ADOPTION OF CLIMATE RESILIENT AGRICULTURAL TECHNOLOGIES FOR SUSTAINABLE CROP PRODUCTION

A THESIS

BY

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STUDENT ID.: MS-200819

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AGROTECHNOLOGY DISCIPLINE

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ABSTRACT

During the past five decades the agriculture sector in southwestern region of Bangladesh had undergone wide-ranging changes in terms of ownership of land, climate resilient agricultural technologies, climate resilient crop varieties, cropping patterns, cultivation practices, productivity, and intensity of cultivation. The main objectives of the study were to identify climate resilient agricultural technologies which were adopted by the farmers, to determine the extent of adoption of climate resilient agricultural practices, crop varieties and cropping patterns, and to explore relationship between the selected characteristics of the farmers and their extent of adoption of climate resilient agricultural practices, crop varieties and cropping patterns. Data were collected from randomly selected 80 farmers of five villages of Dumuria upazila under Khulna district, from 13th to 25th January, 2022 by the researcher herself by using a structured interview schedule through face to face method. Appropriate scales were developed in order to measure the concerned variables. Pearson Product Moment Correlation Coefficient (r) was used to test the relationship between the independent and dependent variables. The farmers adopted 11 climate resilient agricultural practices. Majority (66.3 percent) of the respondents had medium extent of adoption whereas, 21.3 percent of the respondents had low extent of adoption and 12.5 percent of the respondents had high extent of adoption of climate resilient agricultural practices. The respondents adopted *gher* dyke vegetable production mostly (94.16%) and less adopted floating bed vegetable production (0.83%). The farmers also adopted 32 climate resilient crop varieties among which 11, 13 and 8 varieties were rice, vegetables and fruits, respectively. Most (87.5 percent) of the respondents had medium extent of adoption while one tenth (10 percent) of them had low extent of adoption and a very few (2.5 percent) had high extent of adoption of climate resilient crop varieties. In the case of rice, vegetables and fruit varieties the highest extent of adoption was observed regarding BRRI*dhan*28 (84.48%), Super snowball (Cauliflower) (47%) and BARI *tormuj*-2 (34.54%), respectively while the lowest extent of adoption was observed regarding BRRI*dhan*86 (42.75%), BARI *pepe*-1 (*Shahi pepe*) (27.3%), BARI *sofeda*-2 (12.5%) and BARI *kathal*-1 (12.5%), respectively. The farmers adopted 4 climate resilient cropping patterns. Majority (58.8 percent) of the respondents had medium extent of adoption, 21.2 percent of the respondents had high extent of adoption whereas 20 percent of them had low extent of adoption. Among 4 climate resilient cropping patterns, highest extent of adoption was observed in Boro-*Gher* (vegetables)-Fallow (34.17%) while the lower extent of adoption was found incase of Fallow-Fallow-T. *Aman* (6.67%). There were 7 causes of adopting climate resilient agricultural technologies adopted by the farmers. An overwhelming majority (76.2 percent) had medium number of causes for adoption while 17.5 percent had high number of causes for adoption and a few (6.3 percent) had low number of causes for adoption about the causes of adopting climate resilient agricultural technologies. Among 7 causes of adoption, most (86.50%) of the respondents adopted climate resilient agricultural technologies because of increasing cropping intensity and climate resilient high yielding cropping pattern (56.75%) was the less important cause in adopting climate resilient agricultural technologies. Besides there were 12 problems that all the respondent farmers faced. Majority (70 percent) of the respondents found to face medium problem and the rest 18.8 percent and 11.2 percent found to face high and low problem, respectively during adopting climate resilient agricultural technologies. Among 12 problems the respondents faced mostly the problem of saline soil (89.58 percent) and lower yield of resilient variety (32.5 percent) was the less severe problem faced by the respondents during adoption of climate resilient agricultural technologies. Among 13- selected characteristics of the respondent farmers level of education, experience in adoption of resilient technology, farm size, annual family income, cosmopolitanism, innovativeness, extension contact, training and knowledge was positively correlated with both of the adoption of climate resilient agricultural practices and cropping pattern, but none of the selected characteristics of the respondents showed any significant relationship with their extent of adoption of climate resilient crop varieties. Majority (66.3% and 58.8%) of the respondents showed medium adoption behavior regarding climate resilient agricultural practices and climate resilient cropping patterns respectively, while most (87.5%) of them showed same (medium) adoption behavior regarding climate resilient crop varieties. Most (86.50%) of the respondents adopted climate resilient agricultural technologies because of increasing cropping intensity, while all the respondents faced most severely the problem of saline soil (89.58%).

Key words: Adoption, climate resilient, agricultural technologies.

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March 2022 The Author

DEDICATED TO

MY BELOVED PARENTS
AND ALL THE FARMERS OF
MY COUNTRY

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CHAPTER I
INTRODUCTION

1.1 General Background

Bangladesh is recognized as one of the most vulnerable countries to climate change impact. Its national economy strongly depends on agriculture which is very much sensitive to climate change impact. Adoption to climate change did not receive much attention in the first years of the international climate change studies, where there was more focus on mitigation and impacts, but adoption has recently been covered more extensively due to the increasing vulnerability of some countries (Kates, 2000). During the past five decades the agriculture sector in southwestern region of Bangladesh has undergone wide-ranging changes in terms of ownership of land, climate resilient agricultural technologies, cropping pattern, cultivation practices, productivity, and intensity of cultivation. Bangladesh has an agrarian economy, although the share of agriculture to GDP has been decreasing over the last few years. Yet it dominates the economy because 16% of GDP have to rely directly on agriculture (Anonymous, 2016).

The coastal districts of the country have generally been identified as a disadvantaged region in terms of poverty, food insecurity, environmental vulnerability and limited livelihood opportunities. Agricultural land use in the coastal districts is very poor. The average cropping intensity of the country was 200% in 2014, whereas it is 128-147% in southern districts (BBS, 2014). The major part of this region is affected by different gradient of salinity. The low land use in the region is mainly due to salinity and peculiar hydrology, waterlogging in Kharif II and early Rabi season and lack of quality irrigation water (drought) in Rabi and Kharif I seasons, and tidal storm (Rahman and Ahsan, 2011).

The southwestern part, Khulna, Bagerhat and Satkhira districts are the worst hit by water and soil salinity (SRDI, 2010). The stress environment of the southern part of the country received very little attention in the past. The increased pressure of growing population demand more food that brings attention to explore the possibilities of increasing the potential of the saline lands for increased production of crops. Moreover, cultivable land area is decreasing day by day in the country. In this context, there is no other alternative but to address less favorable and unfavorable environments for food security and to adapt to the climatic variability. That's why farmers adopt different climate resilient cropping patterns to protect their crops because a choice of correct combinations of crops or cropping patterns can be used as a useful tool to minimize the possible devastations and damages from droughts and floods (Mandal, 2010).

Climate change, to a great extent, has been the outcome of the accumulation of greenhouse gas (GHG), which is caused by human activities (Vermeulen, 2014). Agricultural activities such as bush burning and deforestation are part of the human activities contributing to GHG emission (IPCC, 2014), (Lamboll *et el.* 2017).

Many climate resilient agricultural technologies have been recommended for mitigating the impacts of climate change on agricultural production and for sustainable crop production. Climate-smart agriculture (CSA) practices that integrate the benefits of a sustainable increase in agricultural productivity, the adaptation and building of resilient agricultural and food security systems, as well as the reduction of GHG emissions from agricultural activities, have appeared to be very promising (FAO, 2013), (Lipper *et el.* 2014).

Geographically, Bangladesh is located on an active delta, which is highly exposed to different climatic hazards and natural disasters (Hanif *et el.* 2015), and is globally ranked as the sixth most climate vulnerable country (Kreft *et el.*, 2017). Approximately 41% of the country's total land is under climate change risk (Mandal, 2016). The agricultural sector is extremely vulnerable to increasing mean ambient temperature, changing rainfall patterns and rise of sea level. Almost every year, the country faces tropical cyclones, floods, storm surge, riverbank and coastal erosion as well as drought affecting agricultural activities (Mutahara *et el.*, 2017; Dastagir, 2015), and these extreme events are expected to increase in future (Minar *et al.*, 2013; Dastagir, 2015; Sikder and Xiaoying, 2014). To mitigate the effects of extreme weather conditions, it is necessary to increase coping capacity through adoption of climate smart technologies (Rijal, 2019). For climate change mitigation, adoption of climate smart agriculture technologies is very effective. The Food and Agriculture Organization (FAO) of the United Nations defines CSA as "agriculture that sustainably increases productivity, enhances resilience (adaptation), reduces/removes GHGs (mitigation) where possible, and enhances achievement of national food security and development goals" (FAO, 2010). It aims to ensure food security and wide development goals under the climate change scenario and increasing food demand (World Bank, 2017). The CSA practices have potential to reverse the climate changing trend due to its triple potential benefits of improved productivity and high income, reduction or removal of greenhouse gases (GHGs) and improved household food security (Wekesa *et el.*, 2018). Moreover, CSA can strengthen farmer's livelihoods and increase carbon sequestration by creating carbon sinks, and reducing GHGs emissions from agricultural sectors (Raj *et el.*, 2018).

Saline water intrusion is a common problem in the coastal areas of Bangladesh. Climate change induced hazards including sea level rise, cyclones, storm surges and tidal inundation are contributing to this problem causing salinity ingression into water and land (Baten *et el.* 2015). The southwestern coastal region of Bangladesh is a food deficit area where net food production and the diversity of food production have declined significantly over recent decades due to the salinity problem. Regular devastating cyclonic storm surges, sea level rise and tidal inundation have changed the level of salinity and these have increased the risks associated with normal crop production. The impacts of climate change on coastal regions include inundation from sea level rise, damage from storm surges and loss of water bodies and increased salinity of land from saltwater ingression. Including the coastal region of Bangladesh, worldwide about 600 million people currently inhabit low-elevation coastal zones that will be affected by progressive sanitization (Wheeler 2011).

Large numbers of crops are grown under different cropping pattern in different parts of Bangladesh with variability from a region to another. Greater Khulna consists of both saline and non-saline ecosystems. Agriculture of this region is mainly dominated by rice and fish (shrimp and others) culture. Year round vegetable cultivation as a dyke cropping is also frequently observed in Rice-Fish system for both ecosystems (Sarker *et el.* 1997). The term cropping pattern refers to the list of the typical crops that are grown in an agricultural area, without considering their spatial distribution or sequence (Singh et al, 2001). The cropping pattern and the changes therein depend on a large number of factors like climate, soil type, rainfall, pest incidence, availability of technologies, availability of irrigation facilities and other inputs, marketing and transport facilities, subsistence pressure and the growth of agro-industries (Neema, 1998, Gadge, 2003, Rashid *et el.*, 2005). There are different types of crops that are practiced in Dumuria upazila of Khulna district. The major cropping pattern of the area is Fallow-T *Aman*-Fallow. There are three cropping seasons namely Kharif-1(mid-March to mid July), Kharif-2 (mid July to mid October) and Rabi (mid-October to mid-March). During the Kharif-1 season farmers cultivate aus rice, oil seeds and different types of vegetables. During the Kharif-2 season T *Aman* is the dominant crop. Different varieties of T *Aman* rice such as BR 10, BR 11, BRRI dhan30, Swarna and local varieties are practiced during this season In the Rabi season, Boro rice such as BRRI *dhan*28, BRRI *dhan*29 and hybrid rice Heera are practiced. Other crops that are practiced are mustard, pulses and different types of vegetables. The area and production of HYV Boro rice in Khulna region was 280210 acre and 551345 metric tons, meanwhile HYVI *Aman* rice was 1517075 acre and 1698337 metric tons, respectively (BBS 2015).

Many technologies (included air conditioning, flood defense systems and irrigation but also monitoring, forecasting and early warning systems for natural hazards) have been used to adapt to contemporary climate variability and extremes. This technology can also be used to adapt climate change; although they may need to be improved and new technologies may need to be developed because climate change is likely to exact new and higher standard of reliability and performance (Ahmed *et el.*, 1999). Researchers are left with the responsibility of informing policymakers. Policymakers need to be advised on the factors that can influence the adoption of these climate resilient agricultural technologies so that they can enact well-informed and practicable strategies that will facilitate the successful adoption of these practices by farmers. Agriculture is crucial for food, nutritional and livelihood security in Bangladesh. It engages almost two-third of the workforce in gainful employment and accounts for a significant share in GDP. Several industries depend on agricultural production for their requirement of raw materials. Due to its close linkages with other economic sectors, growth in agricultural sector has a multiplier effect on the economy of the country.

Our study was conducted to explore the adoption of climate resilient agricultural technologies for sustainable crop production, their causes of adoption and problem confrontations in adopting climate resilient agricultural technologies by the farmers, in South Western Coastal region of Khulna district.

1.2 Statement of the Problem

In the southwestern coastal region of Bangladesh, there is great change in climate resilient agricultural technologies (CRAT). The climate resilient agricultural technologies in the southwestern coastal region of Bangladesh are quite different from that of the national scenario owing to the land topography, salinity and climatic conditions of this region. In this region, annual crops mainly rice dominates the cultivated area. Beside this, now-a-days, the farmers are being interested to produce vegetables, cultivation of finfish, orchard, tree plantations etc. Regarding this change, the study was conducted in Khulna district.

The present study would help to find out the following questions:

(i) What are the climate resilient agricultural technologies adopted by the farmers of the study area?

(ii) What are the causes of adopting climate resilient agricultural technologies adopted by the farmers?

(iii) What are the problems confronted by the farmers in adopting climate resilient agricultural technologies?

(iv) What are the characteristics of the farmers under study?

(v) Is there any relationship between the selected characteristics of the respondent farmers and their adoption of climate resilient agricultural practices, crop varieties and cropping patterns?

1.3 Specific Objectives

The study was conducted to fulfill the following objectives:

(i) To analyze the selected characteristics of the farmers;

(ii) To identify climate resilient agricultural technologies those are adopted by the farmers;

(iii) To determine the extent of adoption of climate resilient agricultural practices, varieties and cropping pattern;

(iv) To identify causes in adopting climate resilient agricultural technologies by the farmers;

(v) To identify the problems faced by the farmers in adopting climate resilient agricultural technologies;

(vi) To explore relationship between the selected characteristics of the farmers and their extent of adoption of climate resilient agricultural practices, crop varieties and cropping patterns.

1.4 Importance:

Climate-resilient agricultural technologies: (i) increase productivity, (ii) improve resilience, (iii) save input cost and (iv) mitigate climate change impact.

1.5 Scope of the Study

The study would help to identify climate resilient agricultural technologies and as well as farmers' adoption of climate resilient agricultural technologies. The results of the study would also help to mitigate the problems faced by the farmers in adopting climate resilient agricultural technologies.

1.6 Assumptions of the Study

(i) The responses furnished by the respondents were reliable and valid. (ii) The respondents included in the sample were capable of furnishing proper responses to the questions included in the interview schedule. (iii) Views and opinions furnished by the respondents were the representative views and opinions of farmers' population of the study area. (iv) The items included in the question of adoption of climate resilient agricultural technologies (agricultural practices, crop varieties and cropping patterns). (v) All the data concerning the variables of the study were normally and independently distributed and were free from bias.

1.7 Limitations of the Study

There were some limitations of the study which have been described below:

i) The study was confined to five villages of Dumuria upazila under Khulna district. So the findings of the research have limitations for the applications particularly in other areas of the district as well as other region of the country.

ii) The resource availability and time constraints limited the coverage of investigation.

CHAPTER II

REVIEW OF LITERATURE

The literature review is primarily directed to an overview of coastal embankment and land use pattern in Khulna District, climate-resilient agricultural technologies and causes of adopting climate-resilient agricultural technologies, problem confrontation of the farmers during adopting climate-resilient agricultural technologies.

2.1 Coastal Embankment and Land Use Patterns in Khulna District

The coastal area of Bangladesh is located in the greater Khulna, Barisal, Patuakhali, Noakhali and Chittagong. It is the vast plain at the apex of the Bay of Bengal bounded with India and Myanmar The area includes the world's largest continuous mangrove forest, estuarine marshlands and numerous rivers, canals and their tributaries (Viju, 1995). The total area of Bangladesh is 1, 47, 570 km².The coastal region covers about 20% of the country and over 30% in the total cultivable area of Bangladesh. It extends inside up to 150 km from the coast (Petersen & Shireen, 2001).

