and Bagmara in the district, the betel plantation is a significant source of income. This work's primary goal is to pinpoint the major issues that cause betel leaf damage as well as the effects of the climate on the leaves.

The betel leaf raised the standard of living for the residents of Saipara and Ganga Para villages, but now that the corona has passed, they are constantly losing a lot of money. As a result, several have shuttered their betel stores and decreased their betel farming. In addition, Rajshahi's unusually high temperatures and low humidity are negatively impacting betel farming, causing a lot of betel leaves to drop off early. Mohanpur Upazila produces the most betel leaves, and it is the primary crop grown there for commercial purposes. The district's betel vines have suffered greatly in recent years from flooding, storms, and rain. The COVID-19 epidemic has resulted in an unusual decrease in the retail price. Additionally, a thousand hectares of the district's farmland were damaged by Cyclone Amphan. According to one reply, "this year's global fallout resulted in abnormal price declining of the crop in local markets, which prevented betel leaf from being exported aside from the non-arrival of traders and business from different areas." A few respondents asserted that the farmers are also not recovering the expenses associated with harvesting the produce. Small stores and betel leaf merchants have closed since the outbreak started. The Khasia people in Bangladesh's Lawachara National Park rely on betel leaf growing for income, highlighting the importance of co-management, diversification, and sustainable behaviours. Challenges include marketplaces and fair prices, while women empowerment is discussed (Riadh, 2008). The study on input cost sensitivity in betel leaf production in Bangladesh is limited by geographical scope, market dynamics, decision-making processes, ecological impact, and policy implications. Addressing these gaps would improve understanding and decision-making for farmers, policymakers, and stakeholders in betel leaf production (Sabur et al., 2022). Khatun 2016 in her study assesses betel leaf growers' innovativeness in Rajshahi district, revealing positive relationships between factors like farm size, farming experience, knowledge, and attitude, but lacking explanations for these relationships.

### Literature Review

For the residents of the northern area, betel growing is currently a very profitable and popular kind of agriculture. Their enthusiasm in this crop is quite evident. In her research, Mrs. Eshrat Jahan notes that betel leaf has long been farmed in Bangladesh. Rajshahi's work is quite impressive. The region where betel leaves are produced has expanded due to farmers' greater interest in cultivating them these days. In real output, there was a sharp increase followed by a sharp decline throughout the years. For the study, both primary and secondary data were employed. Secondary data on betel leaf output, cultivated area, and price in Bangladesh from 1991 to 2019 were obtained from the Bangladesh Bureau of Statistics (BBS) to evaluate the production trend. The Bangladesh Meteorological Department (BMD) was contacted to incorporate monthly rainfall and temperature data into the production models. Ahfuz and Associates, 2020.

In all agricultural cultivation, the environment is a crucial regulating factor. because agricultural productivity is determined by a variety of factors, not only environmental fluctuation. According to

Mrs. Sayma Akhter, one of the biggest concerns facing the globe is climate change, which has an impact on Bangladesh and other vulnerable and disadvantaged countries. The production of betel leaves is significantly impacted by climate change in some ways. It is evident that climate change is occurring in the areas under study. People are already seeing strange changes in the patterns of temperature and precipitation. Many of the places under study are expected to experience dangers due to climate change, and particular businesses, such as the processing of betel leaf, are more vulnerable as a result of these stressors. (Akhter and others, 2013)

Windfall and the disappearance of betel leaves as a result of climate change are directly correlated. Because it is evident that betel leaf becomes yellow in extreme heat and falls during winter storms. Mr. Manaranjan Biswas provided a brief explanation of the primary cause of the decline in betel leaf farming from an Indian perspective. Growing as a commercial crop, betel vine cultivation is one of the most important horticultural crops and is gaining popularity in the Nadia districts. In these areas, growing betel vines is an attractive and profitable venture, but practically all growers have been utilizing their own traditional planting material and nurturing their own betel due to a lack of knowledge about betel vine production.

