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THE IMPACT OF CLIMATE CHANGE ON RICE PRODUCTION IN MINHLA TOWNSHIP, BAGO DIVISION, MYANMAR

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EMDevS - 63 (19th BATCH)

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THE IMPACT OF CLIMATE CHANGE ON RICE PRODUCTION IN MINHLA TOWNSHIP, BAGO DIVISION, MYANMAR

A thesis submitted in partial fulfillment of the requirements for the Executive Master of Development Studies (EMDevS) Degree

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Abstract

This study aims to analyze the impact of the climate change on rice production in Minhla Township, Bago Division, Myanmar. To accomplish these objectives, primary and secondary data were used in this study. A sample of 120 rice farmers across eight villages were selected by using simple random sampling method. The primary data were collected by using structured questionnaire with five-point Likert scale items. In-depth interview was also conducted with rice farmers. Secondary data was obtained relevant text book, previous research and internet websites. The findings indicate that rainfall unpredictability, rising temperatures, and increased frequency of extreme weather events have significantly disrupted traditional rice farming. While many farmers have adapted their planting calendars and adopted climate-resilient rice varieties, the lack of institutional support and access to training remains a significant challenge. The study makes suggestions to improve rice-farming communities' ability to adapt.

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LIST OF ABBREVIATIONS

ADB	Asian Development Bank
ANN	Artificial Neural Network
AWD	Alternate Wetting and Drying
DMH	Department of Meteorology and Hydrology
FAO	Food and Agriculture Organization
HYVs	High-yielding Rice Varieties
IPCC	Intergovernmental Panel on Climate Change
IRRI	International Rice Research Institute
MLR	Multiple Linear Regression
NGO	Non-Government Organization
SARIMAX	Seasonal Autoregressive Integrated Moving Average with Predictors
VAR	Vector Autoregressive

CHAPTER I

INTRODUCTION

1.1 Rationale of Study

Climate change has emerged as one of the most pressing global problems of the 21st century, affecting natural systems, economies, and human livelihoods. Scientific evidence indicates that global warming, changing precipitation patterns, and extreme weather event frequency and intensity are increasingly common due to anthropogenic greenhouse gas emissions. The climatic changes have far-reaching consequences for ecosystems, agricultural production, water resources, and socio-economic stability across the world.

Asia, home to over 4.5 billion people and some of the world's most densely populated and agriculturally dependent countries, is extremely vulnerable to the impacts of climate change. The region is frequently threatened by climate-related hazards in the form of floods, droughts, typhoons, and heatwaves. These events jeopardize food security, water resources, and livelihood—especially in the rural areas where people depend heavily on climate-sensitive sectors like agriculture and fisheries.

In Southeast Asia, as in Myanmar, climate variability has been linked to decreased rice yields, increased pest attacks, saltwater intrusion, and erratic monsoon patterns. Since rice is both a staple food and main economic crop in the region, localized impacts of climate change are significant to inform the development of effective adaptation strategies and policy responses.

Myanmar's economy mainly depends on farming, and rice is the most important crop. In the last few decades, climate change has caused changes in the weather, which has made rice farmers more at risk. Climate change is a major problem for rice-growing areas in Myanmar, especially in Minhla Township, which is in Bago Division. Minhla is mainly a farming area where farmers rely on regular rainfall and normal weather to grow their crops. Since they use rain-fed farming, Minhla is very sensitive to climate changes. Minhla is one of the main places in Myanmar where rice is grown, and small farmers use monsoon rains and predictable seasons to grow their crops. But in recent years, farmers in Minhla have noticed changes in the weather, which are connected to climate change. This study examined how climate change is affecting rice farming and what farmers are doing to adapt at the local level. Rice farming in Minhla Township is increasingly exposed to erratic rainfall, drought, and severe heat. Farmers face lower yields and higher risks, yet there has been no empirical study at the township level to assess the degree and effect of such climatic changes.

1.2 Objective of the Study

The Objective of this study are:

(1) To assess farmers' perceptions on climate change and adaptation strategies on rice production, and

(2) To identify challenges faced by farmers in Minhla Township, Bago Division.

1.3 Methods of Study

The study sought to assess the effects of climate change on rice farming in Minhla Township, Bago Division, Myanmar. Both secondary and primary data gathering methods were employed to gather detailed data. Minhla Township of Thayarwady District consists administratively of 246 villages within 54 village tracts. In the current study, data were gathered from 120 rice farmers residing in eight purposively selected villages of the township. Primary information was collected with the help of structured questionnaires which were employed to understand farmers' perception of climate change, adaptation in agriculture, and institutional support. There was a 5-point Likert scale in the questionnaire on which the respondents marked the degree of agreement with various statements concerning climate, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Secondary data were obtained from several sources like relevant textbooks, previous research journals, and authentic internet sites. They acted like background information on a contextual basis and filled in the interpretation gaps of the primary data. Data were analyzed through descriptive statistical methods like mean, standard deviation, and percentage of agreement to concisely summarize and interpret the findings.

1.4 Scope and Limitations of the Study

The scope of this study was limited to evaluating the impact of climate change on rice production specifically within Minhla Township. It aimed at finding out farmers' experiences and perceptions of rice in eight randomly chosen villages in the township. The research was supposed to establish what farmers perceived about climate variability, their adaptation methods that they have adopted, and how much institutions had supported them.

Despite its focus, the study had several limitations. Firstly, the most important limitation was the limited geographic coverage. Due to financial and time constraints, data collection was limited to eight villages alone, and these may not be a fair representative of the diversified circumstances in the entire township. Second, there were few long-term and village-level climate data available, and these did not permit a more extensive analysis of climate trends by time. Additionally, the relatively small sample size of 120 farmers restricts the generalizability of the results to a larger population of Myanmar rice farmers. Nonetheless, the study provides valuable insights to the understanding and local governance of climate change in a specific farming region.

1.5 Organization of the Study

This study is organized with five chapters. Chapter I present rationale of the study, objectives of the study, scope and method of the study, and organization of the study. Chapter II consists of the literature review concerned with the climate change. Chapter III described about the rice production in Thayarwady District, Minhla Township in Myanmar and the effect of the climate change on rice production. Chapter IV includes the survey analysis on the effect of the climate change on rice production in Thayarwady District, Minhla Township in Myanmar. Chapter V is the conclusion section including summary of the findings, suggestions and needs for the further study.

CHAPTER II
LITERATURE REVIEW

2.1 Global Trends in Climate Change and Agriculture

Global warming is becoming a serious threat around the globe, especially in providing enough food to support the global population. Rice is one of the most adversely affected crops, and it's a major food source for over half of the world's entire population. It is especially crucial in Southeast Asia, not just because rice is a staple food, but also because it's a major source of livelihood for over a million farmers. With climate patterns changing—such as rising temperatures, periodic rain, extended dry spells, and rising sea levels—the ability to grow rice is being severely affected. The changes have the potential to reduce rice yield, ruin crops, and make agriculture more challenging to generate enough food. So, this problem isn't just hurting farmers' income—it's also affecting the whole economy and the health of communities that depend on rice. This chapter talks about what researchers have found about how climate change is changing rice farming. It covers key issues like hot weather causing heat stress, unpredictable rainfall, not enough water because of drought, and rising sea levels causing flooding. It also shows how farmers and governments are trying to deal with these problems, as mentioned in FAO (2021).

Climate change is now one of the biggest challenges around the world, especially for countries that rely on farming. According to the Intergovernmental Panel on Climate Change (IPCC, 2021), the Earth's temperature has risen by about 1. 1°C compared to before the industrial age. This warming has made extreme weather events like floods, droughts, and heatwaves happen more often, and it has also made rain patterns less predictable. These changes in the climate have directly lowered agricultural production, especially in tropical areas like Southeast Asia, where most farming depends on rainwater.

Climate change is a major threat to farming all over the world. The IPCC reports that since the start of the industrial revolution, the Earth's temperature has risen a lot.

This has led to changes in rainfall, more frequent storms, and higher sea levels. These changes are making it harder to grow enough food, especially in poorer countries. Crops like rice, corn, and wheat are especially vulnerable to heat and lack of water. Research shows that for every one-degree Celsius increase in temperature, these crops could lose 3 to 10 percent of their harvest, depending on where they are grown and the type of crop. Farming relies heavily on nature and the seasons, so it is very sensitive to weather changes. Rice, in particular, needs a lot of water and is greatly affected by changes in temperature and rainfall. In 2020, the FAO warned that without taking proper steps to adapt, climate change could greatly reduce rice production in poorer countries.

2.2 Climate Change and Rice Production in Southeast Asia

Rice is the main food people eat in Southeast Asia, and it feeds more than 650 million people in countries like Indonesia, Vietnam, Thailand, Myanmar, the Philippines, Cambodia, Laos, Malaysia, and Timor-Leste. Between 2020 and 2025, rice production in this region has mostly stayed the same, but there have been some small changes. These changes show that there are growing problems from both the weather and other things that affect farming. Indonesia, which is the biggest rice producer in the region, has been making less rice over time, going from 54. 6 million metric tons in 2020 to about 53. 2 million metric tons in 2025. Vietnam, the second-largest producer, has also been producing a little less, decreasing from 43. 2 million metric tons in 2020 to 42. 3 million metric tons in 2025. These drops might be because of issues like less water, damaged land, and harder weather conditions.