Out of 2.85 million hectares of the coastal and offshore areas about 0.83 million hectares are arable lands, which cover over 30% of the total cultivable lands of Bangladesh. A part of the coastal arca, thc Sundarban, is a rcscrvc natural mangrovc forcst covering about 4,500 km. The remaining part of the coastal area is used in agriculture. The cultivable areas in coastal districts are affected with varying degrees of soil salinity. The coastal and offshore area of Bangladesh includes tidal, estuaries and river floodplains in the south along the Bay of Bengal Agricultural land use in these areas is very poor, which is roughly 50% of the country's average (Petersen & Shireen, 2001).

Agricultural land use in the coastal districts is very poor. The average cropping intensity of the country was 200% in 2014, whereas it is 128-147% in southern districts (BBS, 2014). The major part of this region is affectcd by different gradient of salinity. Thc low land usc in thc region is mainly due to salinity and peculiar hydrology, waterlogging in Kharif II and early Rabi season and lack of quality irrigation water (drought) in Rabi and Kharif I seasons, and tidal storm (Rahman and Ahsan, 2011). The southwestern part, Khulna, Bagerhat and Satkhira districts are the worst hit by water and soil salinity (SRDI, 2010).

2.2 Concept of Climate Change

Climate change is a change in the statistical distribution of weather over periods of time that range from decades to millions of years. It can be a change in the average weather or a change in the distribution of weather events around an average (for example, greater or fewer extreme weather events). Climate change may be limited to a specific region, or may occur across the whole Earth (Wikipedia, 2010).

Climate change is expected to be one factor among many that affect ecological systems and economic development. Other factors that interact with climate change could include air pollution, water availability and population growth (Bijlsma *et al.,* 1996).

Jennings (2008) mentioned that a significant effect of global climate change was the altering of global rainfall patterns, with certain effects on agriculture. Extended drought could cause the failure of small and marginal farms with resultant economic, political and social disruption. However, such events had previously occurred in human history independent human history independent of global climate change.

IRRI (2006) stated that technological options in rice production have to remain economically viable under a rapidly changing environment- both in terms of socio-economic development as well as environmental changes.

Selvaraju (2003) showed that farmers in drought prone areas of Bangladesh were affected by non availability of quality seeds in time of draught. They use the available seeds to grow seedlings with the first rainfall. However, erratic and highly variable early season rainfall patterns had led to droughts the damaged seedlings. Extended drought conditions during later stages also lead to production of poor quality seeds. Farmers in the Barind Tracts had needed to Esther the good quality seeds for a longer time.

Arnell *et al.,* (2002) mentioned, that consensus of scientific option is that countries in the temperate, high and mid latitude religions are generally likely to enjoy increased agricultural production. Whereas countries in tropical and subtropical regions are likely to suffer agricultural losses, as a result of climate change in coming decades.

Kumar *et al.,* (2001) stated that the relationship between farm level net, revenue and climate variables in India using cross-sectional evidence. Using the observed reactions of farmers, the study seeks to understand how they have adapted to different climatic conditions across India. District level data is used for the analysis. The study also explores the influence of annual weather and crop prices on the climate response function. The estimated climate response function is used to assess the possible impacts of a "best-guess" climate change scenario, on Indian agriculture.

Ali (1996) stated that Bangladesh is likely to be one of the most vulnerable countries in the world to climate change. Bangladesh is frequently visited by natural disasters such as tropical Cyclones, storm surges, floods, droughts, tornadoes and earthquake. Both qualitative and quantitative discussions are made on Cyclone intensity increase for a sea surface temperature rise of 2 and 4 degrees Celsius. Finally a few remarks are made on the adoption options for Bangladesh in the event of climate change.

Smit and Yunlong (1996) reported that from a variety of studies on Chinese agriculture and climate. Historical studies document the impacts of past climate changes and extremes and the type of adjustments, which have occurred, the vulnerability of Chinese agriculture to climate change. Climate change scenarios are assessed relative to the current distribution of agro climatic regions and farming systems.

Eldis (2010) reported that, people have always adapted to variations in their climate, by making preparations based on their resources and their knowledge accumulated through experience of past weather patterns. Periodically, they have also been forced to reach to and recover from climate extremes and surprises, such as floods, droughts and hurricanes.

2.3 Concept of Adoption

Eveland 1979 reported that adoption is the original dependent variable in innovation research the criterion which is shouting. It is the desirable property of innovative systems, which change agents seek to enhance. "Innovation" is broadly defined as any change in structure design, products or processes in which there is it definable new element introduced into the system. The process is essentially the same for technologies of all degrees of hardness although the specifics may vary.

Rogers (1995) called the "pro-innovation bias", a tendency to assume that adoption of the innovation should be carried out by all possible adopters. In accounting for this slant, it is useful to remember that innovation research began as market research that is, studies aimed at identifying ways to get people to buy more goods and services, particularly in agriculture.

2.4 Concept of Technology

Technology can be most broadly defined as the entities, both material and immaterial, created by the application of mental and physical effort in order to achieve some value. In this usage technology refers to tools and machines that may be used to solve real world problems.

The Merriam-Webster (2007) dictionary offers, a definition of the term, "the practical application of knowledge especially in a particular area" and "a capability given by the practical application of knowledge."

Macek and Jakub (2007), defined technology is the application of math, science and the arts for the benefit of life as it is known. A modern example is the rise of communication technology, which has listened barriers, to human interaction. And as a result has spawned new subcultures, the rise of cyber culture has at its basis the development of the internet and the computer.

Aurangozeb (2002) observed that there was a significant relationship between Innovativeness and adoption of integrated homestead farming technologies.

2.7.9 Extension Media Contact and Adoption

Hossain (2006) concluded that media contact of the farmers had positive significant relationship with their adoption of selected HIYV rice.

Haque (2005) conducted a study to determine the relationship of farmers' characteristics with their adoption of modern rice varieties in Sadar upazila of Mymensingh district. He reported that extension contact of the rice growers had significant and positive relation with the adoption of modem varieties.

Islam (2002) conducted a study on adoption of modem agricultural technologies by the farmers of Sandwip. He found that extension media contact of the farmers had no significant relationship with their adoption of modem agricultural technologies.

Sardar (2002) conducted a study on adoption of IPM practices by the farmers under PETRA project of RDRS personnel of the farmers had a positive significant relationship with their adoption of IPM practices.

Hussen (2001) conducted an investigation on adoption of modern sugarcane cultivation practices by the farmers of Dewangonj upazila in Kamalpur district. He observed that there was a positive significant relationship between extension contact of the farmers and their adoption of modern sugarcane cultivation practices.

Rahman (2001) conducted an investigation on knowledge, attitude and adoption of Aalok-6201 hybrid rice by the farmers of sadar upazila in Mymensingh district. He observed that there was a significant positive relationship between the extension contact of the farmers and their adoption of Aalok-6201 hybrid rice.

2.7.10 Cosmopolitanism and Adoption

Cosmopolitanism of the farmers had a significant and positive relationship with their adoption of modern Boro rice cultivation practices revealed by Hossain (2003) in his study.

Rahaman(2001) conducted a study on knowledge, attitude and adoption of the farmers regarding Aalok 6201 hybrid rice in Sadar upazila of Mymensingh district. He found that cosmopolitanism of the farmers had a significant and positive relationship with their adoption regarding Aalok 6201 hybrid rice.

Kabir (2006) studied on adoption of selected T. Aman production technologies by the farmers and found a positive and highly significant relationship between innovativeness of the fanners and adoption of T. Arnan production technologies.

A study on adoption of modem agricultural technologies by the farmers of Sandwip was conducted by Islam (2002). He reported that cosmopolitanism of the farmers had significant positive relationship with their adoption of modern agricultural technologies.

Sardar (2002) concluded that the cosmopolitanism had positively significant relationship with their adoption of IPM practices.

2.7.11 Knowledge and Adoption

Mondol (2009) found the positive association between knowledge and adoption behavior of farmers regarding hybrid rice cultivation in Mymensingh district.

Islam (2008) conducted a study on adoption of Integrated Plant Nutrient System by the small farmers towards sustainable crop production. He found a significant positive relationship between knowledge and adoption of Integrated Plant Nutrient System by the small farmers towards sustainable crop production.

Akhter (2007) found that the agricultural knowledge of the farmers had significant relationship with their adoption of improved tomato varieties.

Reza (2007) found that maize cultivation knowledge of farmers had a significant relationship with their adoption of modern maize cultivation technology by the farmers.

Hossain (2006) conducted a study on adoption of improved practices in soybean cultivation by the soybean growers in some selected areas of Noakhali district. He found a significant positive relationship between knowledge and adoption of improved practices in soybean cultivation.

Miajy (2005) conducted a study on adoption of hybrid varieties of maize by the farmers in two selected unions under Gaibandha sadar upazila. He found a significant positive relationship between agricultural knowledge and adoption of hybrid varieties of maize.

Hossain (2003) conducted a study on farmer's knowledge and adoption of modern Boro rice cultivation practices and found that education of the respondents had significant and positive relationship with their knowledge on modern boro rice.

2.7.12 Attitude towards Technology and Adoption

Nira (2006) conducted a study on adoption of roof gardening at mirpur-10 area under Dhaka city. She found from her study that the attitude towards roof gardening of the respondents had a positive significance relationship with their adoption of roof gardening.

Kashem *et el.*, (2005) conducted a research and observed that adoption of aquaculture technologies by the farmer had significant positive relationship with attitude of growers.

Rabbi (2006) observed that there was positive significant relationship between the attitude of farmers and their adoption of maize cultivation under sadar upazila of Thakurgoun district.

Ali (2006) conducted a study on adoption of organic manure for Boro rice production at sadar upazila in Gazipur district and observed significant positive relationship between the attitude and their adoption of organic manure.

Sonia (2009) conducted a study on adoption of vegetable cultivation in Patuakhali district and found significant positive relationship between the attitude of growers and their adoption of v egetable cultivation.

Islam (2002) revealed that the attitude of the farmers towards technology had significant positive relationship with their adoption of modern agricultural technologies.

2.8 Causes of Adopting Climate Resilient Agricultural Technologies

Harmeling (2009) reported that, agriculture is the most vulnerable sector of Bangladesh due to climate induced disasters which restrict the national food security. Different agro ecological zones (AEZ) of Bangladesh suffers from different climate-induced disasters that affect agricultural production.

Over the past two decades the principal sources of growth came predominantly from irrigated boro rice, followed by aman (wet season) rice and, to a small extent, wheat. The success in accelerating rice production in the 1980s can be attributed almost entirely to the conversion of local varieties to modern HYVs and, as a result of changes in the policy environment, the adoption of irrigation and fertilizer technologies, which has enabled intensive use of the rabi season. As a result of the heavy emphasis on rice production, yields of other non-cereal crops such as pulses, potatoes, oilseeds and vegetables have stagnated. Land used previously for pulses has been converted for rice production. There have been modest increases in the yields of local rice but the average local yields have been only half of those of the HYV rice. However, of late, it is the yield of modern varieties that is showing signs of stagnation with rice occupying almost 75 percent of the cropped area, followed by wheat which occupies approximately 4 percent and jute which occupies approximately 3 percent, less than 20 percent of the cropped area is devoted to a range of other crops. It appears that the benefits of crop diversification in the country are well known and have been recognized for a long time (SOFA, 1997).

According to Mandal (2010), farmers try to minimize risk from various sources in their own way, often by adjusting the cropping pattern and/or cropping season. Diversified cropping pattern may be resort for the farmer as a coping strategy with flood related risk but scope of diversification is limited due to environmental and climatic condition.

Farmers commented that to earn as much money as possible at the minimum cost and in the shortest time possible to avoid impacts of climate induced hazards and disaster are the major causes of change in cropping pattern. This study also indicate that spread of high-yielding varieties of crops, use of pesticides and fertilizers, substitution of men by machines, shortage of skilled workers etc. have influenced in changing cultivation practices and crop pattern. These results are reinforced by an earlier study and presented that profit is the main significant factor of change in cropping pattern (Shrestha *et el.*, 2009).

Mahesh (1999) commented that, at the previous time monetary income was not the decisive factor for cropping decisions. That time people cultivated their land only for family consumption. But the situation has now changed, in the present scenario; cultivation is mainly for income and profit generation. Farmers therefore take special care to select crops und crop varieties with better yields and tend them carefully, to obtain better yields.

According to Mandal (2010), a choice of correct combinations of crops or cropping patterns can be used as a useful tool to minimize the possible devastations and damages from droughts and floods.

Bangladesh is one of the major horticultural countries in South Asia (Ali, 2000). Several studies have pointed out that there is considerable potential for growing horticultural crops in Bangladesh (Alam, 2005). Among the horticultural produces majority percentage comprises to vegetable. Farmers who are engaged in the production of vegetables often earn higher incomes than those engaged in the production of cereal crops alone (Weinberger and Lumpkin, 2005). Vegetables like eggplant, radish, cabbage, cauliflower, and pumpkin gave returns at least three times higher than rice (Ateng, 1998). For better production and to get more financial benefit from vegetable cultivation use of some climate change resilient technologies or adaptation technologies is at utmost importance. Use of organic fertilizer, high yielding variety, IPM etc. would be feasible for good and better production. According to the definition of UNFCCC (2005), climate change resilient technology or adaptation technology means "the application of technology in order to reduce the vulnerability, or enhance the resilience, of a natural or human system to the impact of climate change".

Lin and Brenda (2011) has conducted a study on Resilience in Agriculture through Crop Diversification Adaptive Management for Environmental Change and found that climate change could have negative consequences on agricultural production and has generated a desire to build resilience into agricultural systems. One rational and cost effective method may be the implementation of increased agricultural crop diversification. Lin and Brenda (2011) mentioned that crop diversification can improve resilience in a variety of ways by engendering a greater ability to suppress pest outbreaks and dampen pathogen transmission, which may worsen under future climate scenarios, well as buffering crop production from effects greater climate variability and extreme events. Such benefits point toward obvious value adopting crop diversification improves resilience.

FAO (2011) cited some examples, such better management of varieties, adoption of crops and varieties that more resilient floods drought and adapted to climate patterns, plant breeding develop new adaptive and productive varieties, and development of efficient seed delivery systems increasing farmer's income.

The World Bank (2011) report highlighted that climate-smart agriculture seeks increase productivity in an environmentally and socially sustainable way, strengthen farmers' resilience climate change, and reduce agriculture's contribution climate change reducing greenhouse gas emissions and increasing carbon storage farmland.

BRAC also introduced maize, sunflower, and other vegetables new crops areas with limited non-saline water part of rehabilitation of SIDR victims and develop climate resilient agriculture for coastal regions Bangladesh that farming communities could face SIDR type cyclones and other disasters because this varieties are less prone disaster Participating farmers identified large profitability these practices and with them BRAC demonstrated year round cropping the untapped coastal regions instead of traditional single rice (BRAC, 2010).

Karim et (1990) reported that, better management crop varieties, the adoption crops and varieties those are more resilient salinity, submergence/floods drought and adapted to new climate patterns, plant breeding develop new adaptive and productive varieties, and development of efficient seed delivery systems for improving farmers access adequate varieties helps increase cropping intensity and production.

2.9 Problems Confrontation of Adopting Climate Resilient Agricultural Technologies

The effect of salt water intrusion both through surface and ground water have long been recognized as a limiting factor to the sustainable development of agriculture in southern region of the country (Karim *et el.*, 1990).

According to Karim (2000), rice production suffers 10% yield reduction when the salinity tolerance limit of 2000 micro-Mons is exceeded and when water salinity exceeds 48000 micro-Mons, yield is reduced by 50%.

Nuruzzaman (1990) showed in his study that shrimp cultivation has reduced both percentage of land under paddy cultivation and yield of paddy per unit area where soil salinity has been increased.

According to Haque (2007), the main obstacle to intensification of crop production in the coastal areas is seasonally high content of salts in the root zone of the soil. The salts enter inland through rivers and channels, especially during the later part of the dry (winter) season, when the downstream flow of fresh water becomes very low.