## 2. METHODOLOGY

The methodology of this study includes a selection of study area, theoretical framework, focus group selection, conducting PRA techniques, data collection, and analytical techniques. Methodology is an important component to guide the entire process of conducting a study. Generally, it includes research questions, research method, data collection process, and data analysis.

For this research, the Bakshimail Union's Saipara village in Rajshahi's Mohanpur Upazila has been chosen as the study area. The primary cash crop grown by the farmers in the research areas is betel leaf. The quality and flavor of the betel leaf cultivated in Mohanpur Upazila are highly sought after both domestically and internationally. The betel plantation is a major source of income for almost 95% of the population. As a result, they regard their Pan Baraj as a child and consider betel leaf to be of great value in their lives. However, a variety of climate change consequences have been identified, and the absence of adaptation methods makes it more difficult to create an environment that is conducive to production.

A reconnaissance survey was conducted to assess the study area's current condition and identify assets and defects, to familiarize the community with its geographical and socio-economic structure.

The study collected primary data from betel leaf farmers through face-to-face surveys, interviews, and focus group discussions to understand their risk and climate change impact, adaptation measures, and business potential in the study area.

Secondary data on betel leaf production in Bangladesh is sourced from various sources including articles, documents, books, maps, expert opinions, internet browsing, Google Earth pro, and monthly temperature and rainfall data.

The study used PRA surveys to collect data for situation analysis and potentiality analysis in communities, focusing on climate change impacts on betel leaf cultivation and the extent of available resources to cope with these impacts.

The study used key informant interviews and focus group discussions to gather primary data on the perception and reactions of the problem of betel leaf plantation in a community. The focus group consisted of 11 local residents, with 7 males and 4 females selected for FGD.

Social mapping is a popular PRA method that explores spatial dimensions of people's realities, including habitation patterns, marketplaces, housing, infrastructure, roads, and schools, while resource maps depict land, vegetation, and roads.

The cause effect diagram visually illustrates the causes and effects of a problem, situation, or phenomenon, providing a comprehensive understanding for local people. This method is used in our study to understand climatic impacts on betel leaf cultivation.

Seasonal Diagram is a PRA approach used for annual analysis, identifying workload periods, credit crunch, diseases, food security, and wage availability. Trend Analysis provides quantitative changes in village life, such as yields, population, and tree numbers, identifying current and future phenomena. An opportunity matrix is created by rephrasing constraints into positive conditions and detailing opportunities for innovation, allowing local people to understand existing services and opportunities.

## **2.1 Resource Map Preparation**

The most widely used PRA technique is social mapping. It helps to examine how people's realities differ spatially is beneficial. The social infrastructure—roads, schools, and other public spaces—as well as the patterns of settlement are shown on social maps. It is not scaled, and it is made by locals rather than specialists.

There were between 3306 and 860 people living in the Mohanpur upazila, Bakshimail union, and Saipara village, which is the research region. Household settlement patterns were mostly grouped, with each cluster being separated from the others.

There is an Eidgah and a common mosque in this village. The majority of the homes had tube wells and were made of mud. On the Rajshahi-Naogaon Highway, there is a roadside cold storage. Though there are small tea booths, there are no nearby big marketplaces in the area where one may purchase fertilizer, insecticides, or anything else. For this, they were compelled to rely on the Bazar/Hat in the distant village of Sadar.

## **2.2 Social Map Preparation**

A resource map essentially shows the land, hills, rivers, crops, vegetation, etc. The resources map reproduces information about roads, ponds, commercial land, vegetation, and agriculture land. Participants in the resource mapping process revealed that fishing and livestock husbandry were important and revenue-focused activities, in addition to betel leaf production (Baraj), which was their primary source of income. Either in groups or individually, participants set up personal Barajs close to their homes. They added that because there were so many ponds, some were leased out for extra money. In addition to the vast number of Boroj, there were numerous barren areas, open spaces, pigeon farms, little bamboo gardens, mango gardens, and so forth. Although there was some paddy produced there, but it was not much.

