Adaptive Capacity of Rural Farmers Towards Climate Variability: Role of Mobile-enablebWeather Information Systems

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DECEMBER, 2020

Adaptive Capacity of Rural Farmers Towards Climate Variability: Role of Mobile-enabled Weather Information Systems

by

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Registration No. 18-09208

A Thesis

Submitted to the Faculty of Agriculture,
Sher-e-Bangla Agricultural University, Dhaka
In partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE
IN
AGRICULTURAL ENTENSION
SEMESTER: July-December, 2020
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ACKNOWLEDGEMENTS

All praises, thanks and gratitude are due to the Supreme Ruler of the Universe, the Almighty Allah for his grace bestowed upon the author for accomplishing this research Study. With boundless love and appreciation to all who helped him bring this study into Reality.

At first, I feel proud to express my deepest respect, sincere appreciation and immense indebtedness to my supervisor, **Prof. Dr. Md. Rafiquel Islam**, Department of Agricultural Extension and Information System, Sher-e-Bangla Agricultural University, Dhaka, for his scholastic and continuous guidance during the entire period of course, research work and preparation of this thesis.

Second, I express my gratitude, best respects and significant obligation to my co-supervisor, **Md. Mahbubul Alam, PhD**, Professor, Department of Agricultural Extension and Information System, Sher-e-Bangla Agricultural University, Dhaka, without whom I would not have been able to come this far. He did not only supervise this thesis but also guide me immensely to successfully accomplish this research work.

I am glad to stretch out my heartfelt thanks on account of the considerable number of resources of the Department of Agricultural Extension and Information System, SAU, for their important instructions, recommendations and consolation amid the time of the examination. I would like to extend my appreciations to **Mahfuz Ahmed,** cheif of water management of Bangladesh, who helped me much for the collection of my data. I am happy to extend my heartfelt thanks to Amalesh Chandro Roy, Deputy Chief Extension Officer of Rangpur, BWDB for their assistance during my data collection period.

To wrap things up, I might want to express my genuine gratefulness to **Raju ahmed** and my husband, my soul children and the greater part of my well-wishers.

The Author

Dedicated
to My
Beloved Parents
&
Lovely Children

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CERTIFICATE

This is to certify that the thesis entitled. **"Adaptive Capacity of Rural Farmers Towards Climate Variability: Role of Mobile-enabled Weather Information Systems"** submitted to the faculty of agriculture, Sher-e-Bangla Agricultural University, Dhaka in partial fulfilment of the requirements for the degree of **Master of Science (MS) in Agricultural Extension & Information System**, embodies the result of a piece of bona-fide research work conducted by **MORSHED REHANA PARVIN**, **Registration No. 18-09208,** under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information, received during the course of this study has been dully acknowledgement by her.

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ABSTRACT

The key concern of this study was to explore the extent of farmers perceived adaptive capacity enhancement through mobile-enable weather information systems (here, BAMIS). Four villages of Gangachara upazila under Rangpur district were randomly selected as the locale of the study. Out of 1368 farmers 114 farmers were selected as the sample of this study. Data for this study were collected through personal interview by the researcher herself during February 5 to March 16, 2020 using structured interview schedule and analyzed by multiple regression analysis using SPSS v23. Age, level of education, farming experience, extension contact, duration of training, media ownership, extent of use of information sources towards weather events, content appropriateness and knowledge on weather events were considered as independent variables while farmers' perceived adaptive capacity towards climate variability was considered as dependent variable of the study. An overwhelming majority (43.9%) of the respondents old aged, 40.4% of the respondents had regular extension media contact about farming activities related to weather events and 68.45% of the respondents had medium farming experience. Among the farmers, all respondents had self-access to feature phone and 99.1% of the respondents had self-access to smart phone. A less than half of the respondents (43.0%) had full access to the Internet while 57.0% had no access to the Internet. Furthermore, 92.1% of the respondent's were found satisfied with content appropriateness of weather-related events through BAMIS. Farming experience, extension contact, media ownership and content appropriateness had positive and significant contribution to the extent of adaptive capacity towards climatic variability through BAMIS which constitutes 42.6% (R^2= 0.426) of the variance. This study also noticed that respondents' extension contact, media ownership and content appropriateness had also positive contribution (at 1% level of significance). Thus, the study concludes with the recommendation to enable favorable environment to promote handheld communication devices for weather related apps (BAMIS / BMD) in receiving weather related information for their farming and livelihoods.

CHAPTER I

INTRODUCTION

1.1 General Background

Bangladesh is one of the most vulnerable countries in the world to climate risks and natural disasters (Agrawala et al., 2003). The location of the country is in low-lying floodplains at the confluence of three mighty Asian rivers, the Brahmaputra, the Ganges and Climate change the Meghna along with their numerous tributaries (World Bank, 2010). Because of this natural geographic design, the country faces severe floods on a regular basis. The floods of 1974, 1984, 1987, 1988 and 1991 were most destructive and caused loss of human lives and serious damage to agricultural production (Agrawala et al., 2003). Besides, its position between the funnel-shaped Bay of Bengal in the south and the world's highest mountain Himalayas in the north has made the country a place of intensive monsoon rainfalls, cyclones, floods, storm surges etc. (Ferdous and Baten, 2011). After the catastrophic cyclones of 1970 and 1991, cyclone Sidr of 2007, for example, was among the most devastating disasters in recent years. It caused a loss of 3,295 lives and destroyed approximately 1.5 million households and 2.2 million hectares of cropland. The total damage was estimated at about US$1.67bn (IFRC, 2010). It has been projected that country will experience more frequent and natural disasters in near future due to climate change (IPCC, 2007).

A sharp rise in temperature and changes in rainfall patterns are already evident in Bangladesh (Shahid, 2010; Shahid et al., 2012). The average daily temperature in Bangladesh has increased by 0.103°C per decade over the past four decades (Shahid, 2010). There have also been reports of changes in spatial variability and seasonal pattern in rainfall (Shahid and Khairulmaini, 2009). The projections say that temperature of Bangladesh will continue to increase by 1°C by 2030, 1.4°C by 2050 and 2.4°C by 2100 due to global warming (IPCC, 2007). Rising temperature will enhance evapotranspiration and air moisture holding capacity which in turn will change the annual and seasonal variability of rainfall and their spatial distributions. Such changes in climate can have severe impacts in an agro-based country like Bangladesh, where more than 55 per cent of the total population directly depends on agriculture, and 12.65 per cent of the gross domestic product (GDP) comes from this sector (BBS, 2020). Crop farming is the primary source of food for 149.77 million people and accountable for food security both in urban and rural populations (BBS, 2015).