Razzaque and Rafiquzzaman (2007) reported that, the inherent problems in the agricultural sector are lack of finances, root irrigation infrastructure, high cost of fertilizer, quality seed, lack of credit, insect and disease problem etc. Farmers who are living on agriculture and fish production they suffer a lot during dry season as drought, wet season flood, cyclone, inundation, flash flood is observed which destroyed livestock, cattle, paddy, trees and crops, and flood water swept away many crops (Nasreen et al, 2013).

The turnaround time after T Aman harvest in the coastal saline environment is very short to catch Rabi crop (Karim, 1990). Moreover, rapid tillage operation in many cases is not possible because of late November shower.

Shahidullah et al, (2005) reported that, a series of constraints were identified in Noakhali district. According to the severity ranking 'unplanned polder/embankment construction' is the most serious one. It results the siltation in rivers and canals. In most of the cases, repair and maintenance of the constructions is not done properly. It aggravates water stagnation situation in an additional scale. Poor soils in char land and soil salinity are the two least frequent constraints possess higher ranks. The most common and frequent constraint is the high price of agricultural inputs, but in the order of ranking it got least priority.

Venktesh (2002) in his study on constraints analysis of tomato growers in the Kolar district reported that 86 per cent of the respondents cited the problem of susceptibility of crop to pest and disease.

Baetligen *et el.* (2003) suggested that, availability of better climate and agricultural information helps farmers make comparative decisions among alternative crop management practices and this allows them to better choose strategies that make them cope well with changes in climatic conditions.

Jones (2003) indicated that, information concerning climate change forecasting, adaptation options and other agricultural production activities remains an important factor affecting use of various adaptation measures for most farmers. Lack of land or limitations in information (seasonal and long-term climate changes and agricultural production) increases high downside risks from failure associated with uptake of new technologies and adaptation measures.

Deressa *et el.* (2009) indicated that, there are five major constraints to adaptation to climate change through resilient crop, vs., lack of information, lack of money, shortage of labor, shortage of land and poor potential for irrigation in the mile basin of Ethiopia. It is clear from the reviews above that farmers are facing many constraints in adaptations to climate change.

O'Brien *et el.* (2000) reported that despite numerous resilient cropping systems that farmers are aware of and willing to apply, the lack of financial resources to purchase the necessary inputs and other associated equipment's is one of the significant constraints to adaptation.

BRAC (2010) reported that although all the crops and cropping patterns produced higher yield and income than the traditional cropping practices, the farmers could not adopt all the cropping patterns across the coastal regions of Bangladesh mainly due to variation in water salinity and unavailability of sufficient relatively non-saline water for year-round crop cultivation. The farmers of Bagerhat, Barguna, Jhalokathi, Patuakhali and Pirojpur districts adopted and cultivated three crops in a year, while those of Khulna and Satkhira mostly cultivated two crops per year.

2.10 Conceptual Framework of the Study

The present study would be tried to focus two concepts; first the farmers' selected characteristics and the second, their adoption of climate resilient agricultural practices, crop varieties, cropping patterns, causes of adoption and problems confronted by the respondent farmers. The above observations of an individual may be influenced and affected through interacting forces in the surroundings. On the basis of above discussion and review of literature, the theoretical framework of this study has been structured as shown in Figure 2.1.

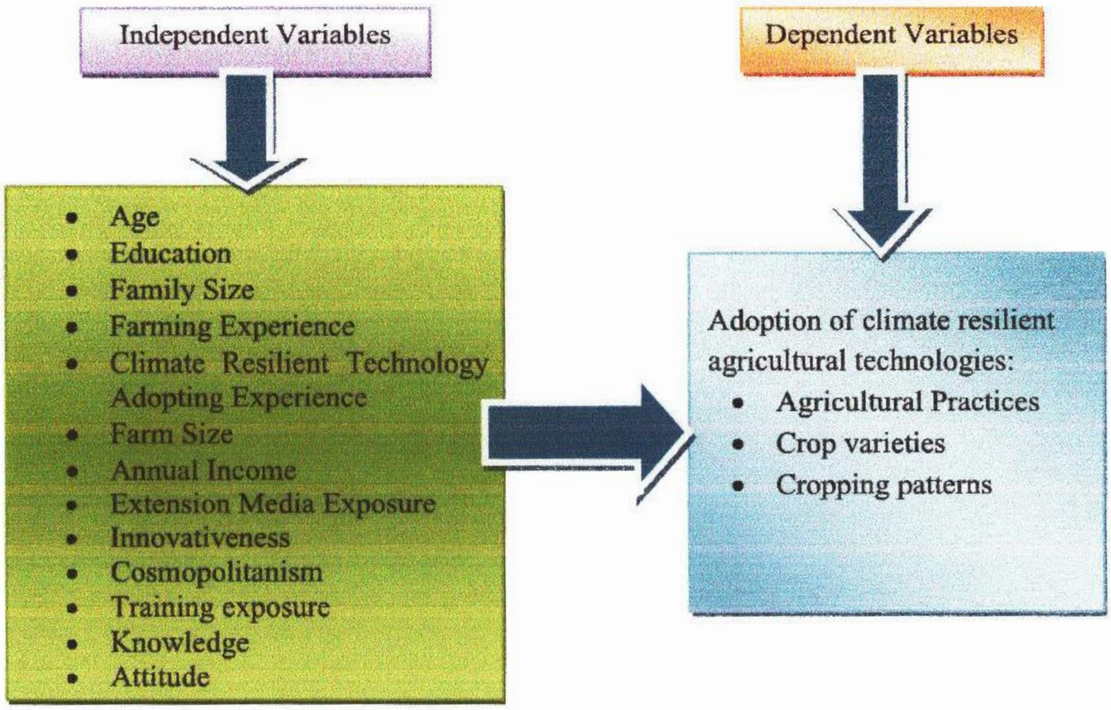

Figure 2.1 The conceptual framework of the study

CHAPTER III

METHODOLOGY

In any scientific research methodology plays an important role. Research methodology is a systematic way to solve any research problem. Appropriate methodology enables the researcher to collect valid and reliable information and to analyze the information properly in order to achieve a correct conclusion. The methods and procedures followed in conducting this study have been described in this chapter.

3.1 Design of the Study

The study was a social scientific survey. It was carried out by following descriptive and diagnostic research design (Kothari, 2004). In the study, two approaches have been used: (i) a statistical survey to identify present climate resilient agricultural technologies in the study area and also to assess the causes of adopting climate resilient agricultural technologies for sustainable crop production, and (ii) a study carried out with participation of local farmers to find out the present climate resilient agricultural technologies and extent of adoption of these technologies.

3.2 Locale of the Study

The study was conducted at 5 villages of Dumuria upazila under Khulna district which was selected purposively. The study area consists of 240 villages. But only 5 villages were selected purposively. These villages constituted the locale of the study. The names of the villages are Kharnia, Kholshi, Mirzapur, Dumuria and Gutudia, those are shown in Table 3.1. The physical, social and cultural and heritage of this area were similar in many cases with other areas of the country. The study area is situated 8 km away from Khulna District. The area of Dumuria upazila is 454.2 sq. km. As the census of 2011, the total population 279862; male 144334, female 135528. Map of district Khulna showing Dumuria upazila presented in Figure 3.1 and map of Dumuria upazila showing under study area is presented in Figure 3.2.

Table 3.1 Distribution of Sample Population of the Farmers

Name of Union	Name of Villages	Sampled Respondents
Khornia	Kharnia	10
Dumuria	Kholshi	25
Dumuria	Mirzapur	12
Dumuria	Dumuria	20
Gutudia	Gutudia	13
Total		**80**

3.3 Population and Sampling

The farmers of the study area who were adopter of climate resilient agricultural technologies were treated as population of this study. A total numbers of 80 farmers were selected following purposive sampling method which was treated as sample for the study.

3.4 Instruments for Data Collection

An interview schedule was used as the research instrument in order to collect relevant information from the respondents. The interview schedule was prepared considering the objectives of the study and it were used to collect valid and reliable information from the respondents. The schedule contained both open and closed form of questions. Most easy, simple, direct questions and different scales were used to collect information. Direct questions were also used to obtain information like age, level of education, farm size, and family income, training etc. Different scales were developed and used to measure extension contact, knowledge, attitude and extent of adoption of climate resilient agricultural technologies etc. A closed form questions was also designed to obtained information on extension media contact, cosmopolitanism, attitude etc. The questions were arranged systematically and presented clearly so that the respondents could understand to furnish information in a consistent and systematic manner. The schedule was pretested and necessary corrections and modifications were made before final collection of data. An English version of the interview schedule is enclosed in Appendix A.

3.5 Collection of Data

Data collection for the study was done by the researcher herself mainly through face to face interview using the interview schedule. To familiarize with the study area and for getting local support, the researcher took help from the local leaders concerned SAAO and UAO. The researcher made all possible efforts to establish desired rapport with the respondents in order to get valid and pertinent information from the respondents and the objectives were clearly explained by using local language as far as possible. The other relevant data were collected by several methods such as field observation and systematic study of available records, and browsing internet.

After completion of interview each statement was checked and verified for proper recording of data. Good cooperation was received from all of the respondents during interview. Data were collected during the period of 13th January, 2022 to 25th January, 2022.

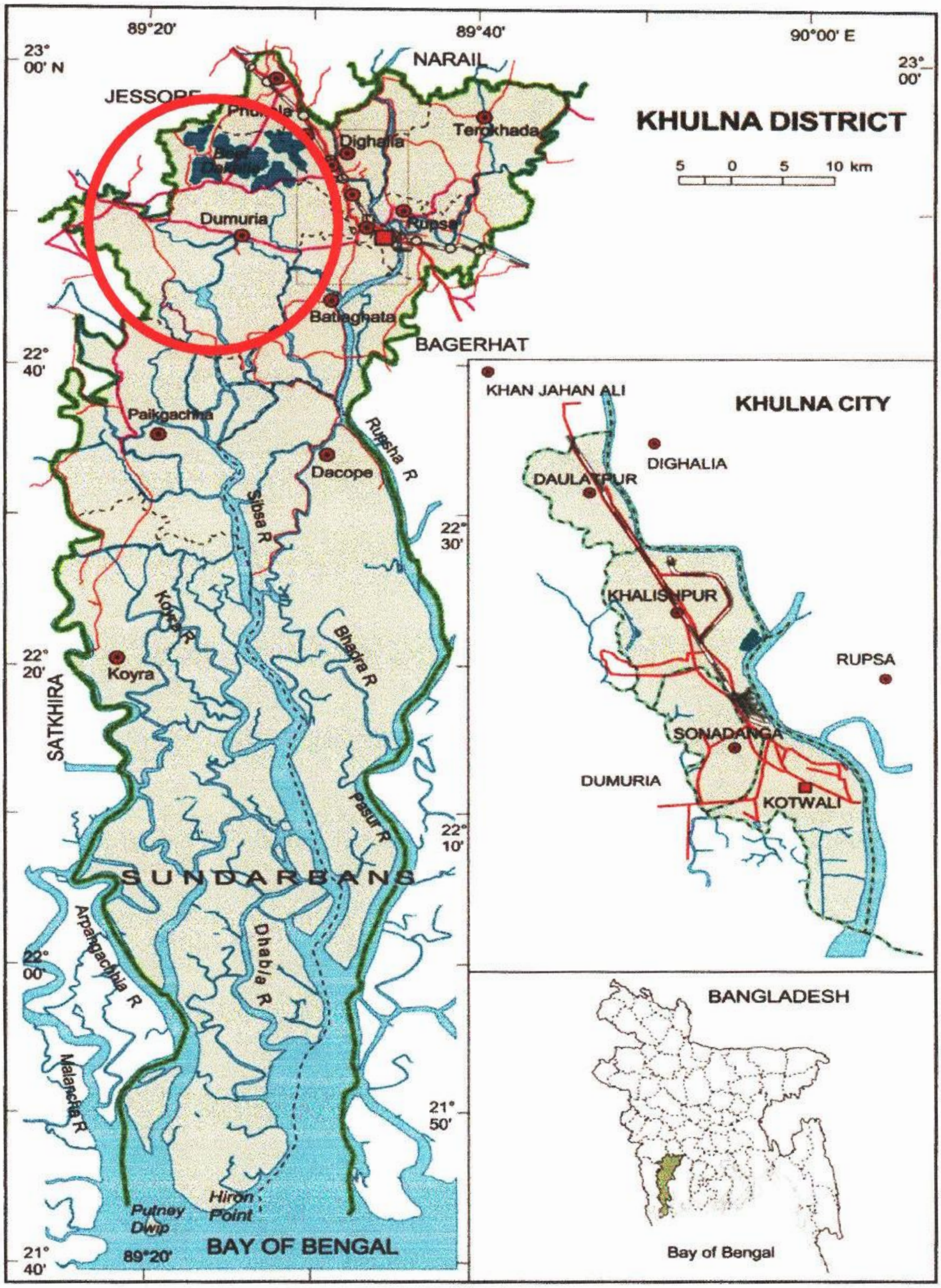

Figure 3.1 A map of Khulna district

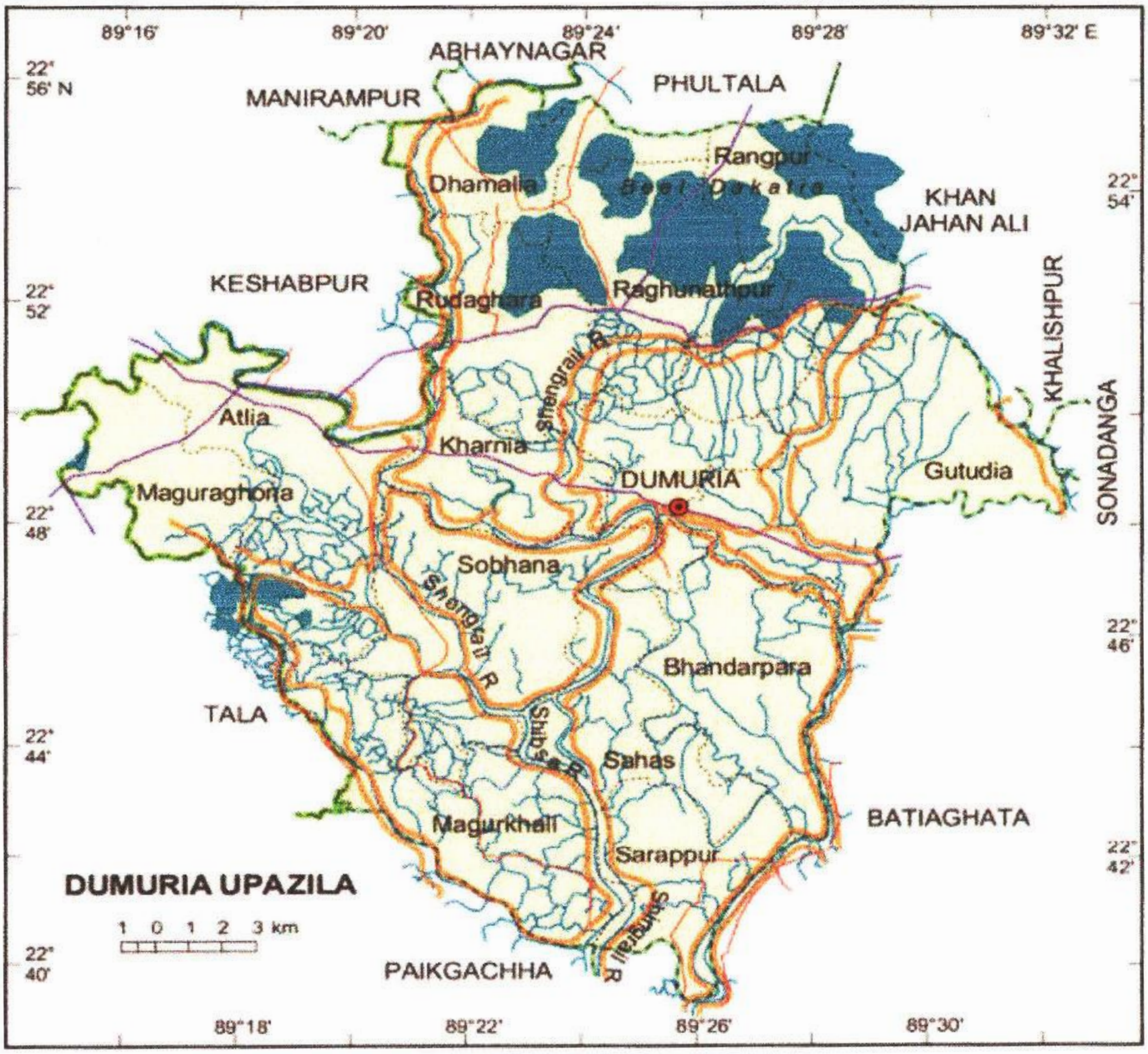

Figure 3.2 A map of Dumuria upazila showing the study unions

3.6 Selection and Measurement of Variables

A variable is any characteristic, which can assume varying or different values in successive individual cases (Ezekiel and Fox, 1959). A well organized piece of research usually contains at least two important elements, viz. an independent variable and a dependent variable. An independent variable is that variable which is manipulated by the researcher in his attempt to ascertain its relationships to an observed phenomenon. A dependent variable is that variable which appears, disappears or varies as the researcher introduces, removes or varies the independent variables (Townsend, 1953). In a scientific research the selection and measurement of variables constitutes a significant task. In this connection, the researcher reviewed literature to widen her understanding about the nature and scope of the variables relevant to this piece of research.