## **3. ILLUSTRATIONS**

### **3.1 Figures and Graphs**

#### **3.1.1 Habitation Background (Social Map Preparation)**

Social mapping is the most popular method in PRA. It helps to explore the spatial dimensions of people's realities. Social map depicts the habitation patterns, the nature of marketplaces, housing and social infrastructure roads, schools etc. It is not drawn to scale and is made by local people, not by experts.

The population of our research region in Mohanpur upazila, Bakshimail union, Saipara, and Gangopara villages was around 3306 and 721 correspondingly. The majority of household settlement patterns were clustered, and each cluster was dispersed from the others.

For both villages, there was a common mosque and an Eidgah. The most of the dwellings were constructed of mud and had tube wells. In Gangopara, there is a cold storage. There are no adjacent

large marketplaces in the villages to buy fertilizer, insecticides, or anything else, albeit there are little tea stalls. They were forced to rely on the Bazar/Hat in the far-off village of Sadar for this.

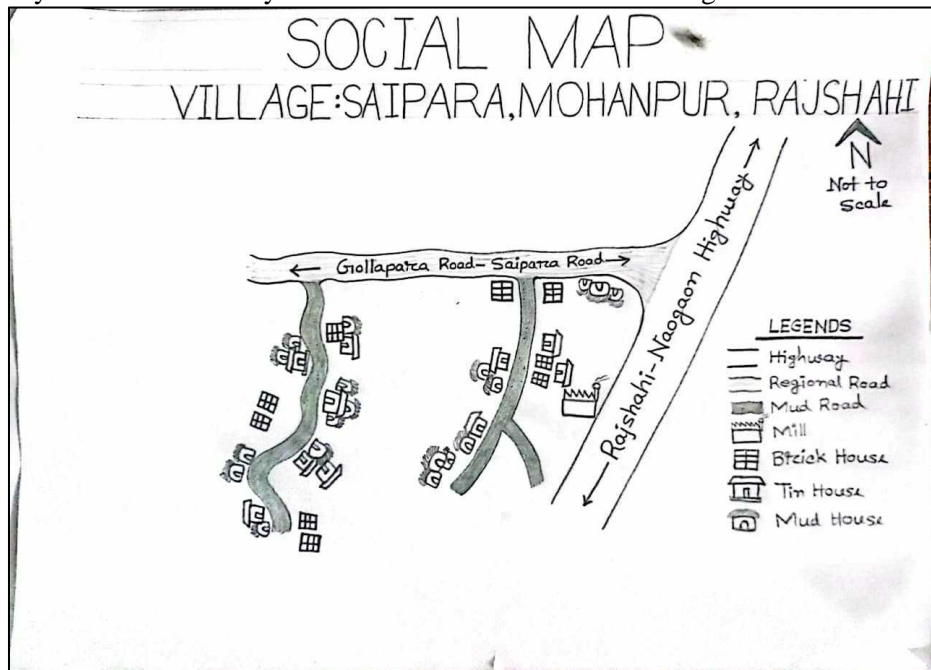


Figure 1: Social Map (Saipara, Mohanpur, Rajshahi)

### 3.1.2 Natural Resource of the Study Area (Resource Map Preparation)

Basically, it depicts land, rivers, hills, fields, vegetation etc. In the resources map agriculture land, Vegetation, pond, Road, Commercial land etc. is reprinted.

The participants in the resource mapping process disclosed that in addition to betel leaf production (Boroj) serving as their main source of income, fishing and livestock farming were also significant and revenue-focused activities. Participants either gathered in clusters or had personal Borojs next to their dwellings. They also stated that ponds were given out to lease for additional revenue due to the sheer number of them. Aside from the enormous number of Boroj, there were also small bamboo gardens, mango gardens, pigeon farms, several barren lands, open spaces and so on. Although paddy was grown there but the quantity was negligible.