Thailand, however, has seen a small increase in rice production, going from 31. 4 million metric tons in 2020 to 32. 7 million metric tons in 2025. This could be because of good government policies or strong farming systems. Myanmar has been producing a little less, dropping from 25. 1 million metric tons in 2020 to 24. 3 million metric tons in 2025. This may be due to political problems, unpredictable weather, and higher costs for things farmers need. The Philippines has had a modest increase in rice production, going from 19. 3 million metric tons in 2020 to about 20. 4 million metric tons in 2025. This might be because of better seed technology and more efficient farming equipment. Production in the other minor rice-producing countries such as Cambodia, Laos, Malaysia, and Timor-Leste was comparatively stagnant but did not have any significant upward movement. Overall, Southeast Asia's combined rice production is projected to decline marginally from 190.6 million metric tons in 2020 to 189.6 million metric tons in 2025. The decline might seem minimal, but it signals more fundamental system-level weaknesses to regional food security under climate change, land constraints, and shifting labor trends. Such trends indicate the imperative necessity of adaptive strategies and investment in region-wide sustainable agriculture practices.

Rice farming in most of these nations not only guarantees food self-sufficiency but also provides major contributions to rural livelihoods, national livelihoods, and foreign exchange receipts. The mere concentration of the region, though, on rice farming has also made it more vulnerable to the debilitating impacts of climate change. As temperatures continue to rise, it's becoming harder to predict when it will rain, sea levels are increasing, and extreme weather events are happening more frequently. These changes are making it very difficult to grow rice and keep things sustainable over time.

2.2.1 Impact of Rising Temperatures on Rice Production

In Southeast Asia, where rice is the main food and a big part of daily life for millions of people, climate change is causing temperatures to go up. This is a serious issue because rice is very sensitive to heat, especially during important growth stages like when the flowers open (when pollination takes place) and when the grains are forming. Research shows that for every 1°C increase in temperature, rice production could decrease by about 10%. This is a big worry for countries like Thailand, Vietnam, the Philippines, and Myanmar, where rice is grown in large amounts and helps support many people in rural areas. Even a small increase in temperature can lead to major losses in rice production.

Furthermore, Wassmann et al. (2009) showed that not just daytime temperatures but even high nighttime temperatures reduce the quality as well as the quantity of rice grains. This is most alarming for Southeast Asian lowland rice ecosystems, where warm nights and high humidity are on the rise due to climate change. If the temperature exceeds 35°C, the rice crop is subjected to heat stress that prevents the plant's ability to photosynthesize (the process by which plants develop) and kills the plant's reproductive system, leading to lower grains and poor yield.

2.2.2 Impact of Rainfall Variability and Water Stress

In Southeast Asia, the majority of rice farmers depend on rainfed rice systems, that is, they rely largely on natural rainfall rather than irrigation. Therefore, they are very susceptible to changes in the distribution of rainfall as a result of climate change. Studies such as Tuong and Bouman (2003) have shown that with the irregular or unpredictable nature of rain, water stress—a lack of water when rice plants most need it—is caused. It is especially harmful during pivotal stages like seedling establishment, flowering, and grain filling. When rice plants are denied enough water during the right moment, they give lower yields and harvests that are not reliable.

Climate scientists, such as the IPCC (2021), have forecast that future weather events will become more frequent. These include prolonged dry periods (droughts) and unexpected bursts of heavy rain (floods). Unpredictable weather conditions complicate farmers' ability to schedule planting and harvesting, and they also cause damage to fields and crops. Where farmers have limited access to irrigation, the risk is even higher. Without a reliable supply of water to fall back on, there is higher potential for crop failure, which can hurt food production and incomes. In Southeast Asia, increasing variability in rainfall and absence of irrigation networks are endangering rice farmers. If this trend continues, the cultivation of rice in the region could be greatly affected, compromising food security and rural livelihoods.

2.2.3 Impact of Frequency and Severity of Droughts

The most severe threat to rice cultivation in Asia, especially regions like Southeast Asia, is drought, where the majority of the rice farmers rely on rainfed farming. Drought occurs when rain does not arrive for an extended period, leading the soil to parch, resulting in poor crop growth, eventually leading to lower yields.

Drought, according to Serraj et al. (2011), impacts the rice crop in several negative ways. It tends to shorten the growing period of the crop, decrease the yield of tillers (the rice stems that bear rice grains), and decrease the grain production per plant. This implies that there is much less rice being harvested in years when there is drought. In Bangladesh and India, drought areas have already suffered repeated declines in rice yields during the past few decades. It is mainly brought about by a synergy of meager rainfall, declining groundwater, and substandard soil water. The same trend is occurring in Myanmar, Thailand, Vietnam, and Cambodia, especially during El Niño years when rainfall is below average.

Climate models predict that more frequent and intense future droughts will happen particularly in tropical and subtropical areas where rice is farmed. This puts more pressure on governments and farmers to develop solutions. To counteract these risks, scientists and agricultural experts are in the process of developing drought-resistant rice varieties—types of rice that are capable of living with less water. In addition to this, farmers are being encouraged to adopt water-conserving practices such as alternate wetting and drying (AWD), mulching, and rainwater harvesting.

2.3 Institutional Support

Institutional support takes center stage in enhancing the adaptive capacity to climate change of rice farmers. Effective institutions—government, non-government, and international—provide the enabling infrastructure, policy space, and financial resources to support adaptation at the local level. Public institutions play a unique role in providing agricultural extension services, ready accessibility to climate-resilient technology, and timely weather and crop information. For example, programs that help farming deal with climate changes are started by governments and supported by groups like the Food and Agriculture Organization (FAO). These programs give farmers the knowledge and tools they need to handle specific climate problems (FAO, 2016).

In Southeast Asia, the focus is on working together across different groups to tackle risks to rice farming. The International Rice Research Institute (IRRI) is working with government officials to start big pilot projects and training programs. These teamwork efforts make sure that the policies created are based on science and meet the needs of farmers in different kinds of farming areas (IRRI, 2015). Also, institutions help by giving access to loans and insurance. Many small farmers who grow rice don't have enough money to buy new farming technology or deal with bad weather. Government programs that offer agricultural loans, crop insurance, and small financial help reduce these financial risks. In countries like Vietnam and the Philippines, there are funds and insurance that pay out when there's extreme weather, helping farmers stay safe (ADB, 2017).

Training and learning programs from institutions also help communities become more resilient. These programs can strengthen local knowledge and encourage sharing of ideas between farmers, which is important in areas where education or use of technology is not widely available. Lastly, how well institutions work depends on how well different agencies work together, how open they are, and how well they understand the local communities' needs. Without proper involvement from institutions, climate adaptation efforts might not be used effectively or reach those most in need, which can make inequality in how people deal with climate change worse.

2.4 Adaptation Strategies

As climate change becomes a bigger issue, people are trying different ways to keep rice growing, especially in places that are already in trouble, like parts of Southeast Asia. These methods help make rice crops and farming systems stronger so they can deal with bad weather, such as high heat, not enough water, and salty soil. One popular solution is using special kinds of rice that can handle tough conditions. These include rice that can live through flooding, drought, and salt. For example, the International Rice Research Institute created a rice type called Sub1, which can stay under water for about two weeks. This helps farmers in countries like Bangladesh, India, and the Philippines deal with flood problems. Another important approach is changing when farmers plant their rice to avoid the worst parts of the growing season, like very dry or very rainy times. By planting later, farmers can match their planting times with new weather patterns and reduce the risk of losing their crops. Some areas are also trying to plant rice in two stages or at different times to make the best use of limited growing periods. In places where water is harder to get because of irregular rain, improving how water is used is very important. Methods like Alternate Wetting and Drying, collecting rainwater, and using drip irrigation help save water while keeping rice crops healthy and productive. Such methods are especially essential in drought-prone zones like some parts of Cambodia and eastern India, where groundwater resources are declining.

Also, the intersection of digital technology and precision agriculture has been established as a viable adaptation strategy to climate. Through mobile phone apps, satellite images, and automated irrigation sprinklers, farmers are in a position to make proper decisions regarding fertilizer application, water supply, and pesticide application. These technologies help in reducing losses in resources and yield maximization under stress environmental situations. This, however, depends on how educated the farmers are, how easily they can use digital tools, and the help they receive from local experts. As mentioned by IRRI (2015) and Aggarwal et al. (2019), the success of these adaptation efforts depends a lot on how much farmers know and how well they are trained. Teaching farmers about new technologies and methods is very important for helping them stay strong over time. When the government and private companies work together to share research, try out new ideas in real farming situations, and provide training, it helps link new discoveries with what farmers actually do on their farms. So, while solving technical problems is important, it's just as important to have strong social and institutional support to make sure these changes are accepted and work well in the real world.

2.5 Review on Previous Research Studies

Thet Mar Lwin (2023) did a study on how climate change affects rice production in the Ayeyawady Region. The study looks closely at how climate change impacts rice crops in that area. The study used rainfall, maximum and minimum temperatures, and relative humidity at 9 AM and 6 PM as the climate factors. Secondary data were gathered from Pathein, Hinthada, Maubin, and Myaungmya districts for the years 1992-1993 to 2020-2021, covering both the monsoon season (May to October) and the summer season (November to April). To figure out how climate factors affect rice yield, the study used four models: Multiple Linear Regression (MLR), Seasonal Autoregressive Integrated Moving Average with Predictors (SARIMAX), Vector Autoregressive (VAR), and Artificial Neural Network (ANN). The results show that high temperatures and rainfall cause negative effects on rice yield, while low temperatures and humidity have a positive effect in all districts. The ANN model was found to be the best at forecasting rice crop. The actual and predicted values were very close, and the summer rice yield was higher than the monsoon rice yield. It was also found that rice farming can be improved by increasing efforts.