Adaptation to climate change can be expressed as a fine-tuning with ecological, economic and social systems in response to observed or expected changes in climatic stimulus and their effects (IPCC, 2007). Moreover, adaptation can also explain as a set of approaches and actions taken by human in anticipation to the changing climate. Adaptation is a constant activities, performance, choice and approaches that report to decisions about all aspects of life and that reflects existing social norms and processes (Daw *et al.,* 2008). The adaptation is a great deal toward the minimizing the impact of climate change and as quick as needed in the present time. For example, remote sensing techniques have been used for environmental monitoring purposes, decision support tools and information and advisory system have been designed to guide users in the planning and implementing adaptation processes.

There are two main practices of adaptation; autonomous and planned adaptation. The autonomous adaptation is mainly triggered by ecological changes in natural systems whereas planned adaptation is the result of a deliberate policy decision, creation of awareness and applying tools of adaptation (IPCC, 2007). There is an important need to compare the cost and benefits of adaptation strategies for making equilibrium among the society. Further, if adaptation to climate change could be carried out at negligible cost then it may be less expensive, at least in the short-term, than any alternate strategy (Sathaya, *et al.,* 2006). The task of adaptation requires wide spread knowledge, awareness and coordination between scientific communities and people facing climate effect. The factual impact of climate change is difficult to predict that becomes even more complex in case of diverse agro-ecological regions like Bangladesh.

Sharing of information of adaptation to the people involve in agriculture might be a method for success, yet the question remains the same on how to disseminate the techniques and technology to the target beneficiaries. In this context, Information Communication Technologies (ICT) is being helpful to disseminate the knowledge of adaptation for fighting against climate change.

The ICTs could find a new role in the changing economic and social organization as enabler for networked governance. The new forms of economic and social organization and decision-making that will likely be needed not only to adapt to climate change, but to achieve sustainable development. Understanding local situation, the ecosystem itself and its social and cultural environment is very much important if adaptation interventions are to be successful. ICT for climate change adaptation may help in developing information systems that are better able to reflect households' access to agro-climatic events well in advance. ICTs could prove to be a great asset in developing early warning and hazard risks associated with climate change.

Despite the susceptibility of Bangladesh to weather and climate extremes, the country's hydro-meteorological information, early warning and seasonal advisory related information is beyond to reach the farmer. There is an opportunity to provide reliable agro-meteorological information to farming community effectively. This sort of information is highly important for sustainable agricultural development yet this information should disseminate in a way that to the farmers can understand it and use in planing their farming activities more efficiently.

World Metrological Organization (WMO) had organized a technical seminar back in 2012 regarding climate services in Bangladesh. This seminar identified three key areas to develop and disseminate agro-meteorological services to Bangladeshi farming community. These were: i) development of agro-meteorological observation by joint collaboration of meteorologist and agriculturist in order to, provide medium and long term seasonal forecast and advisories; ii) development of timely and rapid dissemination mechanism to deliver reliable agro-meteorological services; iii) capacity building of all stakeholders to use agro-meteorological information by training and developing a feedback mechanism from the end users. According to the suggestion of WMO and with the financial support of The World Bank, Bangladesh Weather and Climate Services Regional Project (BWCSRP) was approved by the Government of Bangladesh in February 2017. Bangladesh Meteorological Department (BMD), Bangladesh Water Development Board (BWDB) and Department of Agricultural Extension (DAE) have been jointly implementing this project. On the consequence, DAE under the Ministry of Agriculture (MoA) is implementing "Bangladesh Agro-Meteorological Information Systems"(BAMIS,2019) development Project throughout the country.

BAMIS developed a dynamic web portal with a view to disseminate agro-meteorological services and other related information to the different users, particularly to the farmers. It accumulates meteorological data from BMD and hydrological data from BWDB in BAMIS portal. After being translated and validated by the DAE's Agro-met Technical Committee the information disseminates to the targeted lead farmers. They then will be linked it to other relevant stakeholders. Besides, any users can find information using BAMIS web portal or apps.

Climate change adaptation also demands emergent actions that cannot be foreseen in advance, and which require the development of communities more as self-organizing systems. This will require ICTs to be transformational as much as informational, developing collective as much as individual capacities. As yet, though, signs of self-organization through mobile-based applications appear limited.

Considering the vulnerability and sensitivity of Bangladeshi agriculture sector to climate change, the researcher intended to take an attempt to understand about the role of Mobile-enabled weather information systems to build adaptive capacity of rural poor towards climate variability. Viewing and analyzing the aforesaid conditions the researcher has become interested to undertake a research entitled "Adaptive Capacity of Rural Farmer towards Climate Variability: Role of Mobile-enabled Weather Information Systems".

1.2 Statement of the Problem

Adaptation strategies are activities that reduce the negative effects of climatic variability and/or takes advantage of new opportunities that may be presented which includes activities that are taken before impacts are observed (anticipatory) and after impacts have been felt (reactive) (Mcdowell and Heiss, 2012). Adaptation in agriculture is how perception of climate change is translated into the agricultural decision-making process (Bryant et al., 2000). Farmers have experienced that climate change and variability like salinity, flood, drought, etc. have directly affected the agriculture sector, especially in crop production. That situation led the people to take adaptation strategies to mitigate the risk. Adaptation can be a specific action like a farmer changing crops, a systemic change like diversifying livelihoods or an institutional reform like changing resource management practices. It can also denote the whole process, including learning about risks, evaluating response strategies, mobilizing resources, implementing adaptations and revising choices with new learning (Leary et al. 2008). The study also aimed at finding out those factors, which facilitated adaptive capacity towards climatic variability. The purpose of this study was to have answers to the following research questions:

- ✓ To what extent farmers are able to build their adaptive capacity using BAMIS?
- ✓ What are the selected factors drivers that influence farmers to use or continue use of BAMIS for their farming and livelihoods?
- ✓ Is there any influence of the selected drivers to farmers' use or continue use of BAMIS application for their farming and livelihoods?

1.3 Objectives of the Study

The following specific objectives were set forth in order to proper direction to the study:

i. To determine the extent of farmers perceived adaptive capacity through BAMIS;

ii. To describe the drivers that influence farmers' use or continue use of BAMIS for their farming and livelihoods;

iii. To explore the contribution of the selected drivers to farmers perceived adaptive capacity of rural farmers towards climate variability through BAMIS.

1.4 Justification of the Study

Climate change adaptation is a process by which "strategies to moderate, cope with and take advantage of the consequences of climate events are developed and implemented. Knowledge and information play key role in overcoming such constraints and are pivotal for building and strengthening the capacity of multiple stakeholders involved in adaptation. Internet- based applications, mobile phone, telecentre, community radio, etc. that are increasingly available in developing regions provide an exceptional opportunity to improve the creation, management, exchange and application of relevant climate information and knowledge. They should also be recognized for their productive and transformative capabilities. Faced with the unprecedented challenges posed by climate change, developing countries are starting to address the need to adjust and adapt to new, and often uncertain climatic conditions. BAMIS has been introduced with an aim to inform farmers about weather- events so that they may adopt measures in minimizing negative impacts of weather variability on their farming and livelihoods. However, no study has so far been conducted on its effectiveness. Therefore, this study to investigate to what extent farmers are able to improve their adaptive capacity with the help of BAMIS.