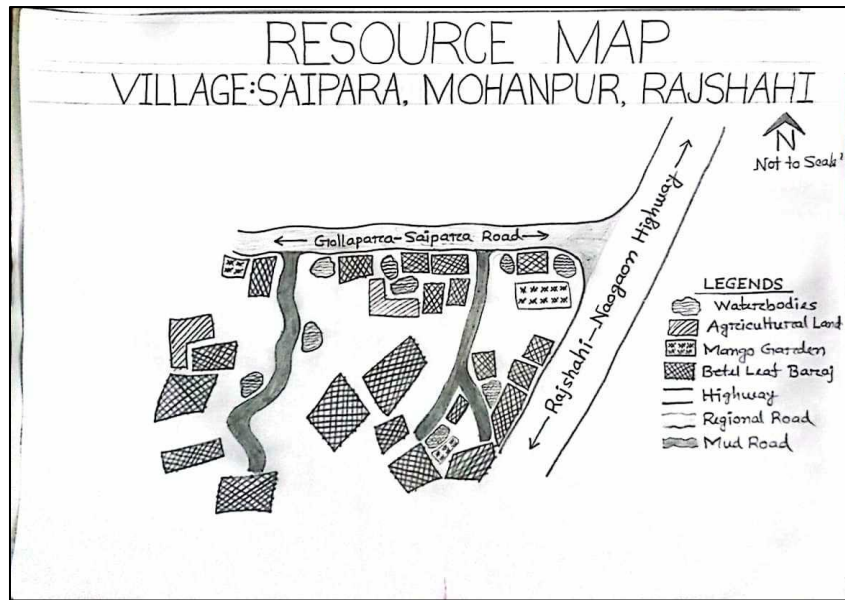


Figure 2: Resource Map (Saipara, Mohanpur, Rajshahi)

### 3.1.3 Seasonal Diagram

Agricultural resources	Summer	Rainy Season	Autumn	Late Autumn	Winter	Spring
<b>Period</b>						
<b>Happiness</b>	☹️ 2	☹️ 2	😊 4	😊 5	☹️ 3	😊 4
<b>Avg. Income</b>	15k – 20k	15k – 20k	20k – 30k	20k – 35k	15k – 25k	20k – 30k
<b>Betel Leaf Farming</b>	•• •• ••	•• •• •	•• •• •• •• ••	•• •• •• •• ••	•• •• •• ••	•• •• •• ••
<b>Fishing</b>	•• •• •• •• ••	•• •• •• •• ••	•• •• •• •• ••	•• •• •• •• ••	×	×
<b>Paddy</b>	×	×	•• •• •• ••	•• •• •• •• •	•• •• •• •	×

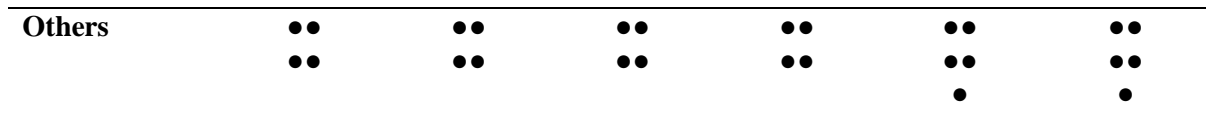


Figure 3: Seasonal Diagram of Agriculture and Economic aspect (Source: Author's Preparation, 2023)

### 3.1.4 Rend Analysis

Agricultural resources	Betel Leaf Farming	Fishing	Paddy	Others
<b>Period</b>				
<b>2015 - 2016</b>	○○○○ ○○○○	○○○	○○	○○
<b>2017 – 2018</b>	○○○○ ○○○○	○○○○	○○○	○○
<b>2019 – 2020</b>	○○○○ ○	○○○○ ○	○○○○	○○○○
<b>2021 - 2022</b>	○○○○ ○○○	○○○○ ○	○○○○	○○○

Figure 4: Trend Analysis of Relevant Filed (Source: Author's Preparation, 2023)

In 2015-2016, Highest betel leaf production rate and fishing, paddy and others agricultural resources production rate at minimal range.