William Sundelin (2020) observed how climate changes, rice farming, and political violence are related in Vietnam. His study adds to the understanding of how climate change and violence are related by checking if there's a cause-and-effect link between climate changes, farming production, and political violence in Vietnam from 2010 to 2019. The idea is that climate changes that hurt farming can lower the cost of violence because people have less income, which might make violence more likely. His study mixes research on climate and conflict, research on civil wars, and studies on how climate affects rice farming in Southeast Asia. To check his ideas, he used mixed-effect models and a method called counterfactual estimation. He found that when minimum temperatures are higher during the rice growing season, rice production goes down. But higher maximum temperatures seem to help increase rice output. The results show that higher minimum temperatures are connected with lower rice output and more political violence the next year. Higher maximum temperatures aren't linked to rice output or violence. These findings match the ideas from his study framework. The effect of minimum temperatures on violence is not huge compared to other factors, but it stays the same across different ways of looking at the data.

The study shows that there is a link between climate, farming, and violence in Vietnam, which is similar to what has been found in other parts of Southeast Asia. However, more research is needed to fully understand how this link works and what exactly causes it. Mst Ashrafun Nahar (2016) looked at how climate change affects the rice market and farm households in Bangladesh. This study used an Aggregate Farm Household Model to examine how potential land loss and lower crop yields due to climate change might affect production, consumption, prices, welfare, and the government's ability to be self-sufficient in rice production. The model was established with information from the Bangladesh rice marketplace using the Household Income and Expenditure Survey from 2010. The results showed that climate change causes a loss in rice productivity and an increase in rice prices in local markets. The loss in productivity lowers rice output, but it increases the output of other non-rice crops. Simulations that assumed a 25% loss in arable land and a 15% loss in productivity showed that both rice land and other agricultural land (not rice) are decreasing every day. However, the drop-in rice output leads to higher imports, making food security harder to achieve. According to the simulation study, rice crop falls by 12. 67%, while rice prices go up by 22. 38% and imports rise by 5. 20%. At the same time, rice production falls by 15% and arable land by 25%. On the other hand, the output of non-rice crops increases by 0. 19%, and the prices of non-rice agricultural products rise by 1. 33%. In both cases, the consumption of non-rice and rice drops by 2. 28% and 26. 24% respectively. Climate change has a more negative effect on the consumption of non-rice crops compared to rice, mainly because rice is a staple food for subsistence.

Prakash K Karn (2014) studied how climate change impacts rice farming in Nepal. The study checked how changes in weather conditions affect rice production and how much rice output might change in the future. The research found that different stages of rice growth are affected in different ways by climate changes. For example, if the temperature during the rice ripening period rises by 1 degree Celsius, the harvest increases by 27 kilograms per hectare. But if the temperature goes above 29. 9°C during that time, the harvest actually goes down. Since the current average temperature is already above this level, any further increase in temperature could lower rice production. The study also found that too much rain during the early stages of rice growth can greatly reduce the amount of rice produced. If carbon dioxide levels double by the year 2100, as scientists predict, rice production in Nepal might decrease by about 4.2% compared to current levels. However, this prediction doesn't take into account possible benefits from adapting to climate change or from increased carbon dioxide helping plants grow, nor does it consider the harmful effects of extreme weather events caused by climate change.

CHAPTER III
OVERVIEW OF RICE PRODUCTION IN MYANMAR

3.1 History of Rice Production in Myanmar

Rice has been a fundamental part of Myanmar's agriculture and society for centuries. As the country's staple food and main agricultural crop, rice plays an important role in the livelihoods of millions of farmers in national food security. There has been over a thousand years of Myanmar's traditional rice farming. Farmers at this early time relied on human labor and animal power, with water buffaloes for paddy plowing and indigenous rice varieties being cultivated primarily for local consumption. These practices remained largely unchanged until colonial times. With British colonial rule (1824–1948), Myanmar (then Burma) became a major rice exporter to the world. The British introduced massive irrigation projects, railway lines, and ports, particularly in the Ayeyarwady Delta, making rice production immensely possible. Rice became an export crop, and vast areas of land were converted into paddy fields to meet overseas needs. But the focus on the export market sometimes came at the cost of food security in Myanmar. After independence in 1948, Myanmar's rice industry entered a phase of stagnation. The state took over most sectors, including agriculture, and inefficiency and reduced productivity followed. Farmers were not provided with new technologies, fertilizers, and credit. Despite these restrictions, rice cultivation was the backbone of the economy and food self-sufficiency was prioritized using state procurement and rationing systems.

Significant economic and political change began in the late 1980s. Agriculture markets were liberalized by the government, with private sector involvement in rice milling and trading introduced. Access to high-yielding rice varieties (HYVs), irrigation, and chemical inputs increased yield gradually. Farmers were provided land-use rights to induce more investment in production. Rice exports remained concentrated despite infrastructure constraints and changing trade policies. Since 2011, there has been considerable progress in the modernization of agriculture in Myanmar. Cultivators have adopted enhanced rice varieties, pest control measures, and two cropping systems due to support from global donors and the state. Areas such as the Ayeyarwady Delta, Bago Division, and sections of Sagaing and Shan States are still the best areas for growing rice. The past couple of years have seen growing rice exports, especially high-quality varieties like Pawsan Hmwe, to countries like China, Bangladesh, and parts of the Middle East. As much as this is an achievement, there are still challenges. Farmers still face rising input costs, volatile market prices, impacts of climate change such as flooding and droughts, and limited access to storage and processing machinery. However, through ongoing investment, technology adoption, and policy support, Myanmar's rice sector has immense growth prospects as well as the capacity to regain its former stature as a key player in the global rice market.

Myanmar rice production was reasonably stable in harvested area (~6.8–7.0 million ha), but production varied according to climatic conditions and the institutional capacity. Production went down by 2.85 t/ha in 2020/21 to 2.71 t/ha in 2022/23, coinciding with the El Niño-led droughts and irregular monsoon rains. There was a slight increase to 2.83 t/ha in 2023/24 and another decline to 2.71 t/ha in 2024/25, keeping the five-year average yield roughly at 2.77 t/ha. The variability in yields is also reflected in reported climatic stresses farmers reported a 32% decline in yields due to flooding and a 51% decline in yields due to drought during the 2023 monsoon season, indicating the high sensitivity of rice production to climatic shocks. Despite production challenges, Myanmar's FY 2023/24 rice exports totaled about 1.68 million tonnes worth USD 845 million short of the 2.5 million tonne target due in part to disruption from weather conditions. Combined, the data highlights Myanmar's exposure to climate variability and the need for increased agriculture resilience and deliberate adaptation response. Impact of rice production on rising temperature, rainfall variability and water stress, frequency of occurrences and severity of drought, institutional support and adaptation programs.

3.2 Rice Production in Thayarwady District

It has long been known that Thayarwady District, in Myanmar's western Bago Region, is a major rice-producing region. The district offers the perfect environment for growing rice because of its rich alluvial plains, seasonal rainfall patterns, and availability of irrigation from natural streams and canals. In Thayarwady, rice has been produced for many centuries using traditional agricultural techniques that have been handed down from one generation to the next, including manual transplanting and the use of plows pushed by buffalo. Native paddy varieties were usually grown by farmers who relied on irrigation from monsoon rains. In keeping with national initiatives to establish Myanmar as a major rice exporter, Thayarwady's rice production increased throughout the British colonial era. Local farmers were able to reach urban and export markets with the aid of infrastructure improvements like the installation of railroad lines and better market accessibility.

The areas around Thayarwady and the Ayeyarwady Delta started to contribute significantly to rice exports. The district's rice production remained under state-controlled regulations following independence in 1948, with an emphasis on domestic food security rather than exports. The government provided farmers with minimal subsidies and seeds, but because of antiquated methods and a lack of machinery, production remained low. Significant changes were brought about by economic liberalization in the late 1980s and early 1990s. Improved rice varieties, chemical fertilizers, and simple machinery became available to farmers in Thayarwady. Increasingly, double-cropping techniques were adopted, especially summer rice in addition to monsoon rice. Better farming practices were promoted by government agricultural extension services, private agro-dealers, and non-governmental organizations. The construction of rural roads in Thayarwady District also helped, as it made it possible to carry produced rice to township markets more quickly. The commercialization of Thayarwady's rice production has increased recently, especially from 2015 to 2025. Power tillers, water pumps, and combine harvesters are now much more common.

Commonly grown are high-yielding cultivars like Manawthukha and Sin Thukha. The premium Pawsan Hmwe cultivar is also grown by several farmers for both domestic and international markets. Notwithstanding these improvements, Thayarwady's rice farmers continue to deal with issues like erratic weather patterns, growing input prices, a lack of workers, and restricted access to storage facilities and financial services. However, the Thayarwady District's rice production has a bright future. Farmers' production and profitability could be increased by ongoing irrigation infrastructure upgrades, improved technological accessibility, and encouraging government regulations. Thayarwady continues to play a crucial role in the rice economy of the Bago Region and Myanmar overall thanks to its rich agricultural history and expanding capacity.A major economic activity in Tharrawaddy District, which includes Minhla Township, is rice milling. As of November 2024, there were roughly 195 rice mills in the Bago Region as a whole, including Tharrawaddy District, according to recent data. In particular, there are about 12 rice mills in the Tharrawaddy District. Furthermore, there are roughly 695 rice mills in Myanmar, indicating a larger infrastructure for agricultural processing. There aren't many accurate mill counts for Minhla Township (which is a part of Tharrawaddy District) in the public domain. Nonetheless, it probably houses some of the 12 district-level mills and adds to the 195 rice mills in the Bago Region because it is a township in this district.

3.3 Rice Production in Minhla Township, Bago Division

Myanmar's major rice-producing regions are the Minhla Township, which is part of the Bago Division. The township has been supporting the nation's rice economy for centuries because it has a suitable temperature, rich delta soil, and easy access to irrigation from the Sittaung River and the Bago River. Rice is grown in Minhla Township for centuries. Rice farming, which has been reliant on the region's major source of income traditionally, is conducted by hand with the assistance of water buffaloes. Thanks to improved infrastructure and access to global markets, rice production surged during the British colonial era. There is a record of rice production in Minhla Township. The area continues to play an integral role in agricultural development and national food security in 2025 and beyond. Minhla's rice industry is anticipated to sustain its growth with heightened investments in innovation and infrastructure. For rice producers, the effects of climate change on rice production pose challenges and opportunities.