3.6.1 Selection of Variables

Reviewing related studies, the researcher considered 13 - characteristics of farmers as independent variables. The selected characteristics (independent variables) are: age, level of education, family size, farm size, annual income of the respondents, farming experience, experience in adopting climate resilient technologies, innovativeness, extension media contact, cosmopolitanism, training exposure, knowledge about climate resilient agricultural technologies, attitude of respondents (farmers') towards the use of climate resilient agricultural technologies.

On the other hand, the extent of adoption of climate resilient agricultural practices, crop varieties, cropping patterns, the causes and problem confrontations of adopting climate resilient agricultural technologies were treated as dependent variable.

3.6.2 Measurement of Variables

3.6.2.1 Measurement of Independent Variables

The independent variables of the study were the selected characteristics of the farmers. It is very difficult to identify all possible characteristics related to farmers. Also it is not particularly possible to include and investigate all possible independent variables. In this study selected thirteen (13) personal, economic, social and psychological characteristics of the farmers were considered as independent variables. Procedure for measuring independent variables mentioned under section 3.6.1 has been discussed.

3.6.2.1.1 Age

Age of the farmers refers to the period of time from his/her birth to the time of interview. It was measured in terms of actual years on the basis of his/her response to question no. 2 (a) of the interview schedule (Appendix A). Based on age, the respondents were classified into 3 categories as shown in Table 3.2.

Table 3.2 Categories of the respondents according to their age

Categories	Score (Years)
Young aged	≤35
Meddle aged	35-50
Old aged	>50

3.6.2.1.2 Level of Education

The level of education of a respondent was measured by the number of years of schooling. A score of one (1) was assigned for each year of schooling completed. For example, if a respondent completed study of class five his education score was assigned as 5. The educational status of a respondent who could illiterate was assigned a score 0 if a respondent could not read and write. Besides, a score 1 (one) also given to those who can sign their name only. Based on level of education score, the respondents were grouped into 5 categories as presented in Table 3.3.

Table 3.3 Categories of respondents according to their level of education

Categories	Score (Year of schooling)
Illiterate	0
Primary	1-5
Secondary	6-10
Higher secondary	11-12
Above Higher secondary	13-16

3.6.2.1.3 Family Size

The family size of a respondent was measured by the total number of his family members including himself, his family, children and other dependents who were eating and staying together. This variable has been shown in the question no. 1 of the interview schedule (Appendix A). Based on family size, the respondents were classified into 3 categories as shown in Table 3.4.

Table 3.4 Categories of respondents according to family size

Categories	No of family members
Small size family	<5
Medium size family	5 -6
Large size family	≥ 7

3.6.2.1.4 Farm Size

Farm size was measured as the size of his farm on which farmers continued his farming operations during the period of study. It included the area of homestead, land cultivation under his or her family cultivation, land given to others on lease.

The area was measured in terms of hectare. The farm size of a respondent was measured by using the following formula:

Farm size **=A+B+1/2(C+D) +E+F+G** Where,

A. Homestead area

the Farming experience scores, the respondents were grouped into following categories as shown in Table 3.7.

Table 3.7 Categories of the respondents based on farming experience

Categories	Score (Year of experience)
Low experience	<16
Medium experience	16-30
High experience	>30

3.6.2.1.7 Experience in Adopting Climate Resilient Agricultural Technologies

Experience of adoption of climate resilient agricultural technologies of a respondent was measured on the basis of years he/she involved in farming using climate resilient agricultural technologies. For example, if a respondent involved in one year her experience score is 1. Based on the farming experience scores, the respondents were grouped into following categories as shown in Table 3.8.

Table 3.8 Categories of the respondents based on technology adopting experience

Categories	Score (Year of experience)
Low experience	<8
Medium experience	8-14
High experience	>14

3.6.2.1.8 Innovativeness

Innovativeness is operationally defined as the degree to which the respondent is relatively earlier in adopting climate resilient agricultural technologies. The respondents were asked as to when they would like to adopt a climate resilient agricultural technology in farming. The measurement of innovativeness was as follows:

Table 3.9 Categories of the respondents based on innovation (Rogers, 1971)

Categories	Score
Laggard (1)	$\geq(\bar{X} + 2Sd)$
Late majority (2)	$(\bar{X} + 1Sd)$ *to* $(\bar{X} + 2Sd)$
Early majority (3)	$(\bar{X} + 1Sd)$
Early adaptor (4)	$(\bar{X} - 2Sd)$ *to* $(\bar{X} - 1Sd)$
Innovators (5)	$\leq(\bar{X} - 2Sd)$

3.6.2.1.9 Extension Media Contact

It refers to the extent of exposure or taking part by the farmers in extension activities during the last year. The procedure followed by Ranuji (2006) in order to assess the extent of exposure of the respondents in extension activities with slight modification. A number of 19 media were included in the interview schedule and they were asked to indicate their exposure as regularly, sometimes, rarely and not at all. The scores assigned as 3, 2, 1 and 0, respectively. The extension media contact was calculated by adding all the score obtained by the respondents against the 19 media. The extension media contact score was varied from 0-57 where '0' indicates 'no contact' and '57' indicated 'high contact'. The respondents were classified in to three groups (low, medium, high) based on extent of exposure in the particular extension activity by considering frequency and percentage. Based on extension media contact score of the respondents were classified into 3 categories as shown in Table 3.10.

Table 3.10 Categories of respondents according to their extension media contact

Categories	Score
Low extension media contacts	<20
Medium extension media contacts	20-38
High extension media contacts	>38

3.6.2.1.10 Cosmopolitanism

Farmers' cosmopolitanism score was determined by the frequency of visit to the places selected in out of his/ her own social system such as, other villages, other union, own Upazila sadar, other Upazila sadar, own district sadar, other district sadar, Khulna and other cities. The score assigned against the rating scales as frequently (3), occasionally (2), rarely (1) and not at all (0). This variable has been shown in the question no. 9 of the interview schedule (Appendix A). The cosmopolitanism was determined by adding all the score obtained by the respondents against these 8 places of visit. The score was ranged from 0-24 where '0' indicate no cosmopolitanism and '24' indicate high cosmopolitanism. Based on cosmopolitanism score the respondents were classified into following categories as shown in Table 3.11.

Table 3.11 Categories of respondents according to their cosmopolitanism

Categories	Scores
Low	<9
Medium	9-16
High	>16

3.6.2.1.11 Training Exposure

Farmers' training score was determined by the number of training he/she received considering the duration of training, venue of the training, training institute. For example, a respondent received one training; his/her training score was '1'irrespective of its duration. This variable has been shown in the question no. 12 of the interview schedule (Appendix A). Based on training score the respondents were classified into following categories as shown in Table 3.12.

Table 3.12 Categories of respondents according to their training exposure

Categories	Score
No training	0
Low training	1
Medium training	2-3
High training	≥ 4

3.6.2.1.12 Knowledge Level of the Respondents about Climate Resilient Agricultural Technologies

The knowledge of the respondents about climate resilient agricultural technologies was measured by asking 8 selected questions and a score of 2 was assigned to each of the questions. Full marks were given to appropriate answer and partial score was given for partially correct answer whereas 0 (zero) score was given to wrong or no answer. Knowledge score could range from 0 to 16 where 0 indicated no knowledge while 16 indicated high knowledge (question no. 13 of the interview schedule, Appendix A). Based on Knowledge score, the respondents were grouped into following categories as shown in Table 3.13.

Table 3.13 Categories of the respondents based on their knowledge about climate resilient agricultural technologies

Categories	Scores
Low	<6.98 ($<\bar{X}$ - 1Sd)
Medium	6.98-12.69 ($\bar{X} - 1Sd\ to\ \bar{X} + 1Sd$)
High	> 12.69 ($>\bar{X} + 1Sd$)

3.6.2.1.13 Attitude of the Respondents towards the Climate Resilient Agricultural Technologies

A number of 13 statements were included in item no. 14 of the interview schedule (Appendix A) to measure the attitude of the respondents towards climate resilient agricultural technologies. A five point Likert scale such very highly favorable attitude (5), favorable attitude (4), moderately favorable attitude (3), less favorable attitude (2) and very less favorable attitude (1) was employed against the 13 statements. Each of the respondents was asked to indicate their opinion against the 13 statements. The attitude sum of a respondent was calculated by adding all the scores obtained by his/ her against 13 statements. The attitude sum was ranged from 13-65 where '13' indicate 'very less favorable attitude' and '65' indicate 'very highly favorable attitude'. The respondents were classified into following categories according to their attitude as shown in table 3.14.

Table 3.14 Categories of respondents according to Attitude towards the climate resilient agricultural technologies

Categories	Scores
Very less favorable attitude	<14
Less favorable attitude	14-26
Moderate favorable attitude	27-39
Favorable attitude	40-52
Very highly favorable attitude	>52

3.6.2.2 Measurement of Dependent Variable/ Adoption of Climate Resilient Agricultural Technologies

Adoption of climate resilient agriculture technologies observed in terms of the followings:

1. Adoption of climate resilient agricultural practices
2. Adoption of climate resilient crop varieties
3. Adoption of climate resilient cropping patterns

3.6.2.2.1 Adoption of Climate Resilient Agricultural Practices

A number of 11 climate resilient agricultural practices were incorporated in the interview schedule question no 15 (Appendix A) to determine their adoption. A 4 point rating scales such as highly adopted, sometimes adopted, rarely adopted and not at all adopted were employed against the 11 climate resilient agricultural practices and a score of 3,2,1 and 0 was employed against each of the rating scale. Each of the respondents was asked to indicate the level of adoption of climate resilient agricultural practices. The adoption score was computed by adding all the scores obtained by a respondent against the 11 climate resilient agricultural practices. The adoption score related climate resilient agricultural practices could range from 0 to 33 where "0" indicates not at all adopted and "33" indicates highly adoption of climate resilient agricultural practices. Based on adoption score, the respondents were classified into different categories as shown in Table 3.15.

Table 3.15 Categories of respondents according to their adoption of climate resilient agricultural practices

Categories	Scores
Low	<12.68 (<$\bar{X}$ - 1Sd)
Medium	12.68-20.24 ($\bar{X} - 1Sd\ to\ \bar{X} + 1Sd$)
High	> 20.24 (>$\bar{X} + 1Sd$)

3.6.2.2.1.1 Identification and Extent of Adoption of Climate Resilient Agricultural Practices

To identify the important climate resilient agricultural practices, a climate resilient method index was calculated by using following formula:

$$(\%)\ \text{CRMI} = \frac{OCRMIS}{\text{HPCRMIS}} \times 100$$

Where,

CRMI = Climate resilient method index

OCRMIS= Observed climate resilient method index score

HPCRMIS= Highest possible climate resilient method index score

Besides, OCRMIS= $N_{ha} \times 3 + N_{sa} \times 2 + N_{ra} \times 1 + N_{na} \times 0$

OCRMIS could range from 0 to 240 where "0" indicates no adoption and "240" indicates highly adoption method for crop production.

Based on the (%) CRMI, the adoption of climate resilient agricultural practices were ranked in descending order.

3.6.2.2.2 Adoption of Climate Resilient Crop Varieties

A number of 32 climate resilient crop varieties were included into item no. 16 of the interview schedule (Appendix A). Each of the respondents was asked to mention both potential area and actual area under cultivation of a specific variety. The extent of adoption of a particular variety was determined by using following formula:

$$\text{EA} = \frac{\text{AA}}{\text{PA}}$$

Where, AA = Actual area under cultivation of crop varieties

PA = Potential area under cultivation of crop varieties

EA= Extent of adoption crop varieties

For classification of the respondents it was counted into percentage. Based on average extent of adoption score, the respondents were classified into different categories which are shown in Table 3.16.

Table 3.16 Categories of respondents according to their adoption of climate resilient crop varieties

Categories	Scores
Low	<0.47 (<$\bar{X}$ - 1Sd)
Medium	0.47-0.96 ($\bar{X} - 1Sd\ to\ \bar{X} + 1Sd$)
High	> 0.96 (>$\bar{X} + 1Sd$)

3.6.2.2.2.1 Variety-wise Identification and Extent of Adoption of Crop Varieties

The farmers were directly asked to mention the name of the climate resilient crop varieties as adopted by them with their extent. The extent of adoption of a particular variety was measured by using the following formula:

Extent of Adoption Index = $\frac{\sum Ea}{Na} \times 100$

Where, $\sum$Ea = Summation of extent of adoption of a particular variety

Na = Number of respondents adopt that particular variety

Extent of Adoption Index of climate resilient crop varieties were expressed in percentage. Then it was ranked based on the percentage value in descending order.

3.6.2.2.3 Adoption of Climate Resilient Cropping Patterns

A number of 4 climate resilient cropping patterns were incorporated in the interview schedule question no 17 (Appendix A) to determine their adoption. Based on adoption score, the respondents were categorized in Table 3.17.

Table 3.17 Categories of respondents according to their adoption of climate resilient cropping patterns

Categories	Scores
Low	<5
Medium	5-8
High	> 8

A 4 point modified rating scales such as highly adopted, sometimes adopted, rarely adopted and not at all adopted were employed against the 4 climate resilient cropping patterns and a score of 3,2,1 and 0 was employed against each of the rating scale. Each of the respondents was asked to indicate the level of adoption of climate resilient cropping patterns. The adoption score was computed by adding all the scores obtained by a respondent against the 4 climate resilient cropping patterns. The adoption score related climate resilient cropping patterns could range from 0 to 12 where "0" indicates not at all adopted and "12" indicates highly adoption of climate resilient cropping patterns.

3.6.2.2.3.1 Identification and Extent of Adoption of climate resilient cropping patterns

To identify the important climate resilient cropping pattern, a climate resilient cropping pattern index was calculated by using following formula:

$$(\%)\ \text{CRCPI} = \frac{OCRCPIS}{\text{HPCRCPIS}} \times 100$$

Where,

CRCPI = Climate resilient cropping pattern index

OCRCPIS= Observed climate resilient cropping pattern index score

HPCRCPIS= Highest possible climate resilient cropping pattern index score

Besides, OCRCPIS= $N_{ha} \times 3 + N_{sa} \times 2 + N_{ra} \times 1 + N_{na} \times 0$

OCRCPIS could range from 0 to 240 where "0" indicates no adoption and "240" indicates highly adoption cropping pattern.

Based on the (%) CRCPI, the adoption of climate resilient cropping patterns were ranked in descending order.

3.6.2.2.4 The Causes of Adopting Climate Resilient Agricultural Technologies

A 7-item statement was used to determine the causes of adopting climate resilient agricultural technologies. Based on the adoption scores, the respondents were grouped into three categories as shown in Table 3.18.