In 2017-2018, fishing and paddy are increased, but other production rate remain same.

In 2019-2020, fishing, paddy and others agricultural resources production rate are increased, but betel leaf production rate decreased due to Covid-19.

In 2021-2022, Betel Leaf Farming and fishing production rate are increased.

### 3.1.5 Cause Effect Diagram

The biggest challenge facing betel leaf cultivation is climatic unconventionality. As a result of climate change, growers face different types of natural calamities at different times. Moreover, there are also some constraints in cultivation.

High temperature, drought, heavy rainfall, non-rainfall, flash flooding, extreme cold & fog significantly affect betel leaf production among various asymmetric climatic hazards.

There are also some constraints in the hazards. Among them lack of irrigation in drought, lack of plant protection measure, lack of incentives, lack of governmental financial support/bank loan, lack of taking enough precautions to control damages, lack of enough scope and capacity, lack of storing facilities in calamities etc.

Climatic impact analysis on betel leaf production in the selected area has shown that inconsistent climatic changes cause various problems that affect their subsequent production.

Anomalous climatic changes create various problems in betel leaf production. In most cases, due to unconventional climate change, betel leaf production has decreased at an alarming rate.

Also, in some cases it is seen that the betel leaf is completely destroyed which also causes unproductiveness. That is, both the problems cause financial loss to the growers both directly & indirectly. the fertility of the land also decreases. As a result of which subsequent production does not come as expected. Actually, the economic condition of the growers worsened greatly.