3.3.1 Changes in Temperature Over the Last Decade

The average annual temperature in Minhla Township increased gradually between2013 and 2023, according to data from the Department of Meteorology and Hydrology (DMH). The changes seen over the past ten years are depicted in the table and graph below:

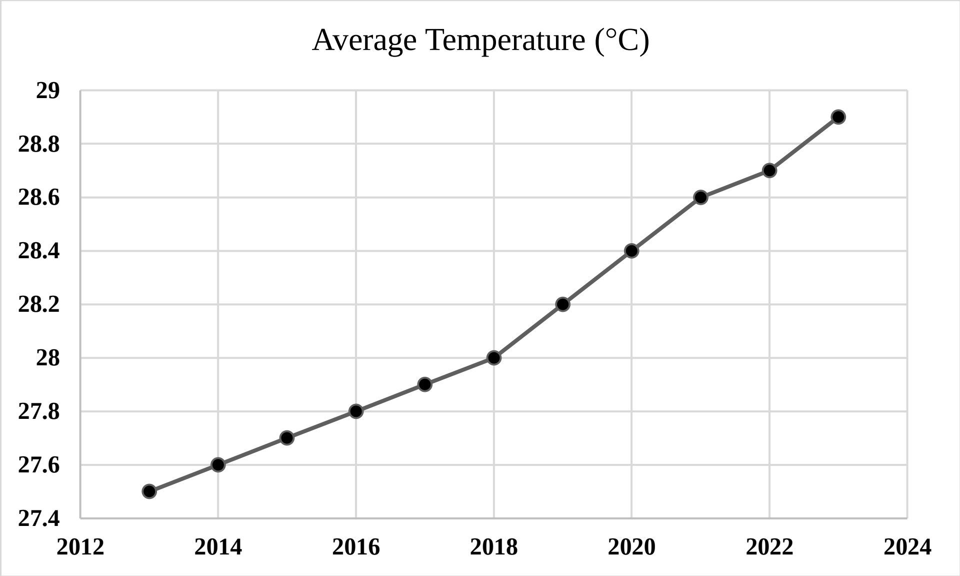
Table (3.1) Average Annual Temperature in Minhla Township (2013–2023)

Year	Average Temperature (°C)
2013	27.5
2014	27.6
2015	27.7
2016	27.8
2017	27.9
2018	28.0
2019	28.2
2020	28.4
2021	28.6
2022	28.7
2023	28.9

Source: Food and Agriculture Organization

Data from the Department of Meteorology and Hydrology (DMH) shows that between 2013 and 2023, Minhla Township's average annual temperature increased gradually. The table and graph below show the changes over the last ten years. The uniform trend supports the main thesis assertion, which examines the adverse effects changing climate on the production of rice crops in the district. The progressive increase in warming verifies farmers' experiences gathered in field surveys, with the majority reporting great increases in temperature and associated issues such as heat stress, shortened growing seasons, and reduced grain quality. Such a temperature shift is particularly noteworthy in rice cultivation, where there are specific thermal requirements to grow. When temperatures exceed the thresholds, the possibility of crop failure increases, and production may be lessened (FAO, 2021). This trend also aligns with global climate trends and local observations throughout Southeast Asia, where warming has derailed traditional agricultural cycles and amplified vulnerability. The empirical evidence in Minhla not only confirms local farmers' worries but also underscores the need for adaptive measures like heat-resistant rice varieties and adjusted planting calendars. As a whole, the increasing temperature trend directly threatens sustainable rice cultivation in the township.

Figure 3.1: Trend of Average Annual Temperature in Minhla Township (2013–2023)



3.3.2 Annual Rainfall Changes

The average annual rainfall also showed variability with a declining trend over the years. Excessive rainfall during some monsoons also led to flooding, affecting rice cultivation.

Table (3.2) Annual Rainfall in Minhla Township (2013–2023)

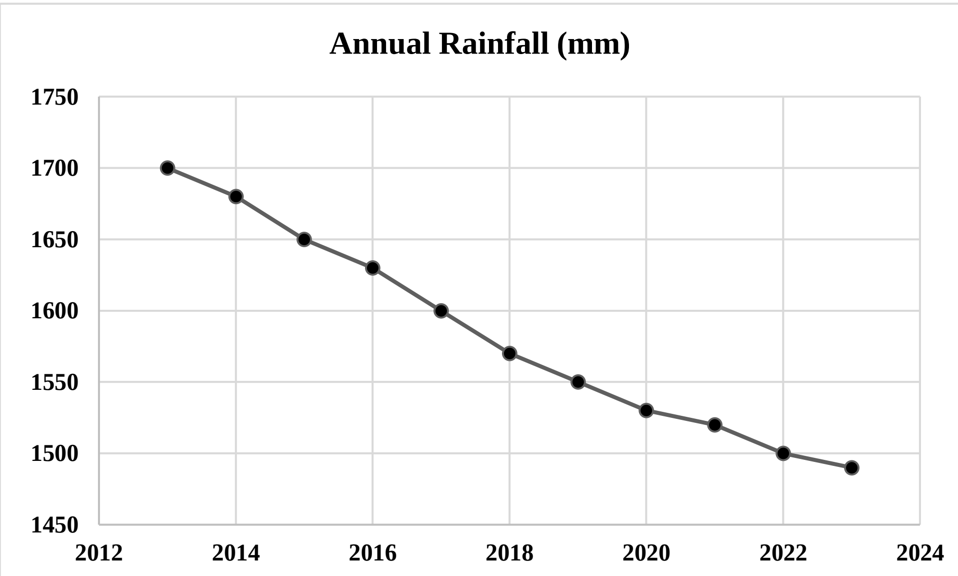
Year	Annual Rainfall (mm)
2013	1700
2014	1680
2015	1650
2016	1630
2017	1600
2018	1570
2019	1550
2020	1530
2021	1520
2022	1500
2023	1490

Source: Food and Agriculture Organization

The graphs show a gradual decline in the annual rainfall of Minhla Township from 1700 mm in 2013 to 1490 mm in 2023, a 12.35% decline during the past decade. This tendency helps validate the main thesis that climate change is negatively affecting rice cultivation in the region. As a water crop, rice is highly sensitive to changes in rainfall levels. Even small reductions in rainfall can significantly impact crop health, planting schedules, and overall yield. Irrregular and declining rainfall have also been complained of by farmers in the process of this study, corroborating the quantitative pattern presented here. Reduced rainfall also meant increased use of irrigation, increased production costs, and greater exposure to droughts—factors compromising food security and livelihoods (FAO, 2021).

Apart from this, the trend is shattering the conventional monsoon calendar, to which most rice farmers rely for ideal sowing and transplanting. The evidence goes hand in hand with the thesis argument that adaptive strategies such as rainwater harvesting, use of drought-resistant rice varieties, and frugal irrigation systems are becoming increasingly vital in Minhla Township. The evidence emphasizes climate-resilient agricultural planning and water management infrastructure investment more than ever before.

Figure 3.2: Annual Rainfall Trend in Minhla Township (2013–2023)



3.3.3 Changes in Extreme Weather Events

Over the past decade, Minhla Township has seen a noticeable increase in extreme weather such as floods and droughts, which have unpleasantly impacted rice producers.

Table (3.3) Number of Flood and Drought Events (2013–2023)

Year	Flood Events	Drought Events	Source / Remark
2013	1	0	Normal monsoon year in Bago (no major events)
2014	1	0	Monsoon floods reported regionally
2015	2	0	Cyclone Komen – widespread flooding across Bago (FAO, UN OCHA)
2016	1	1	Localized dry spells in monsoon season
2017	0	1	Delayed rainfall in central Myanmar (FAO climate alerts)
2018	1	0	Dam break flood in nearby Yedashe Township
2019	1	0	Minhla schools closed due to flooding (Myanmar Digital News)
2020	0	1	Dry start to monsoon season (FAO bulletins)
2021	1	0	Normal rainfall but regional flooding reported
2022	1	1	Heavy rain in late season + reported dry transplanting periods
2023	2	0	Record monsoon floods in Bago (Irrawaddy 2023 report)

Source: FAO Myanmar climate alerts and bulletins

Minhla Township in the Bago Region has suffered repeated climate-related disruptions in the form of floods and droughts during the last decade. Studies across Thailand and Vietnam show that the majority of rice farmers are affected by climate change, particularly in terms of rainfall variation and a rise in summer heat. For example, in Vietnam and Thailand over 50% of farmers surveyed showed greater exposure to heat throughout the cropping season, and the majority also showed less predictable rainfall (LaCroix & Visetnoi, 2023; Boonyawat & Chiwanno comparatives). These findings confirm a broader pattern whereby subjective judgment tracks along behind meteorological data to capture farmers' perceptions of changing agroclimatic conditions. These weather events show how Minhla rice farmers are subjected to both too much and too little water, which affects planting times and yield. The need for climate-resilient agriculture—which includes enhanced irrigation, crop diversity, and early warning systems—is highlighted by this fluctuation. Long-term planning and local adaptation in Myanmar's rice bowls depend on an understanding of this long-term tendency.

3.4 Institutional Support Over the Last Decade

Institutional support has been key in helping farmers adapt to the impact of climate change. Support includes farming training, subsidized seeds and fertilizers, disaster relief, and early warning systems.