1.5 Scope of the Study

The main focus of the study was building adaptive capacity of rural farmers towards climate variability. The findings of the study will be specifically applicable to Rangpur district. However, the findings will also have implications for other areas of the country having relevance to the socio-cultural context of the study area. The investigator believes that the findings of the study will reveal the phenomenon related to diffusion of innovation. These will be of special interest to the policy makers and planners in formulating and redesigning the extension programs especially for climate smart agriculture. The findings are expected to be helpful to the field workers of different nation building departments and organizations to develope appropriate extension strategies for effective working with the rural people.

1.6 Assumptions of the Study

The researcher had considered the following assumption while undertaking the study:

- ✓ The respondents included in the sample were capable of furnishing proper responses to the questions included in the interview schedule.

- ✓ The responses furnished by the respondents were reliable. They express the truth while passing their opinions and providing information.

- ✓ The views and opinions furnished by the rural farmers included in the sample were the representative views and opinions of all the rural people of the study.

- ✓ The researcher who acted as interviewer was well adjusted to the social and cultural environment of the study area. Hence, the respondents furnished their correct opinions without hesitation.

- ✓ Data were normally and independently distributed with their means and standard deviation.

- ✓ The findings of the study will have general applications to other parts of the country with similar personal, socio-economic and cultural conditions.

1.7 Limitations of the Study

Considering the time, respondents, communication facilities and other necessary resources and to make the study manageable and meaningful, it became necessary to impose certain limitations below:-

- ✓ The study was confined to Gangachara upazilla in Rangpur district.
- ✓ Population for the present study was kept confined within the heads of families in the study area.
- ✓ There were many characteristics of the farmers in the study area but only 9 of them were selected for investigation.
- ✓ For information about the study, the researcher depended on the data furnished by the selected respondents during their interview with him.
- ✓ Facts and figures collected by the researcher applied to the situation prevailing during the year 2020.

1.8 Definition of Terms

Adaptation: It refers to change in behavior, resource, Infrastructure or the functioning of a system that reduces vulnerability.

Age: Age of a respondent was defined as the span of life and was operationally measured by the number of years from his/her birth to the time of interviewing.

Level of education: Empirically it was defined to the development of desirable changes in knowledge, skill and attitudes in an individual through reading, writing, observation and other selected activities. It was measured on the basis of classes a farmer has passed from a formal educational institution.

Farming experience: Experience as a general concept comprises knowledge or skill of something or some event gained through involvement in or exposure to that thing or event. Experience refers to the nature of the events someone or something has undergone. Experience is what is happening to use all the time-as long we exist. Experience in farming means how many years farmers have been engaged in farming activities.

Extension media contact: It refers to the extent of contact with various communication media by the farmers in receiving agricultural information.

Duration of training: Duration of training of a farmer was defined as the number of days s/he had so far received training. It was used to refer to the completion of an activity by the farmer which was offered by the government, semi-govt. or non-government organizations to improve the knowledge & skills of farmers and changing attitude of a farmer for doing a specific job properly.

Media ownership: Ownership refers to the act or right of possessing something. Media ownership in this thesis refers to as respondent's possession of different forms of communication media viz. mobile phone, Internet, Computer, Television and Radio for accessing farm related information.

Extent of use of information sources for weather events: Extent of use of information sources of weather events means how much frequently used the technologies or other sources by the respondents for receiving weather-related information such as temperature, rainfall, cyclone, flood, drought, salinity, etc.

Content appropriateness: Content appropriateness means correctness of content or validity of content, regarding the appropriateness of the weather-related information that a respondent receives from BAMIS or local extension office.

Knowledge on weather events: Knowledge on weather events of the farmers refers to the knowledge gained by the respondent about weather variability with the help of weather- related apps such as BAMIS/BMD.

Adaptive capacity: It refers to effective and timely delivery and exchange of all supporting mechanism and meteorological information, thus respondent can successfully adapt necessary measures to mitigate adverse effect of climate change.

BAMIS: Bangladesh agro-Meteorological Information System

BMD: Bangladesh Meteorological Department

CHAPTER II

REVIEW OF LITERATURE

Review of literature gives the clear and concise direction to the researcher for conducting a study. In this Chapter, review of literature relevant to the objectives of this study was presented. This was mainly concerned with “adaptive capacity towards climate variability”. There was serious dearth of literature with respect to research studies on this aspect. So, the directly related literatures were not readily available for this study. Some researchers addressed various aspects of the adaptive capacity towards climate variability and its effect on client group and suggesting strategies for their emancipation from socio-economic deprivations. A few of these studies relevant to this research are briefly discussed in this Chapter under the following five sections:

Section 2.1 Climate Change Impact on Agriculture

Section 2.2 Adaptive Capacity

Section 2.3 ICTs for Adaptive Capacity

Section 2.4 Selected Characteristics of Farmers

Section 2.5 The Conceptual Framework of the Study

2.1 Climate Change Impact on Agriculture

Climate change is a comprehensive global environmental phenomenon which likely to have lethal effects on biophysical entities that can leading to critical mark on the survival of human being (Upadhyay *et al.*, 2015). The impact of climate change is undoubtedly being felt by the entire globe; however, the scenario of Bangladesh seems to be comparatively pertinent due to varying geography and anthropogenic pressure. The situation, such as abnormal fluctuation in temperature (low and high), erratic rain fall (pattern and distribution), drought, flood etc. are the witness of climatic aberration leading to series of problems in the survival and existence of the human being. The consequences of climate change in Bangladesh can be observed in all the sectors; however the fluctuation in time of flowering pattern in the plants (early and late), rising trend of unpredictable disease in animals including human being and shifting agricultural cropping pattern and sequences are some of them. Taking an example of one of the prominent sectors, i.e., agriculture of Bangladesh basically includes crop husbandry, animal husbandry, horticulture and fisheries, experiencing vagaries in climatic parameters particularly, rise in temperature and erratic rainfall pattern making agriculture to more vulnerable.

It is very much evident that the major impacts of climate change will be on agricultural and food systems over the next few decades (Brown, *et al.*, 2008). However application of crop modeling tools, have pointed out that climate change is likely to reduce food availability due to a reduction in agricultural production (Lobell, *et al.,* 2008). Now there is a unified voice from the scientific community, policy makers and common man of the country to develop proper adaptation and mitigation mechanism against changing climatic parameters. In order to overcome the alarming situation of climate change, adaptation and mitigation are two options. Adaptation is said to be older than mitigation. Various strategies of adaptation to climate change have been employed throughout the history, while mitigation initiatives have evolved only when the scientific community reached on a conclusion and determined a possible interaction between human actions and climate. There is uncertainty in the exact intensity and impact of climate change because of complex interaction in ecosystem, improper feedback.