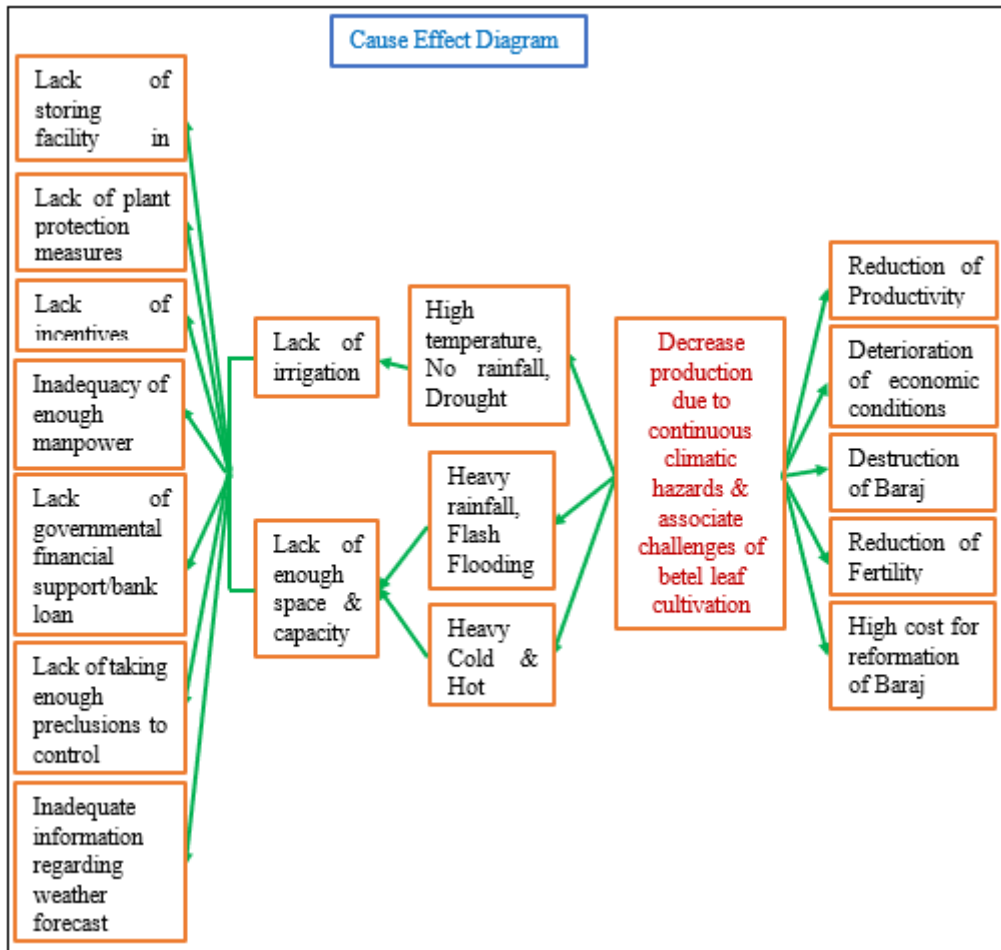


Figure 5: Cause Effect Diagram (Source: Author's Preparation, 2023)

That is, both the problems cause financial loss to the growers both directly & indirectly. the fertility of the land also decreases. As a result of which subsequent production does not come as expected. Actually, the economic condition of the growers worsened greatly.

### 3.1.6 Impact Diagram

Various climatic hazards have a great impact on betel leaf production. Due to geographical location, betel leaves are extensively cultivated in the village Saipara under Mohanpur upazila of Rajshahi. However, since the climate of Rajshahi is relatively sensitive, this kind of anomalous climate change is a serious challenge for betel leaf cultivation. Here high temperature, drought, heavy cold, fog, heavy rain, flash flood & lack of rain each impact on betel leaf production. In many cases the impact is so great that it completely destroys the betel leaf Baraj.

Continuous decline in betel leaf production, destruction of Baraj directly and indirectly impacts the economic condition of farmers. In many cases, this impact is so great that many farmers face financial loss. Instead of making financial gains, they fail to recover production costs.

Due to reduced production, many betel growers are becoming unemployed. Once 95% of the farmers in the area were engaged in betel leaf cultivation, but due to continuous economic downturn they are changing their profession or shifting to other crops such as paddy, jute etc. Again, many self-sufficient farmers used to hire workers to run their production, but now many owners are forced to lay off workers or are unable to pay workers. As a result, a large number of people become jobless in the same incident. Farmers have to face various problems to overcome the economic crisis of climatic hazards and return to normal production. They need financial help in the first step of damage control. For this they try to



take soft loans from various banks/NGOs. But in these cases, they have to pay high interest. Again, to get a loan, they often have to accept harassment or do not get the appropriate amount of loan. Due to such harassment, these marginal farmers are discouraged from taking loans. Due to the lack of necessary money, they cannot return to betel cultivation again through the reformation of barge.