Table 3.18 Categories of the respondents based on their causes score

category	Score assigned
Low number of causes for adoption	<21.39 ($<\bar{X}$ - 1Sd)
Medium number of causes for adoption	21.39-27.64 ($\bar{X} - 1Sd\ to\ \bar{X} + 1Sd$)
High number of causes for adoption	>27.64 ($>\bar{X} + 1Sd$)

A 5-point Likert type modified scale such as strongly agree, agree, undecided, disagree and strongly disagree were employed against each of 7 statements to determine the extent of adoption of the respondent regarding the causes of adopting climate resilient agricultural technologies. A score of 5, 4, 3, 2 and 1 were assigned against the rating scales respectively (item no. 10 of interview schedule; Appendix A). The adoption score regarding the causes of adopting climate resilient agricultural technologies were determined by summing up all the scores obtained by a respondent against each of the 7-statements. The causes score were ranged from 7-35 where '7' indicate low number of causes for adoption and '35' indicate high number of causes for adoption. To identify the most important causes of adopting climate resilient agricultural technologies, a causes of index (CAI) was determined by using the following formula:

$$(\%)\ CAI = \frac{\text{Observed CAI score}}{\text{Highest possible CAI score}} \times 100$$

$$CAIS = N_{sa} \times 5 + N_{ag} \times 4 + N_{ud} \times 3 + N_{da} \times 2 + N_{sd} \times 1$$

Where, CAIS= Causes of Adoption Index Score

N_{sa}= Number of respondent indicated as strongly agreed

N_{ag}= Number of respondent indicated as agreed

N_{ud}= Number of respondent indicated as undecided

N_{da}= Number of respondent indicated as disagreed

N_{sd}= Number of respondent indicated as strongly disagreed

The CAI scores could varies from 80-400 where "80" indicates low number of causes for adoption and "400" indicates high number of causes for adoption.

Based on the (%) CAI, the causes were ranked in descending order.

3.6.2.2.5 Problems Confronted by the Farmers during Adopting Climate Resilient Agricultural Technologies

A number of twelve (12) problems were incorporated in the item no. 11 of interview schedule (Appendix A). Each of the respondents was asked to express the problems he faced during adopting climate resilient agricultural technologies with their extent of severity. The severity scale designed as highly severe problem, moderately severe problem, less severe problem and not at all problems respectively. And a score of 3, 2, 1 and 0 were assigned against the severity scales respectively. The problem confrontation score of a respondent was determined by adding all the scores obtained against the 12 problems. The problem confrontation score could vary from 0-36 where '0' indicate no problem and '36' indicate high problem.

Based on the scores, the respondents were grouped into four categories as shown in Table 3.19.

Table 3.19 Categories of the respondents based on their problems confrontation score

Scale	Score assigned
No problem confronted	0
Low problem confronted	<17.74 ($<\bar{X}$ - 1Sd)
Medium problem confronted	17.74-29.19 ($\bar{X} - 1Sd\ to\ \bar{X} + 1Sd$)
High problem confronted	>29.19 ($>\bar{X} + 1Sd$)

To identify the major problems that hindered for adopting climate resilient agricultural technologies, a problem confrontation index (PCI) was calculated by using the following formula:

$$(\%)\ PCI = \frac{\text{Observed PIC score}}{\text{Highest possible PIC score}} \times 100$$

$$PCIS = N_{hsp} \times 3 + N_{msp} \times 2 + N_{lsp} \times 1 + N_{nap} \times 0$$

Where, PCIS- Problem Confrontation index score of the respondents of adopting climate resilient agricultural technologies

N_{hsp} -Number of respondent indicated as highly severe problem

N_{msp}- Number of respondent indicated as moderately severe problem

N_{lsp}-Number of respondent indicated as less severe problem

N_{nap}-Number of respondent indicated as not at all problem

The PCI scores could vary from 0-240 where "0" indicates no problem confronted and "240" indicates high problem confronted.

Based on the (%) PCI, the problems were ranked in descending order.

3.7 Compilation of Data

After completion of field survey all the data of the interview schedule were compiled. Local units were converted into standard unit. Appropriate coding and scoring technique were followed to convert the qualitative data into quantitative forms. The responses of the individual respondent contained in the interview schedules were transferred to a master sheet for entering the data in the computer. As soon as the data entered into the computer, it was then analyzed in accordance with the objectives of the study.

3.8 Statistical Analysis

After processing, data were entered in statistical software (SPSS) for further analysis. The SPSS version 25 program is quite good and useful for recording, categorizing, tabulation and computing various simple statistics. All personal traits were categorized and arranged in simple tables for description. The respondents were also categorized based on their adoption scores. MS Excel, statistical software was also used for graphical presentation of data. For presentation of data statistical treatments such as number, percent, mean, median, minimum-maximum, rank order and standard deviation were used. Mean and standard deviation were used in describing the independent and dependent variables of the study. For clarity of understanding tables were used to present the data. To test the relationship between two variables Pearson Product correlation co-efficient was employed.

CHAPTER IV

RESULTS AND DISCUSSION

This chapter deals with the findings of the present research study entitled adoption of climate resilient agricultural technologies for sustainable crop production. Data were collected from the respondents (farmers) and were carefully accomplished, coded, computed, tabulated and analyzed in accordance with the objectives of the study. After completion of those processes this chapter was written carefully. The findings of the study and logical interpretations of the results were presented in this chapter in six sections that are in conformity with the objectives of the study. The sections are:

(i) Facts on the personal and socio-economic profile of the respondents

(ii) Identification of climate resilient agricultural technologies

(iii) Extent of adoption of climate resilient agricultural technologies

(iv) The causes of adopting climate resilient agricultural technologies

(v) The problem confrontations in adopting climate resilient agricultural technologies

(vi) Relationships between the selected characteristics of the respondent farmers (dependent and independent variables) and their extent of adoption of climate resilient agricultural practices, crop varieties and cropping patterns respectively.

4.1 Selected Characteristics of the Respondents

Thirteen characteristics of the farmer were selected to find out their relationship with the adoption of climate resilient agricultural practices, crop varieties and cropping patterns for sustainable crop production. The selected characteristics were age, level of education, family size, farm size, annual income, farming experience, experience in adopting climate resilient technologies, innovativeness, extension media contact, training, cosmopolitanism, knowledge and attitude.

4.1.1 Age

The age of the respondents ranged from 30 to 70 years, with a mean of 45.9 years and the standard deviation of 10.36. Highest proportion (47.5 percent) of the respondents was middle-aged category compared to young aged (28.7 percent) and old aged (23.8 percent).

It was found that middle and young aged farmers were more interested in adopting climate resilient agricultural technologies than old aged. They showed a favorable attitude towards adopting of climate resilient agricultural technologies. The distribution of the respondents according to their age categories is shown in Table 4.1.

Table 4.1 Distribution of respondents according to their age

Categories	Scores (Years)	Respondents(N=80)		Range		Mean	SD
		Number	Percentage	Min	Max		
Young aged	≤35	23	28.7				
Middle aged	36-50	38	47.5	30	70	45.9	10.36
Old aged	>50	19	23.8				
Total		80	100				

The findings in this study is similar with Islam (2008) and Akter (2007) but dissimilar with Sultana *et el.* (2020) where they found majority 63.80 percent of their respondents were old aged.

4.1.2 Level of Education

The level of education score of the farmer ranged from 0-16, with a mean of 7.35 and standard deviation of 3.78. Highest proportion (48.8 percent) of the respondents belonged to the secondary level of education category while 27.5 percent, 12.5 percent, 5 percent and 6.3 percent of the farmers belonged to primary level, higher secondary level, above higher secondary level and illiterate categories respectively.

Farmers need to have some education in order to adopting climate resilient agricultural technologies. The findings indicated that an overwhelming majority (76.3 percent) of the respondents belonged to primary level to secondary level of education. The distribution of the farmers according to their level of education categories is shown in Table 4.2.

Table 4.2 Distribution of farmers according to their education

Categories	Score (Years of schooling)	Respondents (N=80)		Range		Mean	SD
		Number	Percentage	Min	Max		
Illiterate	0	5	6.3				
Primary	1-5	22	27.5				
Secondary	6-10	39	48.8	0	16	7.35	3.78
Higher secondary	11-12	10	12.5				
Above Higher secondary	≥13	4	5.0				
Total		80	100				

Majlish *et el.* (2007), also found similar result in their respective study. But Sultana *et el.* (2020) found that highest proportion (48.80 percent) of the respondents belonged to the primary level of education.

4.1.3 Family Size

Family size is ranged from 3-10, with a mean of 5.26 and standard deviation of 1.56. Highest proportion (43.8 percent) of the respondents belonged to the small size family while 35 percent and 21.2 percent of the respondents belonged to medium size family and large size family respectively. The findings indicated that an overwhelming majority (78.8 percent) of the respondents belonged small to medium sized family in the study area. Average 5.26 members are including per family of the study area which is higher than that of national average (4.5; BBS 2021). This may be due to the poor adoption of family planning measures by the respondents or prevalence of more joint family system in the study area. The distribution of the respondents according to their family size is shown in Table 4.3.

Table 4.3 Distribution of rural women according to their family size

Categories	Scores	Respondents(N=80)		Range		Mean	SD
	(Number)	Number	Percentage	Min	Max		
Small size family	<5	35	43.8				
Medium size family	5-6	28	35	3	10	5.26	1.56
Large size family	≥ 7	17	21.2				
Total		80	100				

The finding in this study is similar with Sultana *et el.* (2020) but dissimilar with Salahuddin *et el.* (2010) where he found highest proportion (49.1 percent) of their respondents belonged medium family size.

4.1.4 Farm Size

The respondents were classified into 5 categories according to the basis of their farm size. The observed farm size scores of the farmers (respondents) varied from 0.03 hectare to 3.07 hectares with average farm size of 0.7122 hectares and standard deviation of 0.49866. Majority (67.5 percent) of the respondents possessed small farm size while 12 percent and 16.3 percent belonged to marginal and medium farm respectively, 1.3 percent of them belonged to large farm and no farmer possessed landless. Most (83.8 percent) of the farmers belonged to small and medium farm size. In Bangladesh, most of the farmers (95.06%) belong to small to medium farm holdings (Anon., 1993) i.e., only 4.94% belong to large size of farm. The distribution of the farmers according to their farm size categories is shown in Table 4.4.

Table 4.7 Distribution of the farmers according to their adopting experience of climate resilient agricultural technologies

Categories	Scores	Respondents (N=80)		Range		Mean	SD
		Number	Percentage	Min	Max		
Low	<8	15	18.8				
Medium	8-14	41	51.2	4	20	11.46	3.8
High	> 14	24	30				
Total		80	100				

Sultana *et el.* (2020) also found similar result with their study.

4.1.8 Innovativeness

Majority 52.5 percent and 27.5 percent of the respondents belonged to early adopter and early majority categories respectively while 5 percent were innovators, 3.8 percent were late majority and 11.3 percent of the farmers were laggard. The distribution of the respondents according to their farming experience categories is shown in Table 4.8.

Table 4.8 Distribution of respondents according to their innovativeness

Innovativeness	Score	Frequency	Percent
Laggard	1	9	11.3
Late majority	2	3	3.8
Early majority	3	22	27.5
Early adaptor	4	42	52.5
Innovators	5	4	5.0
Total		80	100.0

The farmers of the study area are more innovators than that of Rogers (1983). He stated that 2.5 percent were innovators whereas innovators in this study are observed 5 percent which is opposite of his statement.

Salahuddin *et el.* (2010) also found similar result with their study.

4.1.9 Extension Media Contact

The observed extension contacts scores of the respondents ranged from 4-47 having an average of 18.22 with a standard deviation of 8.56. Majority (68.7 percent) of the farmers belonged to low extension contact compared to 27.5 percent and 3.8 percent of the respondents showed medium and high extension contact respectively.

The distribution of farmers (respondents) according to their extension media contact categories is shown in Table 4.9.

Table 4.9 Distribution of farmers according to their extension media contacts

Categories	Scores	Respondents (N=80)		Range		Mean	SD
		Number	Percentage	Min	Max		
Low	<20	55	68.7				
Medium	20-38	22	27.5	4	47	18.22	8.56
High	>38	3	3.8				
Total		80	100				

Sultana *et el.* (2020), Salahuddin *et el.* (2010), Islam (2008) and Akter (2007) also found similar result in farmers' extension media contact on their study.

4.1.10 Cosmopolitanism

The cosmopolitanism of the respondents ranged from 1-19 with an average of 4.92 and a standard deviation of 3.7. Most (85 percent) of the respondents showed low cosmopolitanism followed by medium cosmopolitanism 11.3 percent and high cosmopolitanism 3.8 percent of the respondents. The distribution of farmers according to their cosmopolitanism categories is shown in Table 4.10.

Table 4.10 Distribution of farmers according to their cosmopolitanism

Categories	Scores	Respondents (N=80)		Range		Mean	SD
		Number	Percentage	Min	Max		
Low	<9	68	85				
Medium	9-16	9	11.3	1	19	4.92	3.7
High	>16	3	3.8				
Total		80	100				

The result shows similarity with the finding of Salahuddin *et el.* (2010).

4.1.11 Training Exposure

The observed training exposure score of the farmers ranged from 0 to 4 with mean of 1.3 and standard deviation of 1.19. Highest proportion (33.8 percent) of the respondents belonged to medium training exposure whereas similar percent (31.3) respondents belonged to the no training and low training exposure. On the other hand, 3.8 percent of the respondents belonged to high training exposure.

The distribution of the farmers according to training categories is presented in Table 4.11.

Table 4.11 Distribution of respondents according to training

Categories	Scores	Respondents (N=80)		Range		Mean	SD
		Number	Percentage	Min	Max		
No	0	25	31.3				
Low	1	25	31.3				
Medium	2-3	27	33.8	0	4	1.3	1.19
High	≥ 4	3	3.8				
Total		80	100				

4.1.12 Knowledge Level of the Respondents

Knowledge of the respondents ranged from 3 to 14 with a mean of 9.84 and standard deviation of 2.86. Majority (63.7 percent) of the respondents showed medium knowledge about climate resilient agricultural technologies and 15 percent showed low knowledge whereas 21.3 percent showed high knowledge about climate resilient agricultural technologies. Knowledge influences the farmers to adopt any improved technology. As all the time they spent their time in performing different activities of agriculture so they showed some knowledge about climate resilient agricultural technologies. The distribution of farmers according to their knowledge categories is shown in Table 4.12.

Table 4.12 Distribution of farmers according to knowledge

Categories	Scores	Respondents (N=80)		Range		Mean	SD
		Number	Percentage	Min	Max		
Low	<6.98	12	15				
Medium	6.98-12.69	51	63.7	3	14	9.84	2.86
High	>12.69	17	21.3				
Total		80	100				

The result shows similarity with Salahuddin *et el.* (2010), Islam (2008), Haque (2005), Miajy (2005) and Kabir (2002) in their respective studies.

4.1.13 Attitude of the Respondents towards Adoption of Climate Resilient Agricultural Technologies

The attitude score of the respondents ranged from 25 to 54 with a mean of 48.79 and standard deviation of 4.9. Most (85 percent) of the respondents showed highly favorable attitudes towards adopting of climate resilient agricultural technologies compared to very highly favorable attitude (8.8 percent) towards adopting of climate resilient agricultural technologies. The distribution of farmers (respondents) according to their attitude is shown in Table 4.13.

Table 4.13 Distribution of farmers according to their attitude towards adoption of climate resilient agricultural technologies

Categories	Scores	Respondents (N=80)		Range		Mean	SD
		Number	Percentage	Min	Max		
High Unfavorable Attitude	<14	0	0				
Unfavorable Attitude	14-26	1	1.3				
Moderate Favorable Attitude	27-39	4	5	25	54	48.79	4.9
Highly Favorable Attitude	40-52	68	85				
Very Highly Favorable Attitude	> 52	7	8.8				
Total		80	100				

Pal (2009) and Salahuddin *et el.* (2010) also found similar result in their respective studies.

4.2 Identification of Climate Resilient Agricultural Technologies

4.2.1. Distribution of the respondents according to their adoption of climate resilient agricultural practices

The adoption scores of the respondents ranged from 9-25 against with a mean of 16.46 and standard deviation of 3.78. The distribution of farmers according to their extent of adoption of climate resilient agricultural practices is shown in Table 4.14.

Table 4.14 Distribution of respondents according to their adoption of agricultural practices

Categories	Scores	Respondents(N=80)		Range		Mean	SD
		Number	Percentage	Min	Max		
Low	<12.68	17	21.3				
Medium	12.68-20.24	53	66.3	9	25	16.46	3.78
High	>20.24	10	12.5				
Total		80	100				

Majority (66.3 percent) of the respondents showed medium extent of adoption while 12.5 percent and 21.3 percent of the respondents showed high extent of adoption and low extent of adoption respectively. As majority of the respondents showed medium extent of adoption, so that farmers are gradually adopting climate resilient agricultural practices.