Climate change and variability have human and non-human effects across the globe. Increasing temperatures, changing rainfall patterns, rising sea levels, and increasing frequency and intensity of extreme weather events are adversely affecting ecosystem functioning, agriculture and food security, infrastructure, water resources, and human health (Intergovernmental Panel on Climate Change (IPCC, 2014). However, there is considerable debate on how adverse effects of climate change will genuinely be in different parts of the world. Evidence suggests that developed countries located in temperate regions would face less adverse impacts and may gain from climate change (Mendelsohn and Dinar, 2003). In contrast, there is a scientific consensus that the non-industrialized and low-income nations located in tropical and sub-tropical climate are more prone to the negative impacts of climate change (Wheeler and Von Braun, 2013; Ruamsuke et al., 2015)

Bangladesh is one of the most vulnerable countries to climate change. Climate induced hazards are increasing day by day. The last era the country has faced many climatic hazards. The country has faced devastating Sidr in November 2007, Aila in April 2009, series of flood of 2004, 2007 and 2009, Nargis in 2010 and Mahasen in May 2013 (Ahmed, 2010; MOEF, 2009). The main reasons for its vulnerability include its tropical climate; the predominance of floodplains for the majority of the land area; the low level of elevation and proximity to sea level; the high population density; and limited technological capacities to offset climate change effects (Shahid and Behrawan, 2008; Pouliotte et al., 2009). 9 Climate change effects are already occurring, as measured by increasing temperatures, variable rainfall and an increase in climate related extreme events such as floods, droughts, cyclone, sea level rise, salinity and soil erosion and sea level rise are the most occurring factor of salinity (Yu et al., 2010). World Bank (2000), predicted 0.10 m, 0.25 m and 1 m rise in sea level by 2020, 2050 and 2100 that might affect 2%, 4% and 17.5% of total land mass respectively.

Climatic variability is one of the major factors influencing bio-physical systems and eventually the rural livelihoods in the drought-prone areas of Bangladesh. It directly affects the agriculture, which contributes 18.70 percent of the GDP and employs roughly half (47.30%) of the labour force of the country (BBS, 2013). In addition, monsoon precipitation is likely to increase 6.8 percent by 2050 (Ali, 1999). Moreover, the distribution pattern of precipitation during the growing season with high temperature and high rates of evapotranspiration will create further water stress and a decline in agricultural production in the drought-prone areas (Paul, 1998; Huq, et al., 2003). IPCC has identified South Asia as the most susceptible region in the world to climate change. Furthermore, 4^{th} Assessment Report (AR) of IPCC has found that global surface temperature increase of ±0.18°C during the last 100 years ending in 2005 (IPCC, 2007). IPCC (2007) also states that the rise of mean annual temperature will be 3.4°C per century. The mean annual temperature of Bangladesh has increased during the period of 1895-1980 at 0.31o C (Kates, et al., 1985; ADB, 1994; Burton, 1997). Likewise, Agarwala, et al. (2003) reported that the future climate change projections show increased rainfall during monsoon season and reduced rainfall in winter months. The monsoon season rainfall is projected to increase; the rainfall availability may increase significantly causing more intense rainfall and/or longer dry spells. The international community has also recognized that Bangladesh is more vulnerable to climatic variability due to various hydro-geological and socioeconomic factors such as flat deltaic topography with low elevation, extreme climatic variability governed by monsoons, high population density with huge number of population below poverty and dependency on crop agriculture which is highly susceptible to climatic variability and change (Ahmed and Alam, 1998; Ali, 1999; Agarwala, et al., 2003; Paul and Routray, 2010). Moreover, modelling of temperature and rainfall variability suggests that mean global temperature of Bangladesh may rise by 1.5°C to 1.8°C by 2050 (Ahmed and Alam, 1998).

Based on existing studies, it can be said that present climate is somewhat different from the past and rapid change is being taking place gradually. Recent trends of temperature and rainfall show that temperature has been increased and rainfall pattern has been changed in the Barind region of Bangladesh. Based on the climate change scenarios and projections, it can be opined that Bangladesh (especially western part) will. be at risk of drought under climate change conditions (Paul, 1998). In Bangladesh, drought is a recurrent phenomenon, which is defined as the period when moisture content in soil is less than the required amount for satisfactory crop-growth during the normal crop-growing season (Paul, 1998; Paul, et al., 2014). During the last 50 years, Bangladesh suffered from more than 20 drought conditions, and severe droughts took places in 1973, 1978, 1979, 1981, 1982, 1989, 1992, 1994 and 1995 (Adnan, 1993; Erickson, et al., 1993). Major droughts can cause greater damage to crops and property than a flood or cyclone and also can affect more people over a wider area (BBS, 1986; Brammer, 1987, Paul, 1998). The impacts of drought are diverse and can broadly be classified as economic, environmental and social (Paul, et al., 2014). The north-western part especially the upper Barind tract of Bangladesh is considered to be the most drought-prone (Murshid, 1987). This region is relatively drier and receives much lower rainfall in compare with rest of the country. Owing to a reduction in the amount of rainfall, the north-western region of Bangladesh experienced a severe drought in 1994-1995 (Paul, 1998). Besides, this region is also considered to be the granary of Bangladesh because of fewer people and good land that produces a surplus of rice - the staple of the country. The drought condition in north-western Bangladesh in recent decades had led to a shortfall of rice production of 3.5 million tons in the 1990s (Banglapedia, 2007).

Increased climatic variability may create additional threats to drought-prone environment and is considered as a key crop production risk factor. Therefore, under the condition of climate change it is very important to adopt some adaptation measures to combat adversities posed by climatic anomalies in the upper Barind tract of northwestern Bangladesh.

Every crop has a temperature range for their vegetative and reproductive growth. When temperature falls below the range or exceeded the upper limit then crop production faces constraints. A study found that 10 C increase in maximum temperature at vegetative, reproductive and ripening stages there was a decrease in Aman rice production by 2.94, 53.06 and 17.28 tons respectively (Islam, *et al*., 2008). With the change in temperature (by 20 C and 40 C), the prospect of growing wheat and potato would be severely impaired. Production loss may exceed 60% of the achievable yields (Karim Z. 1993). Higher temperature has negative effect on soil organic matter also. Rainfall is one of the major climatic factors for crop production. All crops have critical stages when it needs water for their growth and development. Moreover excessive rainfall may occur flooding and water logging condition that also lead to crop loss. It was found8 that 1mm increase in rainfall at vegetative, reproductive and ripening stages decreased Aman rice production by 0.036, 0.230 and 0.292 ton respectively. Scarcity of water limits crop production while irrigation coverage is only 56% as delivered by the Bangladesh Agriculture Development Corporation (BADC, 2017).