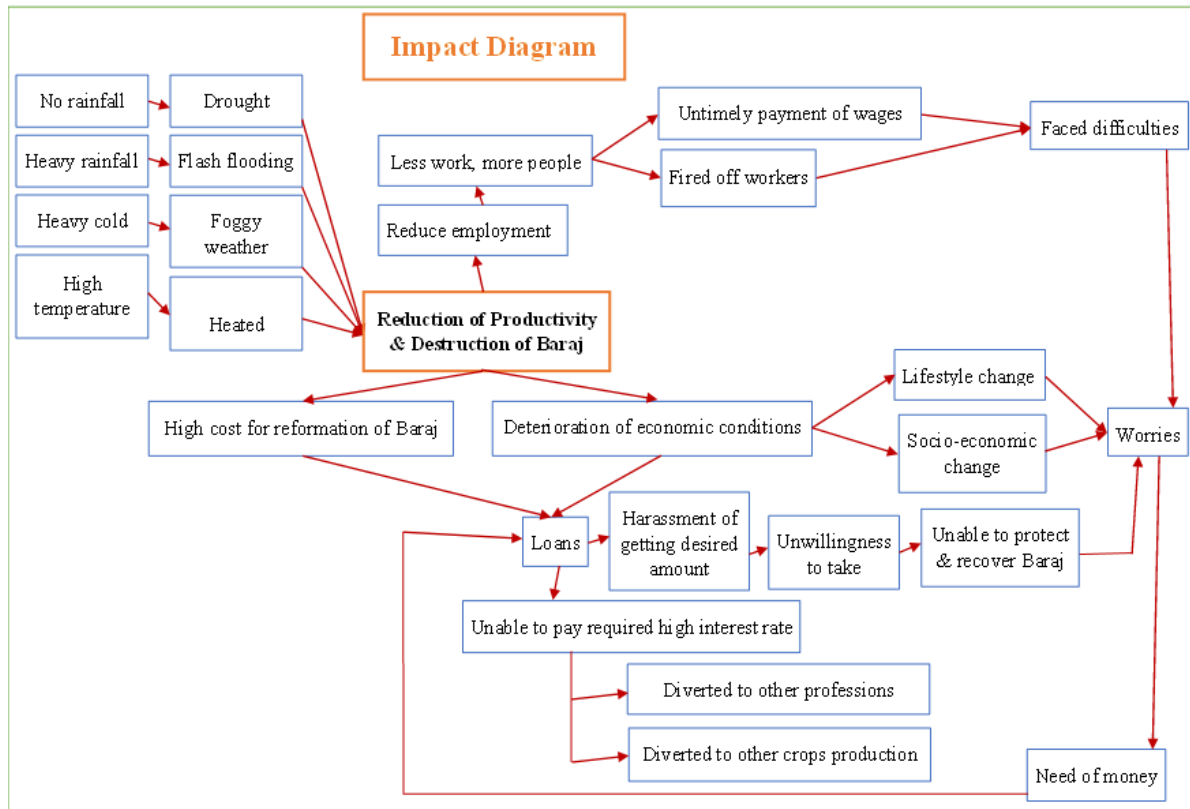


Figure 6: Impact Diagram (Source: Author's Preparation, 2023)

### 3.2 Tables

#### 3.2.1 Opportunity Matrix

The development of an opportunity matrix starts with rephrasing each identified constraint into positive desirable conditions and detailing the opportunities for innovation and change. It is used to explore the local people's perception of the existing services and opportunity available. The focus is on the availability of service and opportunity while in the later the focus is on the adaptation measures people follow.

Table 1: Opportunity Matrix (Source: Author's Preparation)

Constraints	Desired Condition	Opportunities
Red/yellow betel leaves	Fresh green betel leaves	- Well-drained soil with partial shade - Harvesting in advance
Nutritional inadequacy in the land	Proper nutritional adequacy on the land	- Utilize of cow dung as fertilizer. - Use of rotted manures or leaf mold - Increase use of mulching

Decayed root	Fresh root	<ul style="list-style-type: none"> <li>- Removing the entire plant and destroying it</li> <li>- Regular watering</li> <li>- Allow proper soil drainage (especially during the rainy season)</li> </ul>
Lower productivity	Higher productivity	<ul style="list-style-type: none"> <li>- Practice of mulching to conserve soil moisture</li> <li>- Use of clean water</li> <li>- Providing support and shade</li> </ul>
Diseases and insects attack	Defending of diseases and insects	<ul style="list-style-type: none"> <li>- Use of insecticides</li> <li>- Providing organic pesticides</li> <li>- Replace used soil</li> </ul>

Betel leaf was deliberately selected due to its potential profitability at a time when conventional crops like rice and jute are proving to be less profitable. Numerous job possibilities have also been created by Rajshahi's expanding betel leaf sector. However, because of climate change, the region's betel vines have been severely impacted by flood, storm, rain, and cyclone Amphan. Thousands of betel vines have been damaged by the severe winds. The effects and adaptations of climate change on societies' farming systems have been demonstrated.

From our study we have found out that, harvesting is done early to minimize this problem since betel leaf becomes red in the presence of cold and heavy fog. In cultivated land, there are nutrient deficits as a result of soil erosion. They employ cow dung as a fertilizer to improve the soil's fertility and nutritional content. Since the majority of them have cows, this natural fertilizer is free of cost. Production is hampered by the lack of water. When the temperature is really hot, mulching is used to hold the moisture of the soil and improve water abundance. They utilize well of water side by side as well.