4.2.1.1 Identification and Extent of Adoption of Climate Resilient Agricultural Practices

From Table 4.15 it was found that, the farmers adopted *gher* dyke vegetable production mostly (94.16%) followed by crop production through inner canal technology (87.08%), mini pond irrigation (82.5%), varieties (76.25%), sarjon system (50.41%), saline tolerant crop production (45.41%), dibbling and transplanting (44.16%), vegetable production through sack method (25.83%), zero tillage (21.25%), synchronize cultivation (19.58%) and less adopted floating bed vegetable production (0.83%). The graphical representations of extent of adoption of climate resilient agricultural practices are shown in (figure 4.1).

Table 4.15 Identification and extent of adoption of climate resilient agricultural practices

Sl.No	Agricultural practices	Method Index	Rank order
01	Crop production through inner canal technology	87.08%	2nd
02	*Gher* dyke vegetable production	94.16%	1st
03	Mini pond irrigation	82.5%	3rd
04	Sarjon system	50.41%	5th
05	Zero tillage	21.25%	9th
06	Dibbing and transplanting	44.16%	7th
07	Saline tolerant crop production	45.41%	6th
08	Vegetable production through sack method	25.83%	8th
09	Floating bed vegetable	0.83%	11th
10	Synchronize cultivation	19.58%	10th
11	Varieties	76.25%	4th

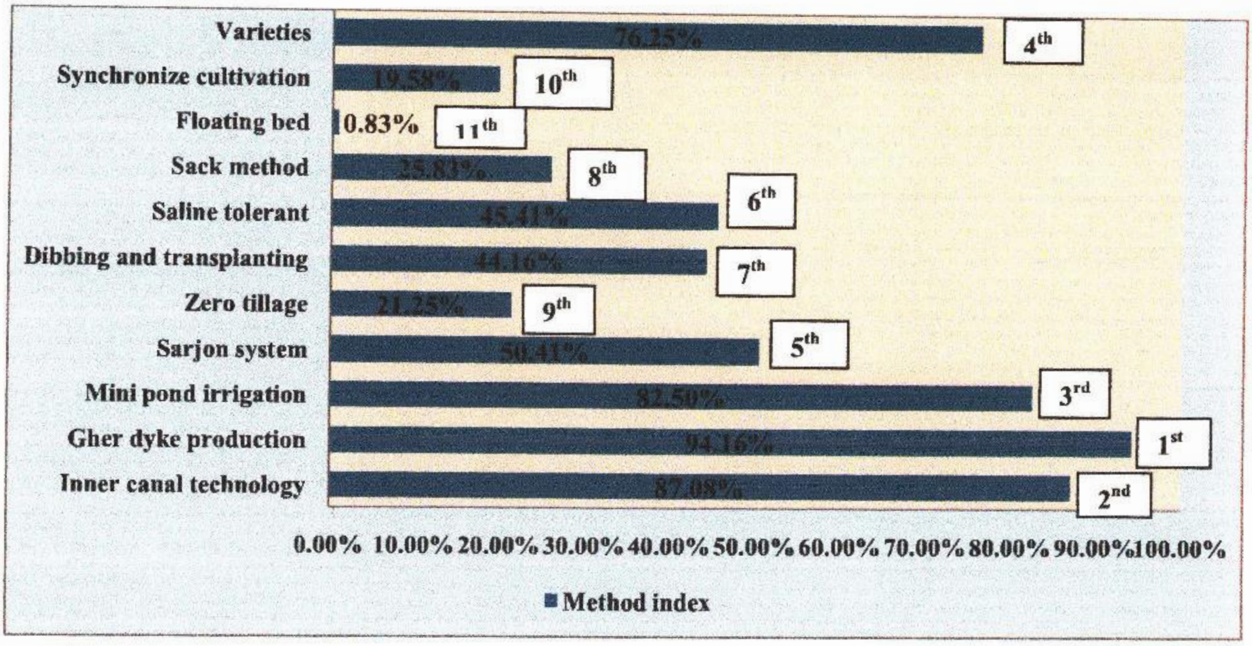

Figure 4.1 Graphical representations of extent of adoption of climate resilient agricultural practices

4.2.2 Distribution of Respondents According to Their Adoption of Climate Resilient Crop Varieties

The adoption scores of the respondents ranged from 0.32-2.34 against with a mean of 0.716 and standard deviation of 0.241. The distribution of farmers according to their extent of adoption of climate resilient crop varieties is shown in Table 4.16.

Table 4.16 Distribution of respondents according to their climate resilient crop varieties adoption

Categories	Scores	Respondents (N=80)		Range		Mean	SD
		Number	Percentage	Min	Max		
Low	<0.47	8	10				
Medium	0.47-0.96	70	87.5	0.32	2.34	0.716	0.241
High	>0.96	2	2.5				
Total		80	100				

Most (87.5 percent) of the respondents showed medium extent of adoption while one tenth (10 percent) of them showed low extent of adoption and a very few (2.5 percent) showed high extent of adoption of climate resilient crop varieties. Majority of the respondents showed medium extent of adoption. That means farmers are gradually adopting climate resilient crop varieties.

4.2.2.1 Identification and Extent of Adoption of Climate Resilient Rice Varieties

Table 4.17 Identification and extent of adoption of climate resilient rice varieties

Sl. No	Rice Varieties	Rice Index	Rank order
01	BRRI *dhan*28	84.48%	1st
02	BRRI *dhan*86	42.75%	11th
03	BRRI *dhan*67	66.99%	9th
04	BRRI *dhan*48	74.2%	5th
05	BRRI *dhan*82	73.58%	7th
06	BRRI *dhan*27	73.97%	6th
07	BRRI *dhan*49	76.56%	2nd
08	BRRI *dhan*72	72.47%	8th
09	BR-10	45%	10th
10	BR-11	76.3%	3rd
11	BR-22	75.47%	4th

From table 4.17 it was found that, the farmers adopted BRRI *dhan*28 mostly (84.48%) followed by BRRI *dhan*49 (76.56%), BR-11 (76.3%), BR-22 (75.47%), BRRI *dhan*48 (74.2%), BRRI *dhan*27 (73.97%), BRRI *dhan*82 (73.58%), BRRI *dhan*72 (72.47%), BRRI *dhan*67 (66.99%), BR-10 (45%) and the extent of adoption of BRRI *dhan*86 was the lowest (42.75%). The graphical representations of extent of adoption of climate resilient rice varieties are shown in (figure 4.2).

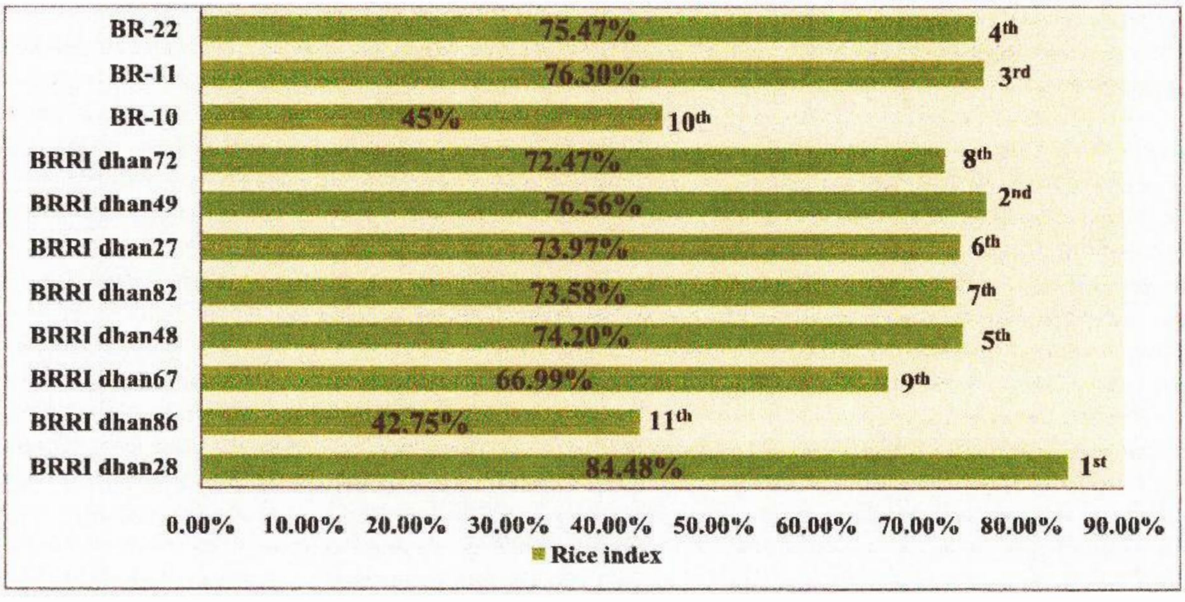

Figure 4.2 Graphical representations of extent of adoption of climate resilient rice varieties

4.2.2.2 Identification and Extent of Adoption of Climate Resilient Vegetable Varieties

Table 4.18 Identification and extent of adoption of climate resilient vegetable varieties

Sl. No	Vegetable varieties	vegetable Index	Rank order
01	BARI *Lau*-1	35.68%	7th
02	BARI *Sita Lau*-1	36.7%	6th
03	BARI *Dherosh*-1	32.57%	9th
04	BARI *sheem*-1	29.03%	12th
05	Epsha *sheem*-1	37.12%	5th
06	Early snowball (Cauliflower)	37.6%	4th
07	Super snowball (Cauliflower)	47%	1st
08	BARI *lal shak*-1	32.23%	11th
09	BARI *Tomato*-2 (*Roton*)	32.25%	10th
10	BARI *borboti*-1	38.19%	3rd
11	BARI *mula*-1	35%	8th
12	BARI *pepe*-1 (*Shahi pepe*)	27.3%	13th
13	BT *begun*	42.15%	2nd

From table 4.18 it was found that, the farmers adopted Super snowball (Cauliflower) in highest proportion (47%) compared to BT *begun* (42.15%), BARI *borboti*-1 (38.19%), Early snowball (Cauliflower) (37.6%), Epsha *sheem*-1 (37.12%), BARI *Sita Lau*-1 (36.7%), BARI *Lau*-1 (35.68%), BARI *mula*-1 (35%), BARI *Dherosh*-1 (32.57%), BARI *Tomato*-2 (*Roton*) (32.25%), BARI *lal shak*-1 (32.23%), BARI *sheem*-1 (29.03%) and the extent of adoption of BARI *pepe*-1 (*Shahi pepe*) was the lowest (27.3%). The graphical representations of extent of adoption of climate resilient vegetable varieties are shown in (figure 4.3).

4.2.3.1 Identification and Extent of Adoption of Climate Resilient Cropping Patterns

Table 4.21 Identification and extent of adoption of climate resilient cropping patterns

Sl.No.	Cropping pattern	Cropping Pattern index	Rank order
1.	Boro-*Gher*(vegetables)-Fallow	34.17%	1st
2.	Fallow-Fallow-T.*Aman*	6.67%	4th
3.	T.*Aman*-Watermelon-Fallow	22.08%	3rd
4.	Boro- Fallow- T. *Aman*	29.17%	2nd

From table 4.21 it was found that, the extent of adoption of Boro-*Gher* (vegetables)-Fallow was in highest proportion (34.17%) while the lower extent of adoption found incase of Fallow-Fallow-T. *Aman* (6.67%). The graphical representations of extent of adoption of climate resilient cropping pattern are shown in (figure 4.5).

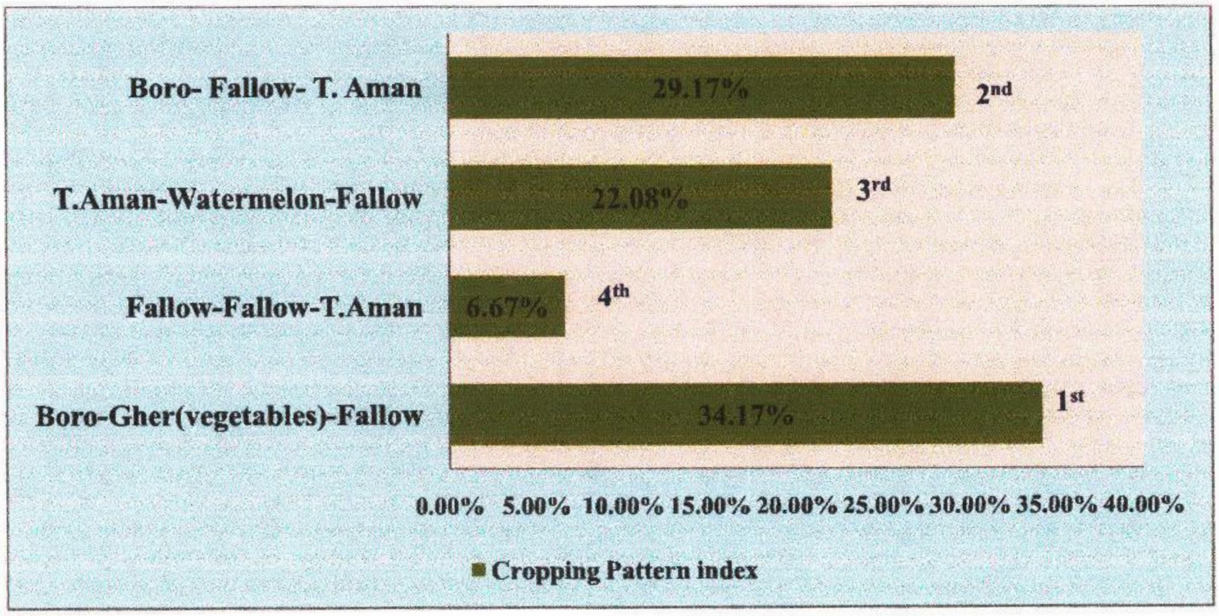

Figure 4.5 Graphical representations of extent of adoption of climate resilient cropping pattern

4.3 The Causes of Adopting Climate Resilient Agricultural Technologies

The farmers of the study area adopted climate resilient agricultural technologies for various causes. Mainly environmental and manmade factors influenced its adoption. The causes of adopting climate resilient agricultural technologies as adopted by the respondent farmers were described in Table 4.22.

Table 4.22 Rank order of the causes of adopting climate resilient agricultural technologies

Sl.No.	Causes	Cause index	Rank order
1.	Increase in cropping intensity	86.5%	1st
2.	Crops are less prone to natural disaster	74.75%	2nd
3.	Lower input cost	70.75%	5th
4.	The Short life climate resilient varieties are adopted highly	60.25%	6th
5.	Climate resilient high yielding cropping patterns	56.75%	7th
6.	The livelihood of people is increasing due to high income from per unit area of land by adopting climate resilient agricultural technologies	73.25%	4th
7.	Neighborhood aspects: Changes in the farming practices and adoption of climate resilient agricultural technologies in the neighboring areas induce other farmers to adopt	73.75%	3rd

The respondents' extent of adoption was tested on the basis of analysis of selected 7 causes, which are detailed out in the methodology chapter in this session the respondents' extent of adoption that analyzed for interpretation and understanding chronologically. Firstly, the causes of adopting climate resilient agricultural technologies and secondly distribution of the respondents according to their extent of adoption were described in this section.

It is very difficult to determine the adoption of climate of climate resilient agricultural technologies of an individual regarding anything because adoption varies from individual to individual. Same thing could be adopted differently/different ways by different individual. However, the respondents were asked to express their adoption by indicating agreement against each of the selected 7 statements related to the causes of adopting climate resilient agricultural technologies and based on the agreements /opinions the respondents were distributed in different categories. An adoption index of all causes for adopting climate resilient agricultural technologies was also calculated. Most (86.50%) of the respondents adopted climate resilient agricultural technologies for increasing cropping intensity followed by crops are less prone to natural disaster (74.75%), neighborhood aspects (73.75%). Climate resilient high yielding cropping pattern (56.75%) was the less important cause for its adoption (Figure 4.6).