Sea level rise affects agriculture in three ways, i.e., by salinity intrusion, by flooding and by increasing cyclone frequency and its depth of damage. Combined effects of these three factors decrease agriculture production in the coastal zone. Salinity intrusion due to sea level rise will decrease agricultural production by unavailability of fresh water and soil degradation. Salinity also decreases the terminative energy and germination rate of some plants (Rashid, et al.,2004). Sea level rise causes inundation of more area which is already reported by scientist. Therefore, damage of agricultural crops will be more in future. About 1/3 of Bangladesh or 49,000 sq. km. area are influenced by tides in the Bay of Bengal. Through study it is clear that the inundation coastal inundation area will be increased in future with an adverse effect on crop production. In a study it was found that if sea level rise up to 1 meter, normal flood waves can be expected to increase from presently 7.4 meters to 9.1 meters. In Bangladesh, about 15-17 million people will be displaced from the land inundation by sea level rise that will cost 12-16% of total land area (World Bank, 2000).

Flood has most deleterious effect on crop production of Bangladesh. The 1988 flood caused reduction of agricultural production by 45%. Higher discharge and low drainage capacity, in combination with increased backwater effects, would increase the frequency of such devastating floods under climate change scenarios. Prolonged floods would tend to delay Aman plantation, resulting in significant loss of potential Aman production, as observed during the floods of 1998. Loss of Boro rice crop from flash floods has become a regular phenomenon in the haor areas over the recent years. Considering all the direct and induced adverse effects of climate change on agriculture, one may conclude that crop agriculture would be even more vulnerable in Bangladesh in warmer world (World Bank, 2000). Impact of Cyclone on Crop Production Cyclone cause huge damage to production of crop. (FAO/GIEWS Global Watch, 2007) reported at the time of the passage of cyclone SIDR, the main 2007 "aman" rice crop, accounting for about 70% of the annual production in the most affected area, was nearing harvest.

Due to Climate Change Drought mostly affects Bangladesh in pre-monsoon and post-monsoon periods. During the last 50 years, Bangladesh suffered about 20 drought conditions. During 1981 and 1982 droughts affected the production of the monsoon crops only. The drought condition in north-western Bangladesh in recent decades had led to a shortfall of rice production of 3.5 million tons in the 1990s. If other losses, such as, to other crops (all rabi crops, Sugarcane, Tobacco, Wheat etc.) as well as to perennial agricultural resources, such as, bamboo, betel nut, fruits like Litchi, Mango, Jackfruit, Banana etc are considered, the loss will be substantially much higher (Banglapedia, 2010).

2.2 Adaptive Capacity

Adaptation is widely used in the biological sciences to refer a successful coping strategy. In social sciences and especially in Anthropology the term has long been used to describe successful or functional interactions of human cultures in localized environment. Adaptive capacity relates to the capacity of system, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences (Finan, 2009).

It is often used as synonymous to adjustment, cope with and other similar words. But one thing is common to all discipline and that is adaptation is related to habitat. Adaptation can be a specific action like a farmer changing crops, a systemic change like diversifying livelihoods or an institutional reform like changing resource management practices. It can also denote the whole process, including learning about risks, evaluating response strategies, to enable adaptation, mobilizing resources, implementing adaptations and revising choices with new learning (Leary, 2008). Adaptation refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Adapt or adaptation is a synonym to make more suitable or to fit some purpose by altering or modifying (Smith et al., 1999). The main goals of climate change adaptation are to reduce vulnerability and build resilience to the impacts brought by climate change (IPCC, 2007).

Adaptation can be spontaneous or planned and can be carried out in response to or in anticipation of change in conditions (Watson et al., 1996). There are many different conceptualizations of adaptation, including actions to improve situations, measures by which to embrace new circumstances and conditions, or strategies to reduce vulnerability, or enhance resilience. Strategies such as coastal protection, adjustments in agriculture and forest management, early warning systems and migration corridors have all been considered adaptation and it is a response to shortterm climate variability, long-term climate change and extreme events (Schipper, 2004).The concept has been criticized for being too techno-managerial, offering the promise that problems are manageable. It excludes the possibility of non-adaptation or simply accepting losses (Orlove 2009 and Schipper, 2004).

2.3 ICTs for Adaptive Capacity

Information and Communication Technology (ICT) can provide a quick access to weather related information to its users. A quick and timely access to weather information not only important to mitigate loses due to climate events but also could save human lives. Climate change adaptation may help in developing information systems within the food sector that are better able to reflect household access to food and food consumption. ICT could prove to be a great asset in developing early warning and hazard risk associated with climate change and to enable integrated management strategies.

ICT is and can act as medium for mass communication. It could continue doing so in the field of climate change with a lot of efficiency. ICTs could be used as a medium for increasing awareness and facilitating dialogue about the effects of climate change. It could be utilized for creating mass awareness and developing sensitivity among masses for climate change and responsible factors for climate change (e.g., Web 2.0 and social networking applications, early warning systems concerned particularly with acute events resulting from climate variability and climate change).

The use of ICTs can be for assessing the effect of climate change by developing a data base. This data base could be utilized for monitoring and measuring climate change, measuring the effects of climate change and controlling the level of interactions with the environment (e.g., the Internet of Things (IoT), monitoring and measurement of climate change impacts, the impact of weather/ climate on natural resources such as water sea levels, annual rainfall and weather dependent economic sectors such as agriculture, horticulture, forestry, fisheries, and the potential impact of climate change on health related issue which could be of long term in nature).

ICTs could find a new role in the changing economic and social organization as enabler for networked governance. The new forms of economic and social organization and decision-making that will likely be needed not only to adapt to climate change, but to achieve sustainable development. The kinds of Internet-based, open organizations and decision-making processes, transmission of information as well as guidance to and between local communities with reference to impacts that they may experience due to climate change. Expert advice system could tell people about actions that they could take to protect themselves against sudden weather-induced crises, and potential lifestyle along with behavioral changes that will help to secure lives and livelihoods in the longer term.

Mobile technologies have been the dominant force in ICTs and mobile-based initiatives can successfully combined local and external information and knowledge. These initiatives could make a valuable contribution to deliberate, pre-planned strategies for adaptation, focusing on the informational role of ICTs and combining local and external capacities (though limited in their development of local capacity).

BAMIS and its mobile based portal plays vital role in case of : weather and climate information across Bangladesh. It updates 64 districts agromet advisories twice in a week and one national agromet advisory once in a week.

2.4 Selected Characteristics of the Farmers

This section describes the selected characteristics of the farmers who use BAMIS and their relationships to perceived adaptive capacity towards climate variability.