Aside from these issues, there are several more issues and infections that hinder the cultivation of betel leaves. Due to unidentified diseases, the root has degenerated. They responded by making a circular hole around the afflicted plant. Then remove the entire plant and burn it to the ground. Reduced yield because of their methods various cropping techniques.

There are several paddy or crop species grown. The Rajshahi region, which includes the large Barind tract and includes our study area, has been experiencing conditions similar to drought, which constitutes a significant danger to the people's ability to live and support themselves. Long periods of dry weather and drought have harmed the general public's health in terms of drinking water, the environment and biodiversity, crop failure, and the production of betel leaves.

Due to the Covid-19 pandemic scenario, they are being compelled to sell their betel leaf harvest at a lesser price than they would normally do, which has significantly increased the number of losses. Since the epidemic started, small businesses and betel leaf merchants have stopped operating. The upstream floodwater's onslaught has flooded several of the betel leaf agricultural plots, harming the crop in the process.

Table 2: Adaption and Mitigation Strategy (Source: Author's Preparation)

Observed climate change impacts on communities' farming system		Adaptation Measures
<b>Climate change adaptation in betel leaf-based</b>	Betel leaf becomes red colored due to heavy fog and cold	Early harvesting

<b>production by communities</b>	Nutrient deficiencies in cultivated land due to soil erosion	Use cow-dung as a manure
	Root decayed due to unknown diseases	Create a circular hole around the affected plant. Then dug out the whole plant and destroy it with fire
	Reduce production due to water scarcity	Mulching practice is done when temperature is very high to hold the moisture of the soil. Side by side they use water of well
	Crop failure due to drought.	No adaptation measure
	Reduction of yield	Multiple cropping practices. Different paddy species are planted

#### 4. CONCLUSIONS

Farmers are increasingly more and more interested in cultivating betel leaves because of its profitability and reduced production costs when compared to many other crops. More and more farmers are lured to betel leaf cultivation since it has yielded more revenues in the last several years. The growers in our research region have become self-sufficient and successful through betel-leaf agriculture. Growing it for financial gain is radically changing the lives of many farmers.

Here, betel leaf is one of the most profitable crops. All crops are quite profitable, and this one is called "Sonar Pata" (golden leaves). His unceasing efforts and hard labour in betel leaf farming paid off, as only a few farmers in the area built their first concrete dwellings. Inspired by their success, several of their neighbours established "Baraj," which are currently flourishing. By using PRA techniques creatively, traditional knowledge and great local practices may be documented. Peer learning can also be used to gain useful information for the benefit and exchange of knowledge at the community level. Due to climate change, the region's betel vines have suffered greatly from a number of natural catastrophes. Thousands of betel vines have been destroyed by the powerful winds. Despite everything, farmers have learned to live with these measures because this is their main source of income and this crop grows well in this location. Therefore, the government should intervene appropriately to assist farmers in avoiding these issues and damages in order to promote economic prosperity.

This study is very important because it explores the complex relationship between climate change and the socioeconomic structure of betel leaf farming in a particular area. The study offers a comprehensive understanding of the vulnerabilities faced by betel leaf farmers in Mohanpur Upazila by analyzing the socio-economic implications. This analysis is crucial because it sheds light on the wider effects of climate change on livelihoods. This study is essential to understanding how resilient the agricultural industry is to changing weather, especially in betel leaf production. The study also looks at how betel leaf farming has a profound effect on farmers' lives and how that has shaped the socioeconomic dynamics of the neighbourhood. Participatory Rural Appraisal (PRA) techniques are utilized to document traditional knowledge and local practices, which enhances the study and underscores the significance of conserving indigenous wisdom. The study also emphasizes the necessity of evidence-based policies to lessen the negative effects of climate change and provides a guide for legislators to create interventions that support sustainable farming methods and economic growth. This study provides insightful information that has significant implications for community resilience, cultural preservation, and well-informed decision-making in the face of climate change. In short, it goes beyond the immediate context of betel leaf cultivation.

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