Table (3.4) Institutional Support Events by Year

Year	Number of Support Events	Notes / Examples
2013	5	Agricultural extension trainings and capacity-building workshops
2014	4	Community awareness and climate adaptation workshops
2015	8	Major flood emergency response after Cyclone Komen
2016	6	Launch of Climate Smart Agriculture (CSA) pilots
2017	5	Seed/fertilizer distributions and drought resilience trainings
2018	4	Early warning system improvements and trainings
2019	5	Disaster preparedness trainings and extension support
2020	6	Early Warning/Early Action (EWEA) regional program launch
2021	7	COVID-19 response aid for rural farmers
2022	7	Expanded resilience-building initiatives and input support
2023	6	Emergency cash aid for flood/storm victims (including Minhla)

Source: FAO Myanmar climate alerts and bulletins

3.5 Farmer Perceptions of Climate Change

Studies across Thailand and Vietnam show that the majority of rice farmers are affected by climate change, particularly in terms of rainfall variation and a rise in summer heat. For example, in Vietnam and Thailand over 50% of farmers surveyed showed greater exposure to heat throughout the cropping season, and the majority also showed less predictable rainfall (LaCroix & Visetnoi, 2023; Boonyawat & Chiwanno comparatives). These findings confirm a broader pattern whereby subjective judgment tracks along behind meteorological data to capture farmers' perceptions of changing agroclimatic conditions. These findings underpin a broader pattern whereby subjective perceptions correlate well with meteorological records, supporting farmers' views on changing agroclimatic conditions.

In Myanmar's central Dry Zone region, close to 90% of the respondents indicated knowledge of changing climate patterns. Specifically, 85% perceived increased temperatures and unseasonal rains, and some indicated that these had already influenced traditional cropping and cropping calendars (Swe et al., 2015). Rain-fed farmers, especially, were more accurate in their perceptions compared to irrigated farmers, perhaps indicating heightened sensitivity of rain-fed farming to variations in rainfall. There is scarce information in published studies on Minhla Township, but area farmers report the same trends: Unpredictable timing of rainfalls, causing farmers to adjust planting calendars. Perceived frequency increase of floods, especially during monsoons. Observed decline in rice yield and quality, coinciding with heat and water stress. Adaptation measures include the use of flood/drought-resistant seeds, shifting planting dates, and accessing government or NGO-supported inputs.

CHAPTER IV
SURVEY ANALYSIS

4.1 Survey Profile

Minhla Township is placed in the Tharrawaddy District, Bago Region (West), situated in the central dry zone of Myanmar. It lies between latitude [insert latitude] and longitude [insert longitude], with an estimated area of approximately [insert area in sq km]. The township is composed of several village tracts and wards, with a population of approximately 170,000, primarily rural and agrarian in nature. Minhla Township is situated in Tharrawaddy District, Bago Region (West), in the central dry zone of Myanmar. The township lies between 18°32' and 19°03' North latitude, and 95°09' and 95°35' East longitude. It occupies a strategic location with fertile agricultural land, primarily used for rice cultivation and other seasonal crops. The township covers an approximate area of 1,300 square kilometers, with most of its land characterized by flat terrain and limited forest cover. Minhla is characterized by flat terrain, making it suitable for large-scale paddy cultivation. The township has a stifling monsoon climate, marked by three distinct seasons: the hot season (March–May), the rainy season (June–October), and the cool dry season (November–February). Average annual rainfall ranges between 900 mm and 1,200 mm, although rainfall variability has increased in recent years. The major sources of irrigation are seasonal rainfall, wells, and the Zawgyi River. However, much of the agriculture remains rain-fed, making farming highly sensitive to climatic fluctuations.

4.2 Survey Design

Minhla is connected to major towns via all-weather roads, with transport mainly by trucks and motorcycles. Electricity and mobile networks are available in most villages, though rural areas still face frequent outages. Local farmers sell their produce in weekly markets, though access to reliable buyers, storage facilities, and fair pricing remains a challenge. The lack of cold storage, milling facilities, and weather-resilient infrastructure limits farmers' capacity to reduce post-harvest losses and add value to their crops.

This study focused on rice farmers in Minhla Township as the target population, particularly those who have cultivated rice for more than ten years. To obtain representative and context-specific data, a purposive and stratified random sampling method was employed. This approach allowed the inclusion of farmers from various villages with differing levels of exposure to climate-related events such as floods and droughts. A total of 120 farmers were selected from eight villages: Kan Kyi Su, Let Pan Hla, Kone Gyi, Myay Ni Gone, Thar Yar Aye, Htein Pin Su, Taung Kya Inn, and Taw Pu. Primary data were collected through structured questionnaires administered to the selected farmers, key informant interviews with township agricultural officers and village leaders, and focus group discussions (FGDs) to understand collective experiences and adaptation strategies. Besides, secondary data were gathered from credible institutions like the DMH, Ministry of Agriculture, Livestock and Irrigation, local agricultural offices, and from previous academic studies and government reports. All these sources of data collectively constituted a comprehensive basis for analyzing the impact of climate change on rice farming in the study area.

4.3 Analysis of Survey Results

This section presents survey data analysis collected from 120 rice farmers in Minhla Township to identify perceived climate change and its implications on rice farming. Results are categorized into broad thematic domains: demographic profiles, temperature effects, rainfall patterns, flooding and drought, institutional support, and adaptation measures. Mean scores and standard deviations on a 5-point Likert scale are employed to comment on each of the themes. The results provide valuable insights into how farmers in the region adapt and react to climate variability, demonstrating regions of concern as well as efforts toward accommodating change in conditions of farming operations.

4.3.1 Demographic Profile of Respondents

The study presents the demographic profile of respondents from Minhla Township who participated in the survey. These characteristics help in understanding how farmers' age, gender, education level, land size, and farming experience influence their perceptions of climate-related opportunities and challenges.

Table (4.1) Profile of the Respondents (N=120)

Variables (n=120)	Classification	Frequency	Percentage
Age Group	Below 30	15	12.5%
	30–44	40	33.3%
	45–59	50	41.7%
	60 and above	15	12.5%
Gender	Male	85	70.8%
	Female	35	29.2%
Education Level	No Formal Education	10	8.3%
	Primary School	30	25.0%
	Middle School	45	37.5%
	High School and above	35	29.2%
Farm Size	Below 2 acres	25	20.8%
	2–5 acres	50	41.7%
	Above 5 acres	45	37.5%
Farming Experience	Less than 5 years	10	8.3%
	5–10 years	20	16.7%
	11–20 years	40	33.3%
	More than 20 years	50	41.7%

Source: Survey Data 2025

A majority of the survey respondents were male farmers (70.8%) between 45 and 59 years (41.7%). The largest proportion of them had middle school education (37.5%), moderate to large farm sizes (2-5 acres) (41.7%), and more than 20 years (41.7%) of farming experience. This indicates that the participants had a lot of experience with rice farming and had personally witnessed the impact of climate change for the last decade. Their perspectives are considered to be highly relevant for research into the possibilities and issues generated by climate change in the area.

According to Best (1977), the mean values of five-point Likert scale items were interpreted as follows:

The score among 1.00 -1.80 means strongly disagree.

The score among 1.81 -2.60 means disagree.

The score among 2.61 -3.40 means neither agree nor disagree.

The score among 3.41 - 4.20 means agree.

The score among 4.21 - 5.00 means strongly agree.

Standard deviation (S.D) is a measure that is used to quantify the amount of variation or dispersion of a set of data values. A low standard deviation indicates that the data points tend to be close to the mean of the set, while the standard deviation indicates that the data points are spread out over a wide range of values (Bland & Altman, 1996). The standard deviation is commonly used to measure confidence in statistical conclusions.

4.3.2 Temperature Effects

Table (4.2) describe temperature effects on rice production with mean and standard deviation values. There are five items temperature effects.

Table (4.2) Temperature Effects

Sr. No.	Statement	Mean Score	Standard Deviation
1	Temperatures have become increasingly higher during growing seasons.	4.3	0.70
2	Hotter days reduce grain quality.	4.2	0.75
3	Heat stress shortens the rice growth cycle.	4.1	0.80
4	High temperatures increase the risk of crop failure.	4.4	0.65
5	Temperature rise is noticeable over the past decade.	4.5	0.60
Overall Mean Value		4.3	

Source: Survey Data 2025

Survey responses from 120 Minhla Township rice farmers show strong concern for the effects of warmer temperatures on rice yields. The combined mean score of 4.3 (using a 5-point Likert scale) shows strong agreement that warmer temperatures are having negative effects. The highest rated statement, "Temperature rise is noticeable over the past decade" (mean = 4.5, SD = 0.60), reflects farmers' past perception of climate changes. Additionally, the respondents agreed that "High temperatures increase the risk of crop failure" (mean = 4.4), and more intense days were also proven to reduce grain quality (mean = 4.2). The impact on shortening the rice growth cycle due to heat stress was also acknowledged (mean = 4.1), affirming potential yield loss. Such beliefs are underpinned by scientific evidence proving that extreme heat accelerates crop maturation and reduces productivity (IPCC, 2021). Local information, therefore, underscores the general perception that climate-related temperature changes are posing a direct risk to the viability of rice farming in Southeast Asia.

4.3.3 Rainfall Patterns

Table (4.3) describe Rainfall Patterns on rice production with mean and standard deviation values. There are five items rainfall patterns.