Age: Elements of adaptive capacity are socially differentiated along the lines of age, ethnicity, class, religion and gender' (Adger et al., 2007). It is often thought that institutions that ensure equitable opportunities to access resources are likely to promote adaptive capacity within a community. The personal characteristics that may influence the adaptive capacity of a personnel include age, gender, education, and level of farming experience (Peal, 2015). He found farmers had significant influence on their adaptive strategies towards saliniTy effects in agriculture.

Level of education: Education improves human capital, farm management capacity, the ability to understand and adopt recommended agricultural practices (Bezuayehu *et al.*, 2002). Peal (2015) found that farmers had significant positive contribution on their adaptive strategies towards salinity effects in agriculture. Adaptation will require effective services from outside the community itself to support the use of information. These services include quality education, the generation of information and expertise on climate or agriculture and much more effective communication of that information than has often been the case (Nagy, 2003).

Farming experience: Farming experience is helpful to increase knowledge, improve skill and change attitude of the farmers. It also builds confidence of the farmers for making appropriate decisions at the time of climatic or weather variability. Peal (2015) revealed that farming experience of the farmers had significant and positive contribution on their adaptive strategies towards salinity effects in agriculture.

Extension contact: A key characteristic of adaptive capacity relates to the system's ability to foster innovation and support new practices (Smith et al., 2003). As social and environmental changes continue, communities will need to alter existing practices, resources and behaviors', or in some cases adopt new ones. Experimentation, innovation and adoption as part of the learning process are essential in ensuring the system's ability to cope with and respond to changing circumstances. Moreover, innovation is crucial to enable a system to remain dynamic and functioning – though at the local level the willingness and capacity to foster innovation (and to accept failure) vary greatly. It is important to recognize that this is not only about 'high-tech' and large-scale innovation, but also micro-level initiatives, as many of the actions taken to adapt to changing shocks and trends will be done spontaneously or autonomously at the local level (Wongtschowski et al., 2009). Peal (2015) revealed that extension contact of the farmers had significant and positive contribution on their adaptive strategies towards salinity effects in agriculture.

Duration of training: Training provides the structures, techniques and awareness to manage time and workload efficiently, which increases productivity and motivates farmer more to achieve more. Training received develops the farmers' knowledge, skill, and attitude in positive manner. The farmer who has no training cannot gain enough knowledge, skill and practical experience. Such consideration indicates the need for improving knowledge and skill level of the farmers by supplying enough training for gaining the knowledge on climate or weather-related issues**.** But Peal (2015) revealed that training exposure of the farmers had non-significant and positive contribution on their adaptive strategies towards salinity effects in agriculture.

Media ownership: Ownership of the media is the paternity or possession of a medium of communication. If a person possesses media (like mobile phone, internet connectivity, radio, etc.), he / she will be able to gather information easily by it. ICTs could find a new role in the changing economic and social organization as enabler for networked governance. The new forms of economic and social organization and decision-making that will likely be needed not only to adapt to climate change, but to achieve sustainable development.

Extent of use of information sources for weather events: Adaptation to any hazard, including climate change, does not depend on information only about the hazard itself. A community's ability to know where to find and use new crop species or to apply for financing to fund investment in agricultural change are as important as knowing the weather forecast, and how the climate is expected to change in the future. Similarly, an important aspect is general awareness-raising and capacity-building of stakeholders to inform adaptation decisions (McGray, 2009). Relevant information needs to reach key stakeholders to ensure that actions are effective in the long term, and prevent maladaptive practices (i.e., actions or processes that may deliver short-term gains but ultimately increase vulnerability in the longer term). Haque (2017) revealed that access to information sources have positive significant relationship with their adoption of climate smart agriculture.

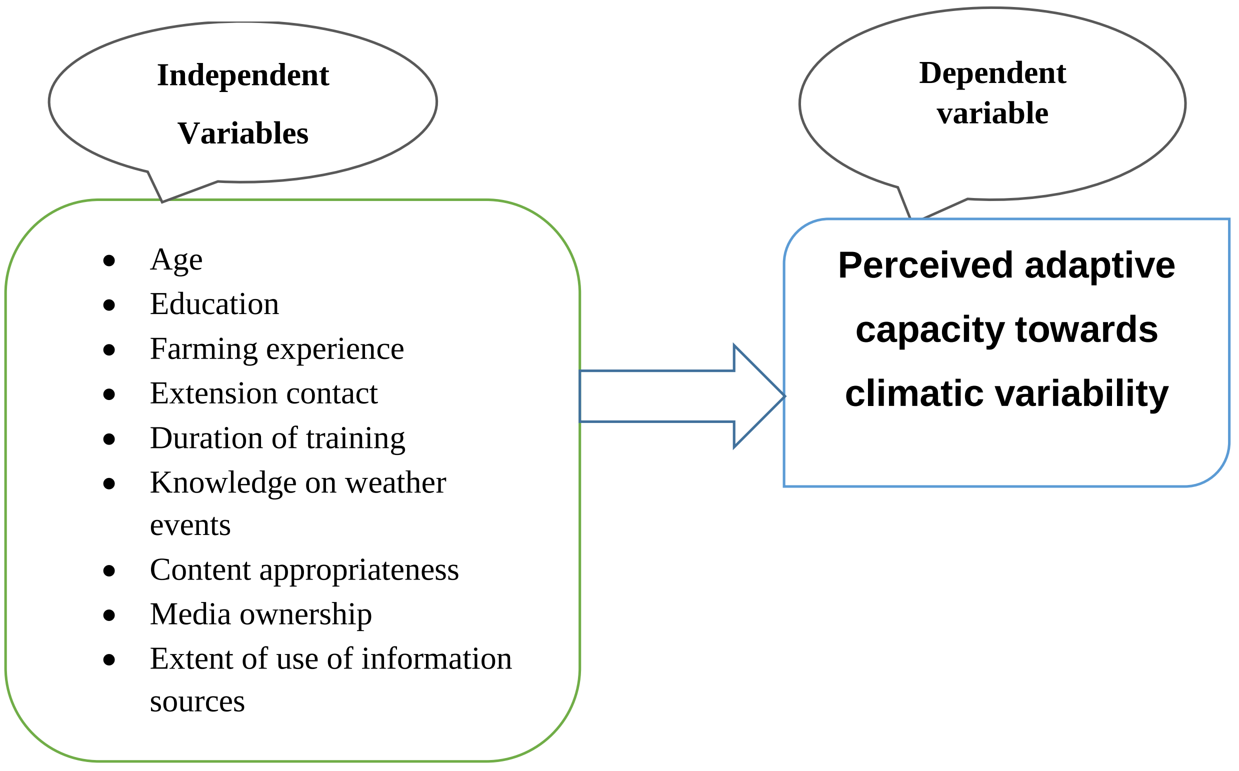
Content appropriateness: Correctness of content or validity of content, regarding the appropriateness of the weather-related information that a respondent receives from BAMIS or local extension office. Information needs to reach key stakeholders to ensure that actions are effective in the long term, and prevent maladaptive practices (i.e., actions or processes that may deliver short-term gains but ultimately increase vulnerability in the longer term). Correctness of received information enhance adaptive capacity towards climatic variability in case of decision making process. Trust can create a social obligation, engaging reciprocal action, which is referred to as reciprocity (Pretty and Ward 2001). Providing space for individuals to develop private as well as publicly sanctioned social relationships is seen as an important resource for adaptation. Pelling et al. (2008) showed how such relationships contribute to the accumulation of trust and reciprocity between stakeholders, assisting in the formation of planned adaptations to environmental change. Theorists have drawn a distinction between specific forms of reciprocity and diffuse reciprocity (Keohane 1986).