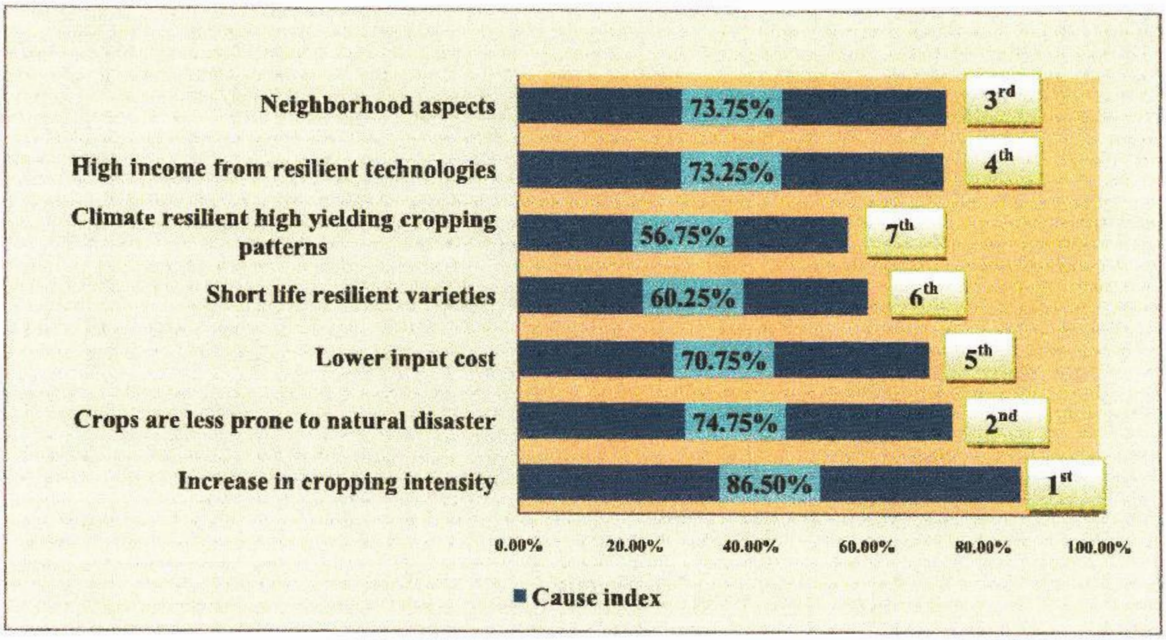

Figure 4.6 Causes of adopting climate resilient agricultural practices by the respondent farmers

Increase in Cropping Intensity

Most (86.5%) of the respondents expressed their strong agreement that they adopted climate resilient cropping patterns for increasing cropping intensity while the remaining respondents expressed simple agreement against that cause. Previously farmers mostly grow low yielding traditional rice varieties only during the monsoon (Aman) season. Most of the lands remain fallow during rabi and aus seasons because of high soil and water salinity and lack of good quality irrigation water. But now-a-days due to adoption of different resilient varieties of vegetables, salt tolerant rice varieties and lodging resistant varieties of crops farmers are able to produce crops round the year and thereby the cropping intensity is increasing.

Karim et. al. (1990) also found the similar result that the adoption of crops and varieties those are more resilient to salinity, submergence/floods or drought and adapted to new climate resilient technologies helps to increase cropping intensity and production.

Crops are Less Prone to Natural Disaster

Climate resilient varieties are more tolerant to salinity, drought, flood and other natural disaster. In the study area it was found that, a majority (74.75%) of the respondents agreed with this cause (BRAC, 2010) reported that, BRAC introduced maize, sunflower, and some vegetables as new crops in areas with limited non-saline water as part of the rehabilitation of SIDR victims and to develop climate resilient agriculture for the coastal regions of

Bangladesh so that the farming communities could face SIDR type cyclones and other disasters because this varieties are less prone to disaster.

Lower Input Cost

Mojority (70.75%) of the respondents in the study area was found to be agreed with this statement. Because the input cost ie, seeds of resilient variety, fertilizers, pesticides, labor cost etc in the study area is not found too high for most of the respondents.

Short Life Cycle of Resilient Varieties

Majority (60.25%) of the respondents expressed their agreement that they adopted climate resilient agricultural technologies for short life cycle of resilient variety. Short duration resilient varieties are introduced in the coastal region of Bangladesh to adjust with the changed climatic conditions. The honorable Minister for Agriculture emphasized that the government would put highest emphasis on southern areas including the coastal belt in the next fiscal year's budget to increase food production (Daily Star, 2010). She told that coastal areas belonged to many untapped prospects and the government will take various steps like, digging canals and introducing saline-tolerant, short duration hybrid crops to increase land productivity of the coastal regions of Bangladesh.

Climate Resilient High Yielding Cropping Patterns

Majority (56.75%) of the respondents in the study area was found to express their simple agreement with this statement. Climate resilient cropping pattern is suggested as an important strategy to cope with risk and uncertainty associated with agriculture due to unpredictable change in climate (Shiyani and Pandya, 1998). Traditional varieties of crops and wrong choice of crop combination makes it more susceptible to salinity, drought, flood, pest and diseases etc.

The Livelihood of People is increasing Due to High Income from Per Unit Area of Land

In the study area it was found that a majority (73.25%) of the respondents agreed to this cause. FAO (2011) cited some examples, such as better management of crop varieties, the adoption of crops and varieties that is more resilient to floods or drought and adapted to new climate resilient agricultural technologies help to increase farmer's income thereby improving the livelihood of the farmers.

Neighborhood Aspects: Changes in the Farming Practices and Crop

Majority (73.75%) of the respondents in the study area found to be agreed with this statement. Changes in the farming practices and climate resilient agricultural technologies in the neighboring areas induce other farmers to adapt to the changes (Mahesh, 1999). However, underlying all these had been the people's attitude to agriculture. For the older generation agriculture was a way of life, while for the present generation it is a commercial activity. The latter therefore utilizes it to earn as much money as possible at the minimum cost and in the shortest time possible.

4.3.1 Distribution of Respondents According to Their Causes of Adoption

The overall adoption scores of the respondents for causes of adopting climate resilient agricultural technologies varied the possible range of 9-30 having an average and standard deviation of 24.51 and 3.13 respectively. Based on the adoption score, the respondents were classified into three categories.

Table 4.23 Distribution of respondents according to their causes of adoption

Categories	Scores	Respondents(N=80)		Range		Mean	SD
		Number	Percentage	Min	Max		
Low number	<21.39	5	6.3				
Medium number	21.39-27.64	61	76.2	9	30	24.51	3.13
High number	>27.64	14	17.5				
Total		80	100				

An overwhelming majority (76.2 percent) showed medium number of causes of adoption while 17.5 percent belonged to high number of causes of adoption and a few (6.3 percent) showed low number of causes of adoption about the causes of adopting climate resilient agricultural technologies (Table 4.23).

4.4 The Problem Confrontation of Adopting Climate Resilient Agricultural Technologies

The respondents were asked to express their opinion by indicating severity against each of the selected 12 statements related to the problems of adopting climate resilient agricultural technologies and based on the opinions, the respondents were distributed in categories.

Table 4.24 Rank order of the Problem Confrontation of Adopting Climate Resilient Agricultural Technologies

Sl.No.	Problems	Problem index	Rank order
1.	Problem of saline soil	89.58%	1st
2.	Jow condition comes late	77.92%	2nd
3.	Unavailability of fresh irrigation water	72.5%	4th
4.	Non availability of inputs in time	67.08%	6th
5.	Difficulty to shift to resilient variety	46.25%	11th

6.	Higher cost of agricultural inputs	57.08%	9th=
7.	Lower yield of resilient variety	32.5%	12th
8.	Shortage of water during Boro season	63.33%	8th
9.	Lack of information about climate resilient agricultural technologies	67.08%	6th=
10.	Lack of information about long term climate change	67.92%	5th
11.	Low price for the produce in the market	57.08%	9th=
12.	Problems of pest and disease	76.25%	3rd

A problem confrontation index of all problems for adopting climate resilient agricultural technologies were also calculated (Table 4.24). All respondents faced mostly the problem of saline soil (89.58%) followed by jow condition comes late (77.92%), problem of pest and diseases (76.25 %), unavailability of fresh irrigation water (72.5%), lack of information about long term climate change (67.92%) and lower yield of resilient variety (32.5%) was the less severe problem faced by the respondents during adoption of climate resilient agricultural technologies (Figure 4.7).

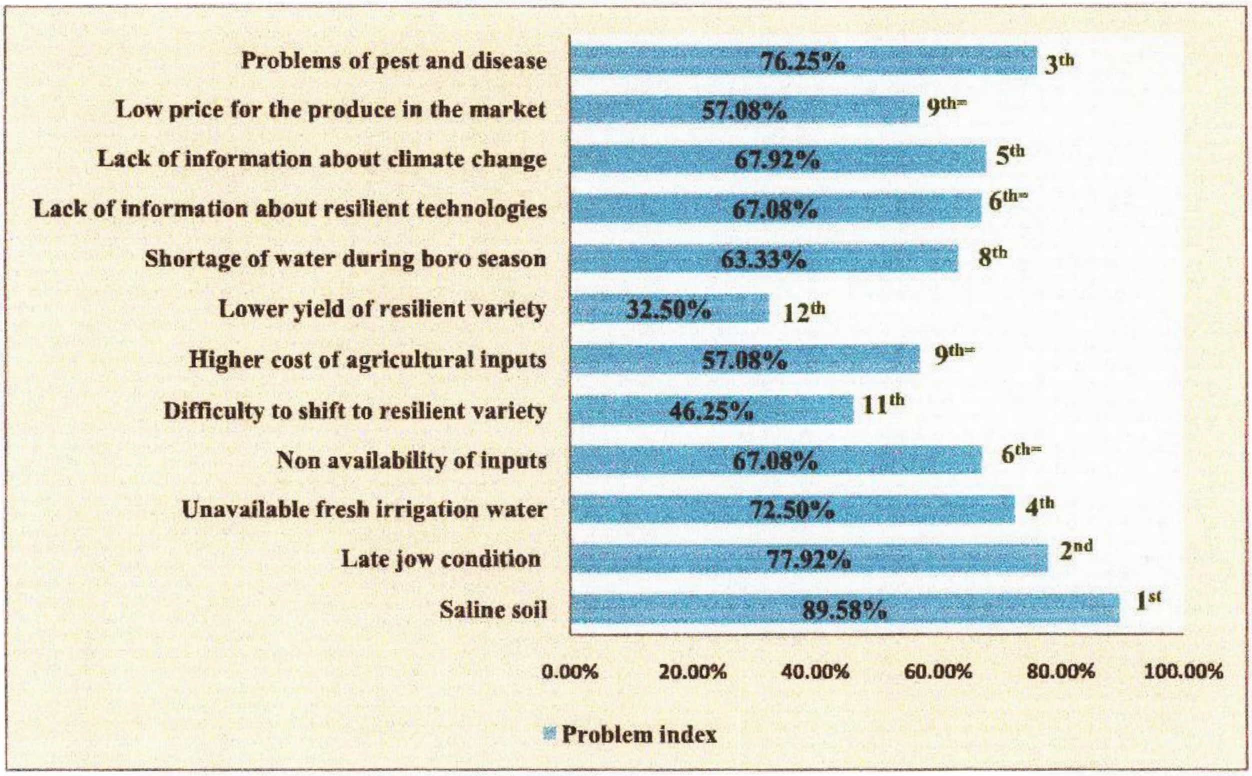

Figure 4.7 Problem confrontation index of adopting climate resilient agricultural technologies

Problem of Saline Soil

Soil salinity is the most dominant limiting factor in the study area especially during the dry season, identified by all of the respondents (89.58%). It affects certain crops at different levels of soil salinity and at critical stages of growth, which reduces yield and in severe cases total yield is lost. A substantial area of land is tidally affected by saline water.

Karim *et el.* (1990) reported that, the effect of salt water intrusion both through surface and ground water had long been recognized as a limiting factor to the sustainable development of agriculture in southern region of the country.

Jow Condition Comes Late

Late arrival of moisture condition in soil is the 2nd most dominant limiting factor in the study area especially during the dry season, identified by all of the respondents (77.92%). It affects certain crops at different levels of critical stages of growth, which reduces yield and in severe cases total yield is lost.

Unavailability of Fresh Irrigation Water

Majority of the respondents (72.5%) in the study area found to identify the problem as highly severe problem. According to the respondents, the main constraint is the scarcity of quality of fresh irrigation water.

Non-Availability of Inputs in Time

Majority of the respondents (67.08%) identified it as medium severe problem in the study area. Some of them told that now-a-days all the inputs like seeds of resilient variety of different crops, fertilizers, pesticides, insecticides etc are available in the market. On the other hand some of them told the opposite. Although sometimes due to high cost of inputs they cannot able to buy it in proper time.

Difficulty to Shift Resilient Variety

Highest proportion of the respondents (46.25%) identified it as low severe problem in the study area (BRAC (2010) reported that although climate resilient agricultural technologies produced higher yield and income than the traditional cropping practices, the farmers could not adopt all the technologies across the coastal regions of Bangladesh mainly due to variation in water salinity and unavailability of sufficient relatively non-saline water for year round crop cultivation.

Higher Cost of the Agricultural Inputs

Majority of the respondents in the study area belonged to low income category (Table 4.24). Higher cost of agricultural inputs is found to be considered as medium severe problem by most of the respondents (57.08%).

O'Brien *et el.*, (2000) reported that despite numerous resilient cropping systems that farmers are aware of and willing to apply, the lack of financial resources to purchase the necessary inputs and other associated equipment's is one of the significant constraints to adaptation.

Lower Yield of Resilient Variety

Highest proportion of the respondents (32.5%) identified it as low severe problem in the study area. According to researchers from Khulna University, stress-tolerant varieties had limitations: they might adapt to more adverse conditions, but the yields will be reduced and incomes will consequently decrease.

Shortage of Water during Boro Season

Majority of the respondents (63.33%) in the study area found to identify it as medium severe problem. According to the respondents, the main constraint is the scarcity of quality irrigation water especially during dry season limits cultivation of Boro rice and Rabi (winter) crops.

Rahman and Ahsan (2011) also found that the major part of this region is affected by different gradient of salinity. The low land use in the region is mainly due to salinity and peculiar hydrology, waterlogging in Kharif II and early Rabi season and lack of quality irrigation water (drought) in Rabi and Kharif I seasons, and tidal storm.

Lack of Information about Climate Resilient Agricultural Technologies

Maority of the respondents (67.08%) identified it as the same medium severe problem as non availability of input in time in the study area.

According to Mandal (2015), a choice of correct combinations of crops or resilient technology can be used as a useful tool to minimize the possible devastations and damages from droughts and floods. Majority of the respondents in the study area showed high experience in agriculture and most of them known about proper crop combination.

Lack of Information about Long Term Climate Change

Majority of the respondents (67.92%) identified it as medium severe problem in the study area. Jones (2003) indicated that, information concerning climate change forecasting, adaptation options and other agricultural production activities remains an important factor affecting use of various adaptation measures for most farmers. Lack of land or limitations in information (seasonal and long-term climate changes and agricultural production) increases high downside risks from failure associated with uptake of new technologies and adaptation measures.

4.5.3 Relationship between the selected characteristics of the respondent farmers and their adoption of climate resilient cropping pattern

Incase of the correlation between the selected characteristics of the respondent farmers and their adoption of climate resilient cropping pattern, Table 4.26 revealed that level of education, farming experience, resilient technology adopting experience, farm size, annual family income, cosmopolitanism, innovativeness, extension contact, training, knowledge, causes and climate resilient technologies was positively correlated with the adoption of climate resilient cropping pattern.

Hossain (2003), Rahman (2001) and Hussen (2001) found the similar result that, farmers' education showed a positive significant relationship with their adoption. Sardar (2002), and Hussen (2001) found that farm size of the farmers showed a positive significant relationship with their adoption. But Aurangozeb (2002) found no relationship with farm size. Hussen (2001), Rahman (2001) found that, income showed a positive significant relationship with their adoption. But Sardar (2002) Islam (2001) found no relationship with income. Aurangozeb (2002) found that the Innovativeness of the farmers showed significant relationship with their causes of adoption. But Rahman (2003) found that the innovativeness of the farmers showed no significant relationship with their adoption. Hossain (2006), Haque (2005), Sardar (2002), Hussen (2001) and Rahman (2001) showed positive significant relationship with their adoption. But Islam (2002) found no significant relationship. Reza (2007), Hossain (2006), Miajy (2005) found that the agricultural knowledge of the farmers showed significant relationship with their adoption.

Whereas age, family size, and attitude showed no-significant relationship with the adoption of climate resilient cropping pattern. On the other hand, problems confrontation was negatively correlated with the adoption of climate resilient cropping pattern.