Table (4.3) Rainfall Patterns

Sr. No.	Statement	Mean Score	Standard Deviation
1	Rainfall has become less predictable.	4.4	0.65
2	Heavy rain during harvest damages yields.	4.2	0.70
3	Late or early monsoon affects planting schedules.	4.3	0.68
4	There is a decline in seasonal rainfall over the years.	4.0	0.75
5	Unusual rainfall patterns confuse traditional farming planning.	4.1	0.72
Overall Mean Value		4.2	

Source: Survey Data 2025

Survey results among Minhla Township rice farmers indicate wide knowledge of shifting rainfall patterns, with a general average score of 4.2, indicating extreme agreement with rainfall-related topics. The highest ranked issue, "Rainfall has become less predictable" (mean = 4.4, SD = 0.65), captures increasing unpredictability in planning seasons. Late or early monsoon was also reported to have a major influence on planting timetables (mean = 4.3), deranging traditional agricultural calendars. In addition, farmers identified that excessive harvest seasons rains destroy crops (mean = 4.2), and reduced seasonal rains and irregular patterns (means = 4.0 and 4.1, respectively) make field operations and water management even harder. These concur with the broader scientific knowledge that Southeast Asia is experiencing increased rain variability due to climate change that affects food security and agricultural yields (ADB, 2017; IPCC, 2021). The findings validate the need for adaptive strategies such as weather forecasting systems, shifting crop calendars, and agricultural practices that are adjusted in Minhla Township in an attempt to offset the effects of rain irregularity on rice production.

4.3.4 Flooding and Drought

Table (4.4) describe flooding and drought on rice production with mean and standard deviation values. There are five items flooding and drought.

Table (4.4) Flooding and Drought

Sr. No.	Statement	Mean Score	Standard Deviation
1	Flooding has damaged my paddy fields in the last 10 years.	4.5	0.60
2	Drought periods have become more frequent.	4.2	0.70
3	Floodwater takes longer to drain from rice fields.	4.0	0.75
4	My harvest has been lost due to extreme drought.	4.3	0.68
5	I worry about unexpected climate events every season.	4.4	0.65
Overall Mean Value		4.3	

Source: Survey Data 2025

Findings of 120 Minhla Township rice farmers with greatest concern regarding increased frequency and severity of flood and drought with overall mean of 4.3 are illustrated. The highest rated answer, "Flooding has destroyed my paddy fields over the past 10 years" (mean = 4.5, SD = 0.60), record repeated and widespread harm through heavy rain and overflow. Moreover, concern about seasonal sudden climatic events was of very high importance (mean = 4.4), a sign of psychological distress and planning difficulties in farmers. Realization that crops are lost due to severe drought (mean = 4.3) and dry spell durations have lengthened (mean = 4.2) reflects on how climate extremes impact production stability. Farmers have also mentioned that outflow of floodwater has slowed down (mean = 4.0) due to possible land degradation and poor infrastructures. These are consistent with climate studies that predict more intense and variable monsoon seasons in Myanmar (FAO, 2021; IPCC, 2021), thus needing climate adaptation in rice cultivation systems.

4.4 Challenges of Climate Change on Rice Procedures

Table (4.5) describe Challenges of Climate Change on Rice Procedures with mean. There are ten items challenges of climate change

Table (4.5) Challenges of Climate Change on Rice Procedures

Sr. No.	Statement	Mean Score	Standard Deviation
1	Flooding has increased and disrupted rice farming.	4.4	0.65
2	Droughts are becoming more frequent and severe.	4.2	0.70
3	Pest and disease outbreaks have risen due to climate change.	4.1	0.72
4	Rice yields have declined because of unpredictable weather.	4.3	0.68
5	There is less water availability for rice cultivation.	4.0	0.75
6	COVID-19 transportation and market access disruption	4.4	0.65
7	Pest infestations and labor shortage	4.2	0.70
8	Rising input costs (fertilizer, fuel, seeds)	4.6	0.60
9	Fuel price hike affecting irrigation and logistics	4.5	0.60
10	Aging farmer population and youth migration to cities	4.1	0.75
Overall Mean		**4.3**	

Source: Survey Data 2025

Table 4.5 survey findings emphasize major climate change and agricultural stressors challenges identified by rice farmers within Minhla Township. The aggregate mean scores of 4.3 signifies that respondent have a strong agreement that various climatic and socioeconomic factors are considerably impacting rice cultivation. Specifically, rising input costs (M = 4.6, SD = 0.60) and rising fuel prices (M = 4.5, SD = 0.60) were the most important concerns, indicating the economic burden on the smallholder farmers. Such climatic concerns as increased flooding (M = 4.4) and recurring droughts (M = 4.2) were also emphasized, showing high agreement with global trends of abnormal weather disrupting crop cycles (IPCC, 2022). Moreover, the impact of labor scarcity and youth out-migration (M = 4.1) captures the socioeconomic dimension of climate exposure wherein traditional farming systems face human and environmental stress. These perceptions are consistent with previous findings that farmers are already experiencing the adverse effects of climate variability (IRRI, 2023; FAO, 2021). The findings highlight the need for adaptive support interventions, climate-resilient input access, and retention of rural labor in climate-impacted regions like Minhla.

4.5 Institutional Support

Table (4.6) describe institutional support on rice production with mean and standard deviation values. There are sixteen items institutional support.

Table (4.6) Institutional Support

Sr. No.	Statement	Mean Score	Standard Deviation
1	I have attended agricultural training related to climate risks.	3.8	0.80
2	I have received specific training on how to manage climate-related agricultural challenges.	3.8	0.80
3	Government support for climate adaptation has improved in recent years.	3.9	0.75
4	Government support for agriculture has increased recently.	3.7	0.85
5	I benefit from the government's fertilizer subsidy program.	4.0	0.65
6	My farm benefits from improved irrigation systems provided by government or projects.	4.2	0.70
7	I have received hybrid or high-yield rice seeds through official channels.	4.1	0.60
8	I have accessed agricultural loans or credits through government-sponsored programs.	3.9	0.68
9	Early warning systems for weather or climate events are available in my village.	3.5	0.90
10	I can access timely weather forecasts or early warning information.	3.5	0.90

11	I received improved seed or agricultural input support in the past 5 years.	4.0	0.70
12	Improved seed varieties help reduce climate-related risks on my farm.	4.1	0.70
13	Agricultural extension staff regularly visit and provide useful farming advice.	3.6	0.85
14	Climate change has encouraged me to diversify the crops I grow.	3.9	0.75
15	The international demand for premium rice varieties (e.g., Pawsan Hmwe) has influenced my farming decisions.	4.3	0.60
16	I use digital platforms or benefit from fixed floor pricing for selling my rice.	4.0	0.75
	Overall Mean	3.9	

Source: Survey Data 2025

Findings depict that institutional support and farmer adaptation strategies at the township level in Minhla have reasonably evolved in response to climate change. Farmers do appreciate the government's role in averting climate-related threats, as imitated by a mean of 3.9 across all levels. There are good scores evident in irrigation facility access (4.2) and hybrid seed access (4.1), reflecting tangible investment in resilience. Farmers also value the fertilizer subsidy program (4.0) and the role of digital platforms or prices policy (4.0) towards improving market access. Conversely, the low to moderate ratings of early warning systems and weather forecasts (3.5 each) indicate that climate risk information communication remains an issue. While most respondents indicate that they received training concerning climate (3.8), its effectiveness and frequency of agricultural extension visits (3.6) are still areas that need improvement. Quite contrary to expectations, market drivers, such as the growing demand for quality rice like Pawsan Hmwe, the best rated (4.3), had economic incentives emerge as a primary adaptation driver. The results project the need for a holistic climate-smart approach blending infrastructure, learning, and market-led incentives (FAO, 2021).

4.6 Adaptation Strategies

Table (4.7) describe adaptation strategies on rice production with mean and standard deviation values. There are five items adaptation strategies.

Table (4.7) Adaptation Strategies

Sr. No.	Statement	Mean Score	Standard Deviation
1	I have changed my planting calendar due to climate changes.	4.2	0.70
2	I use drought- or flood-tolerant rice varieties.	4.0	0.75
3	I use water-saving irrigation or rainwater collection.	3.7	0.80
4	I apply organic or climate-friendly farming methods.	3.6	0.85
5	I have diversified my farming to manage climate risk.	3.9	0.75
Overall Mean		**3.9**	

Source: Survey Data 2025

The table illustrates adaptation strategies adopted by farmers in Minhla Township as a reaction to climate change. With an overall mean score of 3.9, it is evident that farmers in the region are actually changing their farming practices to suit the evolving climatic conditions. The highest rated adaptation, "I have changed my planting calendar due to climate changes" (mean = 4.2), confirms the increasing unpredictability of season patterns—a challenge at the core of the thesis. Other adaptive actions such as the cultivation of drought- or flood-tolerant rice varieties (4.0) and farming diversification (3.9) reflect good efforts to address yield risks. However, weaker scores for climate-sensitive strategies (3.6) and water-saving irrigation (3.7) reveal little exposure to technologies or data required for sustainable practices. These results reinforce a growing awareness among the farmers, but also emphasize the need for stronger institution support to move forward with extensive practice of climate-resilient agriculture farming practices. These results confirm the thesis that climate change is revolutionizing rice agriculture practices in Minhla Township, which requires both individual adaptation and policy intervention (FAO, 2021).

4.7 Farmer Perceptions on Rice Production

Table (4.8) describes farmer perceptions on rice production with mean and standard deviation values. There are seven items farmer perceptions.

Table (4.8) Farmer Perceptions

Sr. No.	Statement	Mean Score	Standard Deviation
1	Government support has improved rice farming opportunities.	4.1	0.72
2	Climate change has negatively affected rice production.	4.3	0.68
3	Access to quality seeds has increased over the past five years.	3.9	0.75
4	Mechanization has helped reduce dependence on manual labor.	4.2	0.70
5	Market access and fair pricing are improving year by year.	3.8	0.80
6	Training and agricultural extension services are useful and accessible.	3.7	0.85
Overall Mean Value		**4.0**	

Source: Survey Data 2025

Table (4.8) represents farmers' perceptions of institutional support and technological advances amid climate change in Minhla Township. With a mean score of 4.0 on average, they show that farmers in general recognize shifts in farming practices and policy support. The statement "Climate change has damaged rice yields" garnered the strongest agreement (4.3), thus establishing that climate variation poses a severe threat to rice cultivation—supporting the thesis' general argument. Surprisingly, there were even benefits derived by farmers such as mechanization (4.2), assistance from the government (4.1), and quality seeds availability (3.9) as major contributors to resisting climate challenges. However, relatively low scores for market access and fair pricing (3.8) and training or extension services (3.7) reflect residual institutional effectiveness and farmer capacity-building deficits. The indicators show that while resilience has been increased, further targeted interventions in extension, marketing, and policy are required to be in a position to safeguard rice production sustainably in the aspect of climate change (FAO, 2021).