Rahman (2001), (Podder 1999) and Islam (1996) found similar findings with age. Mustafa *et el.* (1999) and Islam (1993) also found similar findings with family size.

Based on the previous findings it could be concluded that, thus the present study showed consistency.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMENDATIONS

This chapter summarizes the study background, introduction, methodology, results and discussions of the studies. Based on these summaries, some logical conclusions and recommendations are put forward below.

5.1 Summary

Agriculture is the back bone for Bangladesh economy. The percentage of agricultural contribution in the national economy is 17%, (around 50 billion USD). During the past five decades the agriculture sector in southwestern region of Bangladesh undergone wide-ranging changes in terms of ownership of land, climate resilient agricultural technologies, cropping pattern, cultivation practices, productivity, and intensity of cultivation. The main objectives of the study was to identify climate resilient agricultural technologies those are adopted by the farmers, to determine the extent of adoption of climate resilient agricultural practices, crop varieties and cropping patterns, to identify causes and problems in adopting climate resilient agricultural technologies adopted by the farmers, to analyze the selected characteristics of the farmers and to explore relationship between the selected characteristics of the farmers and their extent of adoption of climate resilient agricultural practices, crop varieties and cropping patterns. To fulfill the objectives data were collected from randomly selected 80 farmers of five villages of Dumuria upazila under Khulna district, from 13th to 25th January, 2022 by the researcher herself by using a structured personal interview schedule (Appendix A) through face to face method. After completion the field survey and data analysis the following results could be found.

In the study, three approaches were used. A statistical survey to identify the adoption of - 1) climate resilient agricultural practices, 2) climate resilient crop varieties and 3) climate resilient cropping patterns in the study area adopted by the respondent farmers.

5.1.1 Major Findings

5.1.1.1 Selected Characteristics of the Respondents

Highest proportion (47.5 percent) of the respondents was middle-aged category compared to young aged (28.7 percent) and old aged (23.8 percent). Highest proportion (48.8 percent) of the respondents belonged to the secondary level of education category while 27.5 percent, 12.5 percent, 5 percent and 6.3 percent of the farmers belonged to primary level, higher secondary level, above higher secondary level and illiterate categories respectively. Highest proportion (43.8 percent) of the respondents belonged to the small size family while 35 percent and 21.2 percent of the respondents belonged to medium size family and large size family respectively. Majority (67.5 percent) of the respondents possessed small farm size while 12 percent and 16.3 percent belonged to marginal and medium farm respectively, 1.3 percent of them possessed large farm and no farmer are landless. Majority (52.5 percent) of the respondents belonged to low income (≤150000 BDT) whereas 40 percent belonged to medium income (151000-300000 BDT) and 7.5 percent respondents showed high income (>300000 BDT) category.

Majority (62.5 percent) of the respondents belonged to medium farming experience followed by 33.8 percent belonged to high farming experiences and 3.8 percent showed low farming experience. Majority (51.2 percent) of the respondents showed medium experience of adopting climate resilient technologies whereas 18.8 percent and 30 percent showed low experience and high experience respectively. Majority 52.5 percent and 27.5 percent of the respondents belonged to early adopter and early majority categories respectively while 5 percent were innovators, 3.8 percent were late majority and 11.3 percent of the farmers were laggard.

Majority (68.7 percent) of the farmers belonged to low extension contact compared to 27.5 percent and 3.8 percent of the respondents possessed medium and high extension contact respectively. Most (85 percent) of the respondents showed low cosmopolitanism followed by medium cosmopolitanism 11.3 percent and high cosmopolitanism 3.8 percent of the respondents. Highest proportion (33.8 percent) of the respondents belonged to medium training exposure whereas similar percent (31.3) respondents belonged to the no training and low training exposure. On the other hand, 3.8 percent of the respondents belonged to high training exposure.

Majority (63.7 percent) of the respondents showed medium knowledge about climate resilient agricultural technologies and 15 percent showed low knowledge whereas 21.3 percent showed high knowledge about climate resilient agricultural technologies. Most (85 percent) of the respondents possessed highly favorable attitudes towards adopting of climate resilient agricultural technologies compared to very highly favorable attitude (8.8 percent) towards adopting of climate resilient agricultural technologies.

5.1.1.2 Identification of Climate Resilient Agricultural Practices and Their Extent of Adoption

Among 11 climate resilient agricultural practices the respondents adopted *gher* dyke vegetable production mostly (94.16%) and less adopted floating bed vegetable production (0.83%). Overall findings showed that majority (66.3 percent) of the respondents showed medium extent of adoption while 12.5 percent and 21.3 percent of the respondents showed high extent of adoption and low extent of adoption respectively.

5.1.1.3 Identification of Climate Resilient Crop Varieties and Their Extent of Adoption

Among 32 climate resilient crop varieties 11, 13 and 8 varieties were rice, vegetables and fruits respectively. In the case of rice, vegetables and fruit varieties the highest extent of adoption was observed regarding BRRI*dhan*28 (84.48%), Super snowball (Cauliflower) (47%) and BARI *tormuj*-2 (34.54%) respectively while the lowest extent of adoption was observed regarding BRRI*dhan*86 (42.75%), BARI *pepe*-1 (*Shahi pepe*) (27.3%), BARI *sofeda*-2 (12.5%) and BARI *kathal*-1 (12.5%) respectively. The overall findings revealed that most (87.5 percent) of the respondents showed medium extent of adoption while one tenth (10 percent) of them showed low extent of adoption and a very few (2.5 percent) showed high extent of adoption of climate resilient crop varieties.

5.1.1.4 Identification of Climate Resilient Cropping Pattern and Their Extent of Adoption

Among 4 climate resilient cropping patterns, the extent of adoption of Boro-*Gher* (vegetables)-Fallow was in highest proportion (34.17%) while the lower extent of adoption found incase of Fallow-Fallow-T. *Aman* (6.67%). The overall findings showed that majority (58.8 percent) of the respondents possessed medium extent of adoption, 21.2 percent of the respondents showed high extent of adoption whereas 20 percent of them showed low extent of adoption in relation to climate resilient cropping patterns.

5.1.1.5 Causes of Adopting Climate Resilient Agricultural Technologies Adopted By the Farmers

Among 7 causes of adoption, most (86.50%) of the respondents adopted climate resilient agricultural technologies because of increasing cropping intensity and climate resilient high yielding cropping pattern (56.75%) was the less important cause in adopting climate resilient agricultural technologies. Overall findings revealed that an overwhelming majority (76.2 percent) possessed medium number of causes for adoption while 17.5 percent possessed high number of causes for adoption and a few (6.3 percent) possessed low number of causes for adoption about the causes of adopting climate resilient agricultural technologies.

5.1.1.6 Problems Confronted in Adopting Climate Resilient Agricultural Technologies

Among 12 problems the respondents faced mostly the problem of saline soil (89.58 percent) and lower yield of resilient variety (32.5 percent) was the less severe problem faced by the respondents during adoption of climate resilient agricultural technologies. The overall findings revealed that majority (70 percent) of the respondents found to face medium problem and the rest (18.8 percent) and (11.2 percent) found to face high and low problem respectively during adopting climate resilient agricultural technologies.

5.1.1.7 Relationships between the Selected Characteristics of the Respondent Farmers and Their Adoption in Climate Resilient Agricultural Practices, Crop Varieties and Cropping Patterns Respectively

To test the relationship between the selected characteristics of the respondents with their adoption, Pearson's product correlation coefficient was employed (at 1% and 5% level of significance).

Among 13- selected characteristics of the respondent farmers level of education, experience in adoption of resilient technology, farm size, annual family income, cosmopolitanism, innovativeness, extension contact, training and knowledge was positively correlated with both of the adoption of climate resilient agricultural practices and cropping patterns, but none of the selected characteristics of the respondents showed any significant relationship with their extent of adoption of climate resilient crop varieties.

Finally, it could be noted down that 11 climate resilient agricultural technologies, 32 climate resilient crop varieties and 4 climate resilient cropping patterns were adopted by the respondent farmers with different extent of adoption in the study area.

5.2 Conclusions

Majority (66.3% and 58.8%) of the respondents showed medium adoption behavior regarding climate resilient agricultural agricultural practices and climate resilient cropping patterns respectively. While most (87.5%) of them showed same (medium) adoption behavior regarding climate resilient crop varieties.

Most (86.50%) of the respondents adopted climate resilient agricultural technologies because of increasing cropping intensity followed by crops are less prone to natural disaster (74.75%), neighborhood aspects (73.75%).

All the respondents faced most severely the problem of saline soil (89.58%) followed by moisture condition comes late (77.92%), problem of pest and diseases (76.25 %).

5.3 Recommendations

Recommendations have been divided into two sub sections, viz. recommendation for policy implication and recommendation for the further research. Based on the findings and conclusion of the study the following recommendation for policy implications are presented below:

5.3.1 Recommendations for Policy Implication

a) The findings of the study may provide information to the extension workers for understanding the factors which accelerating or hindering the adoption of climate resilient agricultural technologies.

b) The findings of the study may also provide important inputs, useful insights and guidelines for planners and policy-makers to develop a viable plan for climate resilient agricultural technologies in Khulna district as well as other parts of the country.

5.3.2 Recommendation for Further Research

The results of the present study prove the need for further inquiry in other directions. The following suggestions are made for the further researches who undertake similar studies.

a) Researches of similar nature are suggested to conduct covering more areas of the district as well as other parts of the country to have more comprehensive idea about the causes and problems faced by the farmers during adopting climate resilient agricultural technologies.

b) Field level agronomic research is suggested to carry out for studying the impact of the adoption of climate resilient agricultural technologies.

c) Physiological, soil and environmental researches should be conducted to study the causes of adopting climate resilient agricultural technologies.

d) Feasibility of the intervening response of improved technologies to mitigate the problems faced by the farmers during adopting climate resilient agricultural technologies may be studied and their implications to assessed with utmost care.

CHAPTER VI

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7.	Agriculture related book/magazine				
8.	Krishi Mela				
9.	Krishi Katha				
10.	Shomprosharon Barta				

8. Innovativeness:

Kindly furnish your innovativeness by putting (✓) against the following with which you are agree:

Sl. No.	Statement	Tick mark
01.	As soon as it come to my knowledge, I have adopted the innovation	
02.	Having seen the success of others, I have adopted the innovation	
03.	I adopt technology to see my peers who have already adopt technology	
04.	I adopt technology by the pressure of my peers group	
05.	I prefer to wait before adoption of innovation	

9. Cosmopoliteness: Please state your frequency of visits outside your town or village:

Sl No	Place of visit	Frequency of visit			
		Frequently (3)	Occasionally (2)	Rarely(1)	Not at all(0)
1.	Other village				
2.	Other union				
3.	Own Upazilla Sadar				
4.	Other Upazilla Sadar				
5.	Own District Sadar				
6.	Other District Sadar				
7.	City (Khulna)				
8.	Other cities (Dhaka, Chittagong, Rajshahi, Barisal, Mymensingh, Sylhet, Rangpur)				

10. The causes of adopting climate resilient agricultural technologies that you think are:

Sl. No	Statements	Perception				
		Strongly agree (5)	Agree (4)	Undecided (3)	Disagree (2)	Strongly disagree (1)
1.	Increase in cropping intensity					
2.	Crops are less prone to natural disaster					
3.	Lower input cost					
4.	The Short life climate resilient varieties are adopted highly					
5.	Climate resilient high yielding cropping patterns					
6.	The livelihood of people is increasing due to high income from per unit area of land by adopting climate resilient agricultural technologies					
7.	Neighborhood aspects: Changes in the farming practices and adoption of climate resilient agricultural					

	technologies in the neighboring areas induce other farmers to adopt					

11. Problems confrontation of the farmers during adopting different climate resilient agricultural technologies that you think are:

Sl. No	Problem confrontation	Severity of problem			
		Highly severe problem (3)	Medium severe problem (2)	Less severe problem (1)	Not at all problem (0)
1.	Problem of saline soil				
2.	Jow condition comes late				
3.	Unavailability of fresh irrigation water				
4.	Non availability of inputs in time				
5.	Difficulty to shift to resilient variety				
6.	Higher cost of agricultural inputs				
7.	Lower yield of resilient variety				
8.	Shortage of water during boro season				
9.	Lack of information about climate resilient agricultural technologies				
10.	Lack of information about long term climate change,				
11.	Low price for the produce in the market				
12.	Problems of pest and disease				

12. Training:

Have you received any training? **A) Yes** **B) No**

If yes, please mention the name of the training with duration you have received from different organization:

No.	Title of Training	Duration	Organization	Venue of Training

13. The Knowledge Level of Farmers about Climate Resilient Agricultural Technologies:

Sl. No	Statement	Mark Assign (2)	Obtain Mark
1.	Name of three Rabi, Kharif-I and Kharif-II crops		
2.	Name of two climate resilient agricultural technologies		
3.	Which crop is preferable between water melon and dragon fruit?		
4.	Which variety is more suitable between BRRI*dhan*67 and BRRI*dhan*87?		
5.	Which variety provide good yield between BRRI*dhan*28 and BRRI*dhan*48?		
6.	Which crops do you produce in Rabi, Kharif-I and Kharif-II season?		
7.	Which crops did you produce before 5 years ago in those seasons?		
8.	Which technology require less production cost between sarjon system and crop production through inner canal technology?		

	a)Seed, b) Fertilizer, c) Irrigation, d) Intercultural operations		

14. Attitude of Farmers about Climate Resilient Agricultural Technologies:

Sl. No	Statement	Strongly Agree (5)	Agree (4)	Undecided (3)	Disagree (2)	Strongly Disagree (1)
1.	Climate resilient agricultural technologies in south coastal region are available					
2.	The recommended climate resilient agricultural technologies are suitable for south coastal area					
3.	Climate resilient agricultural technologies play an important role in agricultural production					
4.	These provide good yield					
5.	These technologies are cost effective					
6.	Climate resilient crops are safe for health					
7.	Market price of climate resilient agricultural technologies are high					
8.	Nutritional quality of climate resilient agricultural crops are high					
9.	The yield and production of climate resilient agricultural crops are satisfactory					
10.	Water requirement for climate resilient varieties is low compared to other varieties					
11.	Cultivation method of climate resilient agricultural crops are easier					
12.	Government support to adopt climate resilient agricultural technologies is sufficient					
13.	There is a need of training facilities for farmer regarding climate resilient agricultural technologies					

15. Extent of adoption of different climate resilient agricultural practices :

Climate Resilient Technologies	Extent of Adoption			
	Yes			Not at All Adopted (0)
	Highly Adopted(3)	Sometimes Adopted(2)	Rarely Adopted(1)	
1) Crop production through inner canal technology				
2) *Gher* dyke vegetable production				
3) Mini pond irrigation				
4) Sarjon system				
5) Zero tillage				
6) Dibbing and transplanting				
7) Saline tolerant crop production				
8) Vegetable production through sack method				

9) Floating bed vegetable				
10) Synchronize cultivation				
11)Varieties				

16. Extent of adoption of different climate resilient crop varieties: Planning indicates the potential as well as actual areas under different climate resilient agricultural crop varieties:

SL No	Crops		Extent of adoption		Remark
			Potential area (ha)	Actual area(ha)	
	Seasons	**Crops**			
1.	**a) Aus**	**Rice varieties:** BRRI*dhan*28 BRRI*dhan*50 BRRI*dhan*58 BRRI*dhan*67 BRRI*dhan*81 BRRI*dhan*84 BRRI*dhan*86 BRRI*dhan*88 BRRI*dhan*92			
	b) Rabi	**Vegetable varieties:** BARI *Lau*-1 BARI *Sita Lau*-1 BARI *dheros*-1 BARI *sheem*-1 Epsha *sheem* 1 Early snowball (Cauliflower) Super snowball BARI *lal shak*-1 BARI *totato* 2 (*Roton*) BARI *borboti*-1 BARI *mula*-1 BARI *pepe*-1 BT *begun* **Fruit Varieties:** None			
2.	**a) Aman**	**Rice varieties:** BRRI*dhan*27 BRRI*dhan*48 BRRI*dhan*82			
	b) Kharif-I	**Vegetable varieties:** BARI *Lau*-1 BARI *Sita Lau*-1 BARI *dheros*-1 Epsha *sheem* 1 BARI *lal shak*-1 BARI *borboti*-1			