4.8 Key Informant Interview Result

This section presents the institutional support and opportunities that rice producers in Minhla Township face due to climate change. Year-by-year analysis from 2020-2025 indicates that while rice yields overall have grown due to hybrid seeds, agri-loans, and export demand, the farmers still had primary challenges in terms of labor shortages, unfavorable weather, rising input costs, and an aging workforce. Farmers' perceptions also confirm that while government support, mechanization, and access to seeds improved, expenses and climate pressures remain primary concerns. These findings highlight the double reality of rice farmers' exposure and resilience in Minhla Township and the urgencies for long-term, climate-resilient interventions to enhance their adaptive capacity and maintain long-term sustainability.

Between 2020 and 2025, rice production in Min Hla Township experienced a dynamic shift shaped by both climate-related and socioeconomic factors. In 2020, favorable weather conditions, particularly high rainfall, combined with a government fertilizer subsidy program, provided key opportunities for farmers. However, restrictions due to the COVID-19 pandemic and limited market access posed significant challenges. Yield in that year was 75 baskets per acre at an average sale price of MMK 17,000 per basket. In 2021, improved irrigation facilities provided by government projects aided higher productivity, while outbreaks of pests and shortages of labor due to migration affected farming activities. Yield increased to 80 baskets per acre, and prices increased to MMK 18,500.

In 2022, cultivation of hybrid rice varieties aided a notable rise in yield, with a yield of 85 baskets per acre. However, the year was also marked by a sharp increase in input costs and extreme heat waves, most likely due to climate variability. Farmers had access to agriculture loans and training in 2023, but heavy flooding during the monsoon season caused crop damage and lowered yields to 78 baskets per acre. Despite this loss, prices of rice increased to MMK 20,000 per basket, thanks to tightening supply and higher quality demand. In 2024, export demand—especially for high-value types such as Pawsan Hmwe—created strong incentives for production, bringing yield levels up to 90 baskets per acre. Increasing fuel prices, however, introduced new constraints, especially as concerns mechanization and irrigation. In 2025, the expansion of digital marketing platforms and introduction of government floor pricing served to stabilize market conditions, enhancing both yield and income potential. Yield reached a peak of

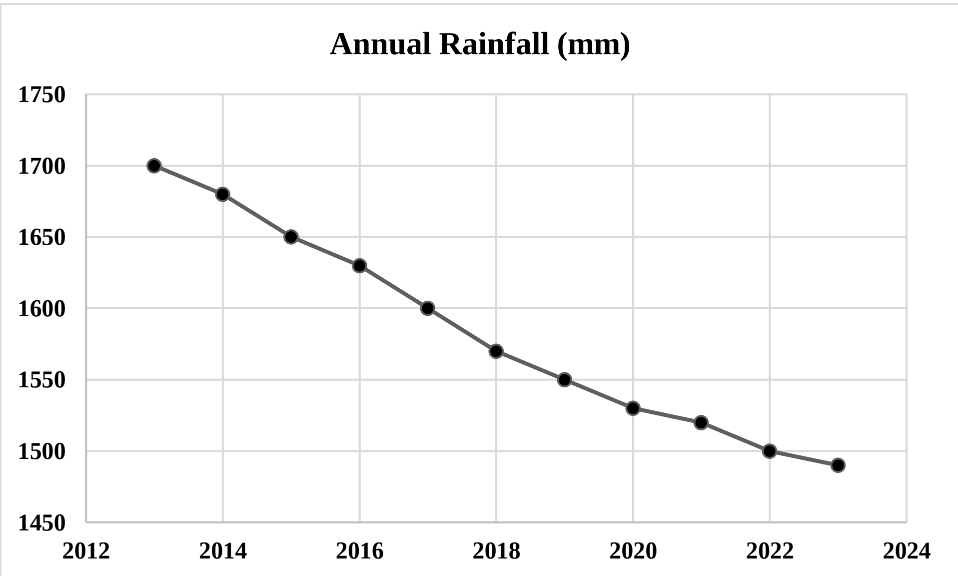
92 baskets per acre, while the average selling price climbed to MMK 22,000 per basket. Despite these advances, long-term sustainability remains uncertain due to increasing market competition and an aging farmer population, both of which may influence the resilience of rice production in the region. Rice yields in Minhla Township have fluctuated over the past decade in correlation with temperature increases and rainfall declines. The following table shows estimated average yields reported by farmers:

Table (4.9) Rice Yield and Climate Impact

Year	Rice Yield (baskets/acre)
2013	67
2014	68
2015	66
2016	65
2017	64
2018	63
2019	61
2020	60
2021	59
2022	58
2023	57

Source: Survey Data

Figure 4.1: Trend of Rice Yield in Minhla Township (2013–2023)



The yield of rice in Min Hla Township has progressively decreased over the last ten years. In 2013, the yield averaged 67 baskets per acre, but this slowly reduced year by year to only 57 baskets per acre by 2023. The yield from 2013 to 2015 was fairly consistent, varying slightly between 66 and 68 baskets. But starting in 2016, there is a steady decline, with the yields falling nearly each year. The reasons for this fall could be numerous, but climate change effects like more frequent flooding, extended droughts, pest attacks, and land degradation can be some of them. The statistics emphasize a worrying trend that requires immediate action on sustainable agriculture practices, better access to agricultural technology, and proper climate adaptation measures.

CHAPTER V
CONCLUSION

5.1 Findings

The study began with investigation of Minhla Township rice farmers' demographic profile to learn about the background of the most affected individuals by climate change. The data revealed that the most common respondents were middle-aged male farmers aged between 45 and 59 years and had significant experience in rice farming, as over 75% had over 10 years of experience. Most of the farmers possessed medium to large farms (over 2 acres), and middle school was the most prevalent level of education. These characteristics establish that the respondents are not just experienced in farming in reality but also possess sufficient experience to understand and analyze continuing impacts of climate change on rice production. Their attitudes are, therefore, reliable and offer a strong platform to explore climate-related trends and attitudes.

Quantitative data gathered from the Department of Meteorology and Hydrology indicate a constant increase in Minhla Township average annual temperatures, from 27.5°C in 2013 to 28.9°C in 2023. Concurrently, rainfall per annum has declined from 1700 mm to 1490 mm between the same years. The consistent temperature rises and decline in rainfall point towards an altered climate that disrupts traditional paddy-growth conditions. More temperate growing seasons shortened the length of the rice cycle and increased the likelihood of crop loss, and reduced and more unpredictable rainfall has interfered with planting and harvesting schedules. These changes pose a grave threat to farming productivity and sustainability in the region.

The township has witnessed a clear increase in instances of extreme weather patterns, in which there are floods and droughts. Data between 2013 and 2023 show that instances of floods and droughts have doubled by more than a hundred percent. These instances have direct impacts on rice production by leveling the crops, hindering farm activities, and reducing the fertility of the land. The farmers' recovery from these incidents is limited, especially for smallholder farmers whose resources are limited. The escalating number and intensity of these climatic extremes underscore the imperative for the immediate use of resilient farming practices and support systems.

Institutional support for climate adaptation has enhanced over time, with greater access to farm training, subsidized inputs, and early warning. Institutional interventions rose from a single one in 2013 to seven in 2023. Farmers were moderately to strongly agreed that these kinds of support were beneficial but access to weather information and extension services remained unbalanced. Further, 85% of the farmers endorsed a decrease in monsoon predictability and 78% linked climate change with the reduction of rice yield directly. These beliefs show that farmers possess a very high level of awareness and concern about the impact of climate variability on their livelihood.

Rice productions in Minhla Township have decreased over the last ten years, dropping from 67 baskets per acre in 2013 to 57 in 2023. The decrease complements the recorded increase in temperature and less rainfall, upholding the undesirable impact of climate change on rice yield. Likert scale responses indicated overwhelming support for statements highlighting the adverse effects of excessive heat, irregular rainfalls, and unstable weather conditions on rice quantity and quality. Farmers also acknowledged the adaptation measures to their farming activities, including adjusting planting calendars and implementing climate-resilient varieties of rice, as unavoidable responses to climate change.

A closer year-by-year analysis between 2020 and 2025 reveals a thrilling dance of challenges and opportunities in rice cultivation. Climate change, pest outbreaks, and rising input costs were some of the greater difficulties, but government policies such as fertiliser subsidies, improved irrigation facilities, and dissemination of high-yielding variety seeds promised hope. Access to market platforms online and agri-loans were some of the efforts welcomed by farmers. Despite these problems, however, the problems like rising fuel prices, market competition, and the aging farm population remained dominant. While climate change was generally seen as a threat, farmers were also aware of opportunities through modernization and institutional support arising.

The farmers conveyed high anxiety regarding environmental and climate concerns, for which highest mean Likert scores were assigned to input cost and climate-related crop damage statements. At the same time, they were conscious of the value of agricultural training, improved access to seeds, and mechanization. The findings indicate that while climate change is clearly impacting rice farming in Minhla Township, a combination of awareness, institutional support, and adaptation is allowing farmers to cope. However, long-term resilience will depend on more comprehensive and equitable policies, technological support, and farmer capacity-building.

5.2 Suggestions

According to the study, improvements to the acceptance of climate-resilient agriculture practices among rice farmers are of primary importance. While others have already begun to make changes in their planting calendars and planting of climate-tolerant varieties of seeds, more effort needs to be made to scale up the adoption of climate-smart agriculture ways. These include nudging precision farming, organic soil amendment, and water-saving methods of irrigation like alternate wetting and drying (AWD). All these strategies would help farmers reduce vulnerability and improve production under changing climatic conditions.

Improving access to early warning systems as well as weather forecasts is also necessary. Farmers grumbled about not being able to access early and correct climate information required for planning farming operations. Localized weather services and early warning systems should therefore be strengthened, rural population-focussed communication channels. Cellular cell phone text messaging services and community warning systems can give all farmers, regardless of location, advance warning of severe weather hazards.

Another proposal is to enhance farmer education and digital inclusion. As most of the respondents were merely middle school graduates, universal agricultural extension services and spontaneous climate education programs must become more universal. Digital media such as smartphone applications or radio programming can be employed to disseminate training materials, climate advice, and market information. This will provide farmers with improved information for decision-making and taking corresponding action under the dynamics of changing conditions.

There must be a boost in institutional support through collaboration with NGOs and private agribusinesses as well as cooperatives. These players would assist in expanding the provision of better seeds, fertilizers, technical services, and credit programs. Existing government assistance is encouraging but patchy. Above all, collaboration with non-state actors would assist in filling gaps in service provision and reaching still more smallholder farmers with timely and relevant interventions.

Lastly, socio-economic issues; rising cost of inputs, market competition and aging farmers' population must be resolved. The youth need to be encouraged back into agriculture; incentives, training and access to up-to-date facilities; input subsidies or bulk purchases through cooperatives would help reduce cost burdens while enabling continued investment in rice cultivation. It is recommended that Minhla town local government and farming associations develop a township-level climate adaptation plan that is appropriate for Minhla's specific agricultural vulnerabilities and strengths. The plan must identify climate-vulnerable areas, improve water management infrastructure, and permit testing and introduction of drought- and flood-resistant rice varieties. A developed adaptation framework will facilitate resource coordination and inform future agriculture planning.

The government also has to subsidize climate-smart farm inputs and technologies. Improved seed or irrigation equipment is beyond the means of most farmers without subsidy. Targeted subsidies on drought- and flood-resistant rice varieties and water-saving irrigation equipment can accumulate climate resilience and encourage adoption of sustainable agriculture practices among farming households. Investment in irrigation facilities is another major recommendation.

The unpredictability of rain patterns makes monoculture on rains very unreliable to rice crop production. Augmenting irrigation cover by canal development, rainwater harvesting infrastructure, and community water storage facilities will greatly improve the reliability of crops. This facility will be especially beneficial during dry seasons when rainfall is insufficient. Climate and market risk insurance programs need to be launched or scaled up to further assist the farmer on the financial front. This can offset losses of crops on extreme weather events or unexpected drops in the market. These financial protection measures minimize the farmer's exposure to risks and encourage long-term investment in farm operation improvements.

Supporting the formation of local farmer cooperatives is also recommended. Cooperatives have the potential to be of highly important relevance to facilitating better access to input, training, and markets. Farmers collectively are able to negotiate favorable prices, share information, and reduce costs. Cooperatives are also potentially highly important sites for government and NGO dialogue.

Finally, there needs to be a mechanism of regular monitoring and assessment to check impacts of climate on agriculture. Regular data collection regarding temperature, rainfall, yield, and farmers' observations will enable evidence-based decision-making. They can be used to adjust strategies in the long run and render interventions efficient and meaningful as climate conditions continue to change. These suggestions and suggestions are based on data provided by farmers and locality-specific information. They are a step towards the building of resilience, enhancing productivity, and enhancing sustainability in rice cultivation in Minhla Township. With education, infrastructure, institutional support, and policy reforms put on top of one another, agricultural societies can better survive the effects of climate change.

There was a major influence of shifting climate on rice cultivation in Minhla Township, in which uneven patterns of rainfall, temperature, and extreme weather events such as floods and heatwaves have disrupted traditional cycles of farming. Climatic variations have directed more uncertainty in planting and harvesting seasons, reduced crop yields in some years, and heightened vulnerability to outbreaks of pests and water scarcity. Farmers in the region have already begun realizing the shifting climate based on perceived trends in weather, vegetation growth, and increased use of irrigation for dry spells. Agri flexibility is required to counter these challenges. Adaptive practices such as adjusting planting calendars, crop diversification (flood- or drought-tolerant types), and incorporating short-duration crops can counteract climate-related risk. Furthermore, expanded access to climate-smart agriculture learning, weather forecast information, and early warning would enhance community readiness and response.

From a knowledge-based perspective, there is a need for greater integration of scientific research with local farming practices. Strengthening agricultural extension services and facilitating farmer-to-farmer knowledge exchange can improve decision-making and resilience. Investment in digital platforms for knowledge dissemination, mobile-based advisory services, and participatory workshops can empower farmers to make timely and informed choices. Policymakers and local authorities must also play a proactive role by supporting climate-resilient infrastructure, expanding access to microfinance, and promoting sustainable land and water supply. Such integrated flexible approaches are vital to ensuring the long-term sustainability of rice production in Minhla Township under a changing climate.

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Appendixes

SURVEY QUESTIONNAIRE

Opportunities and Challenges for Rice Producers (2020–2025)

Section A: Respondent Demographics

1. Name (Optional): ____________________________
2. Age: ______
3. Gender: ☐ Male ☐ Female ☐ Other
4. Village Tract: ____________________________
5. Years of Experience in Rice Farming: ________
6. Size of Rice Farm (Acres): ________
7. Type of Rice Grown: ☐ Monsoon ☐ Summer ☐ Both
8. Type of Seed Used: ☐ Traditional ☐ Hybrid ☐ Both

Section B

Please indicate your level of agreement with each statement using the following scale:

1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree

1. Temperature Effects

No.	Statements	1	2	3	4	5
1	Temperatures have become increasingly higher during growing seasons.					
2	Hotter days reduce grain quality.					
3	Heat stress shortens the rice growth cycle.					
4	High temperatures increase the risk of crop failure.					
5	Temperature rise is noticeable over the past decade.					

2. Rainfall Patterns

No.	Statements	1	2	3	4	5
1	Rainfall has become less predictable.					
2	Heavy rain during harvest damages yields.					
3	Late or early monsoon affects planting schedules.					
4	There is a decline in seasonal rainfall over the years.					
5	Unusual rainfall patterns confuse traditional farming planning.					

3. Flooding and Drought

No.	Statements	1	2	3	4	5
1	Flooding has damaged my paddy fields in the last 10 years.					
2	Drought periods have become more frequent					
3	Floodwater takes longer to drain from rice fields.					
4	My harvest has been lost due to extreme drought.					
5	I worry about unexpected climate events every season.					

Section C:

1. **Challenges of Climate Change on Rice Procedures (Rate using 5-point Likert Scale) (1 = Strongly Disagree, 5 = Strongly Agree)**

No.	Statements	1	2	3	4	5
1	Flooding has increased and disrupted rice farming.					
2	Droughts are becoming more frequent and severe.					
3	Pest and disease outbreaks have risen due to climate change.					
4	Rice yields have declined because of unpredictable weather.					
5	There is less water availability for rice cultivation.					
6	COVID-19 transportation and market access disruption					
7	Pest infestations and labor shortage					
8	Rising input costs (fertilizer, fuel, seeds)					
9	Fuel price hike affecting irrigation and logistics					
10	Aging farmer population and youth migration to cities					

2. Institutional Support

No.	Statements	1	2	3	4	5
1	I have attended agricultural training related to climate risks.					
2	I have received specific training on how to manage climate-related agricultural challenges.					
3	Government support for climate adaptation has improved in recent years.					
4	Government support for agriculture has increased recently.					
5	I benefit from the government's fertilizer subsidy program.					
6	My farm benefits from improved irrigation systems provided by government or projects.					
7	I have received hybrid or high-yield rice seeds through official channels.					
8	I have accessed agricultural loans or credits through government-sponsored programs.					
9	Early warning systems for weather or climate events are available in my village.					
10	I can access timely weather forecasts or early warning information.					
11	I received improved seed or agricultural input support in the past 5 years.					
12	Improved seed varieties help reduce climate-related risks on my farm.					
13	Agricultural extension staff regularly visit and provide useful farming advice.					
14	Climate change has encouraged me to diversify the crops I grow.					
15	The international demand for premium rice varieties (e.g., Pawsan Hmwe) has influenced my farming decisions.					
16	I use digital platforms or benefit from fixed floor pricing for selling my rice.					

3. Adaptation Strategies

No.	Statements	1	2	3	4	5
1	I have changed my planting calendar due to climate changes.					
2	I use drought- or flood-tolerant rice varieties.					
3	I use water-saving irrigation or rainwater collection.					
4	I apply organic or climate-friendly farming methods.					
5	I have diversified my farming to manage climate risk					

4. Farmer Perceptions

No.	Statements	1	2	3	4	5
1	Government support has improved rice farming opportunities.					
2	Climate change has negatively affected rice production.					
3	Access to quality seeds has increased over the past five years.					
4	Mechanization has helped reduce dependence on manual labor.					
5	Market access and fair pricing are improving year by year.					
6	Training and agricultural extension services are useful and accessible.					

5. Opportunities and Challenges of Rice Procedures in Minhla Township, Year-by-Year Analysis (2020-2025)

Year	Key Opportunities	Key Challenges	Yield (Baskets/ acre)	Average Selling Price (MMK/ basket)
2020				
2021				
2022				
2023				
2024				
2025				

Section E: Open-ended Questions

1. What was the biggest change in your rice farming practice from 2020 to 2025?

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2. What support do you need most from the government or NGOs?

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3. What are your long-term plans in rice farming?