Knowledge of weather events: In this study knowledge refers to as an awareness of recommended practices or the optimum that is achievable in terms of efficiency. In this case refer to as awareness on climatic variability in the study area. A lack of understanding or knowledge about the recommended practices is often cited as a strong barrier to the adoption of recommended practices or innovations (Duvel, 1991). In this study knowledge refers to as an awareness of recommended practices or the optimum that is achievable in terms of efficiency. In this case refer to as awareness of recommended rice production practices in the study area. A lack of understanding or knowledge about the recommended practices is often cited as a strong barrier to the adoption of recommended practices or innovations (Duvel, 1991). Communities are often more likely to cope with change if they have appropriate knowledge about potential future threats, as well as an understanding of how to adapt to them. With this in mind, successful adaptation will require: understanding of likely future change and its complexity, knowledge about adaptation options, the ability to assess options, and the capacity to implement suitable interventions (Frankhauser and Tol, 1997). Knowledge can also play a role in ensuring local empowerment and raising awareness of the needs of particular groups within a community (Ospina and Heeks, 2010). Therefore, the way in which a system generates, collects, analyses and disseminates knowledge is an important determinant of adaptive capacity – with obvious links with the institutional context and the governance of knowledge.

2.5 The Conceptual Framework of the Study

In scientific research, selection and measurement of variables constitute an important task. Studies on individual, group and society revealed that acceptance of modern technologies is conditional upon many factors. Some of these are social, personal, economical and situational factors and the behavior of farmers are influenced by these characteristics. The hypothesis of a research while constructed properly consist at least two important elements i.e.: a predicted variable and an experimental variable. A predicted variable is that factor which appears, disappears or varies as the researcher introduces, removes or varies the experimental variables (Townsend, 1953). An experimental variable is that factor which is manipulated by the researcher in his attempt to ascertain its relationship to an observed phenomenon. Variables together are the causes and the phenomenon is effect and thus, there is cause effect relationship everywhere in the universe for a specific events or issues.

This study is concerned with the adaptive capacity towards climatic variability in the selected areas of Gangachara upazila. Thus, adaptive capacity towards climatic variability of the rural poor in the selected area of Rangpur district was the dependent variable and nine selected characteristics of the farmers were considered as the independent variables under the study. Use of mobile enabled weather information system may be affected through interacting forces of many experimental variables. It is not possible to deal with all of the experimental variables in a single study. It was therefore, necessary to limit the independent variables, which include age, level of education, farming experience, extension contact, training exposure, media ownership, extent of use of information sources for weather events, content appropriateness and knowledge of weather events for this study. Considering the above-mentioned situation and discussion, a conceptual framework has been developed for this study, which is diagrammatically presented in the following figure 2.1



2. 1 Conceptual framework of the study

CHAPTER III

METHODOLOGY

Methodology deserves a very careful consideration in conducting scientific research. Importance of methodology in conducting any research cannot be undermined. Methodology enables the researcher to collect valid and reliable information and to analyze them properly to arrive at correct decisions. Keeping this point in view, the researcher took utmost care for using proper methods in all the aspects of this piece of research work. Methods and procedures followed in conducting this study has been described in this chapter.

3.1 The Locale of the Study

The study was conducted at Barabil and Gangachara unions of Gangachara upazila under Rangpur district. Out of ten unions of the mentioned upazila, Barabil and Gangachara unions were purposively selected because of higher climatic variability. However Barabil union has seven villages and Gangachara union has eight villages. Thereafter, two villages namely, Ichli and Kashiabari were selected randomly from seven villages of Barabil union and Shankardaha and Binbina villages were selected randomly from eight villages of Gangachara union. A map of Rangpur district showing Gangachara upazila, a map of Gangachara upazila showing the study area have been shown in Fig 3.1 and 3.2, respectively.

3.2 Population and Sample of the Study

Four separate lists of farmers of the selected four villages were prepared by the researcher herself with the help of the Sub-Assistant Agriculture Officer (SAAO) of Upazila Agriculture Office (UAO), Gangachara. The list comprised of a total of farm family from which 1368 farm family heads from Ichli and Kashiabari villages and 1288 from Binbina and Shankardaha villages under the union of Barabil and Gangachara were selected respectively which constituted the population of the study.

There are several methods for determining the sample size. Here, researcher used Creative Research System (1980) formula for study group:

$$\text{SS} = \frac{z^2 \times (\text{p}) \times (1-\text{p})}{c^2}$$

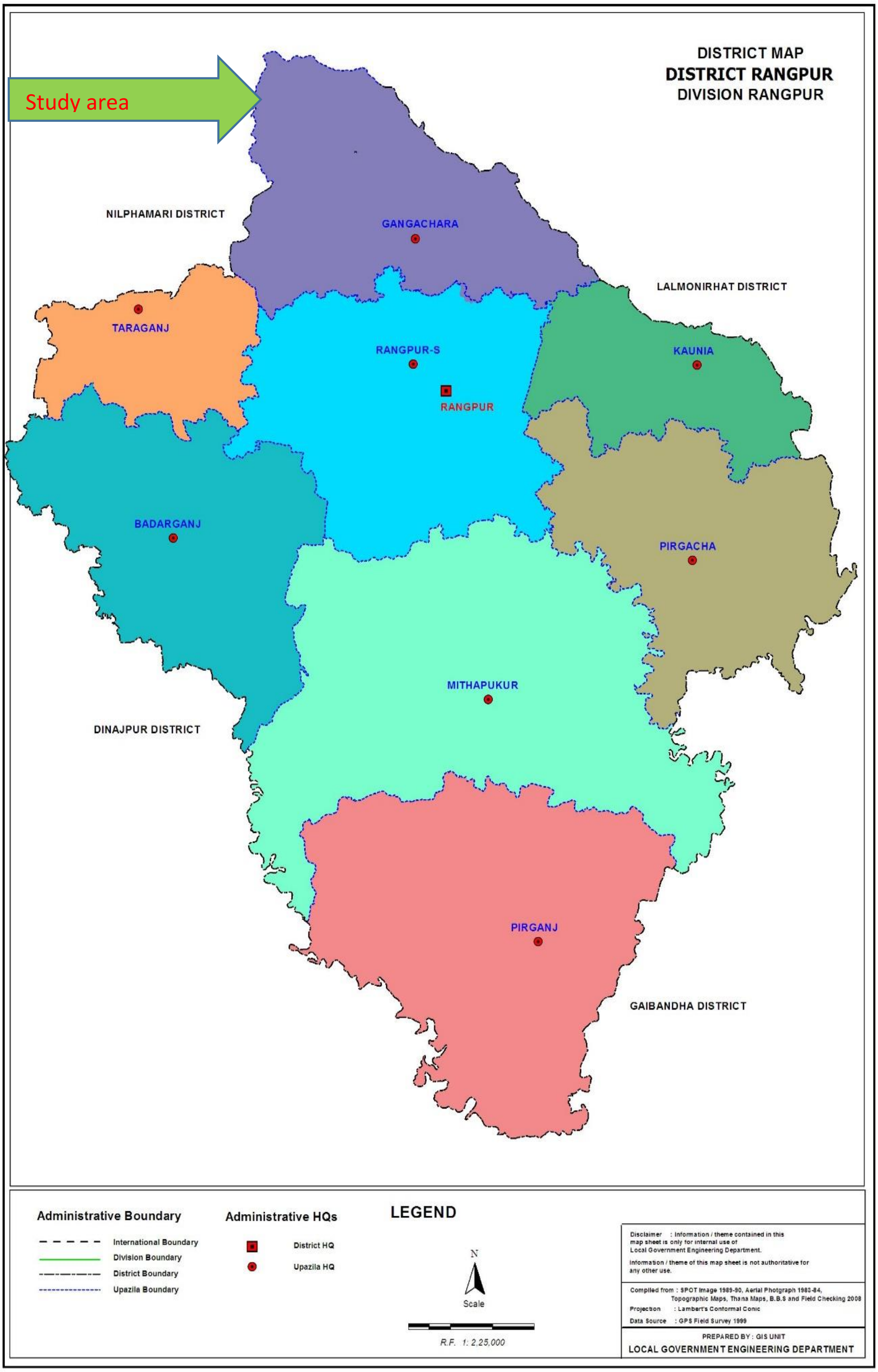


Figure 3.21 A Map of Rangpur district showing Gangachara upazila

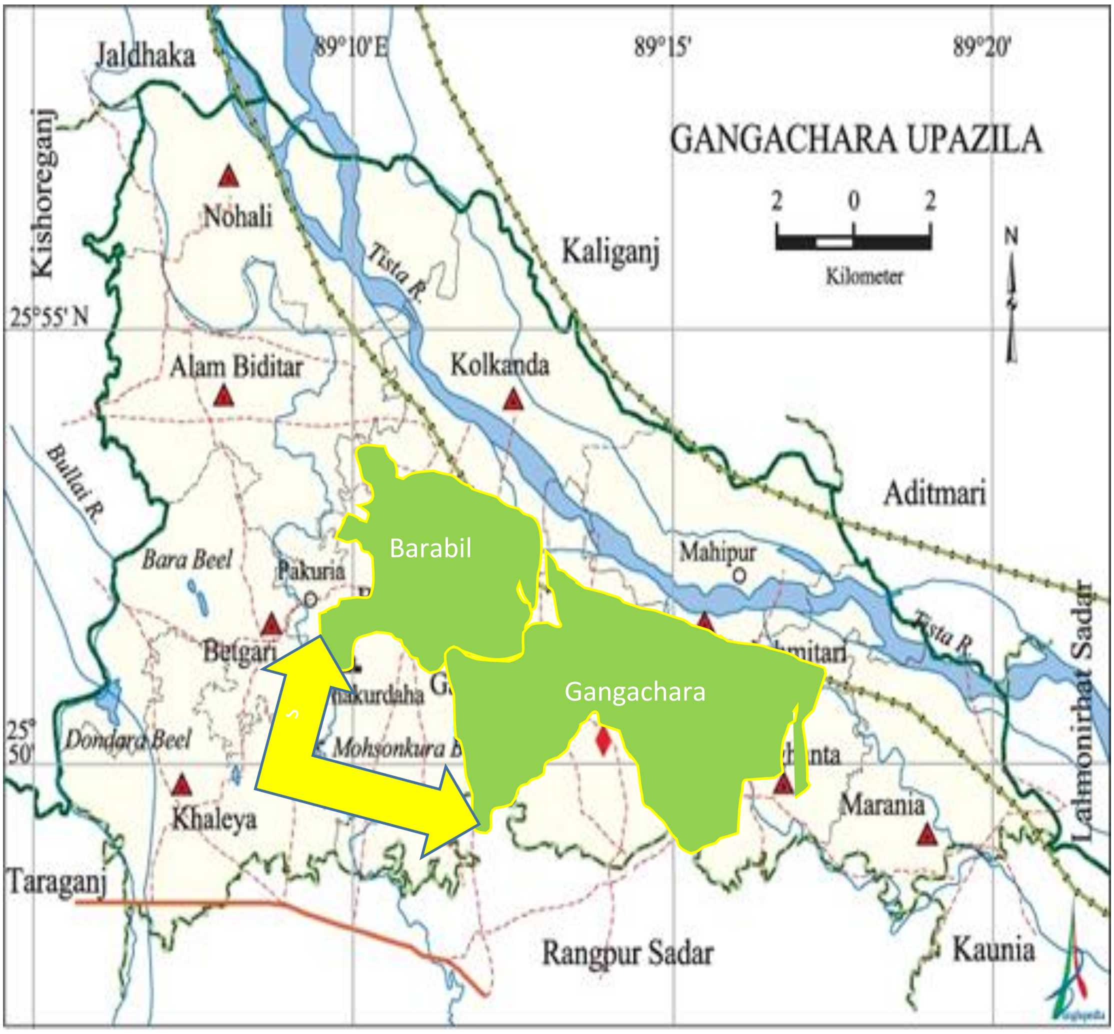


Figure 3.2.2 A map of Gangachara upazila showing the study area (Barabil and Gangachara Union)

Where,

SS = Sample size

Z=Z value (e.g. 1.96 for 95% confidence level)

p = percentage picking a choice, expressed as decimal (.5 used for sample size needed)

c = confidence interval, expressed as decimal (e.g., .01 = ±1) 9%

Correction for Finite Population:

$$\text{Now ss} = \frac{ss}{1+\frac{ss-1}{PoP}}$$

Where,

PoP = Population

By using the above formula, the sample size was determined as 114 for this study. Separate sample sizes of each of the villages were determined proportionately. Sample was drawn from the population by using proportionate random sampling method.

A reserve list of 12 farmers was also prepared by using 10 percent of the sample size so that the respondent of this list could be used for interview if the respondents included in the original sample were not available at the time of conduction of interview. The distribution of the population, sample and number of respondents in the reserve list are given in Table 3.1.

Table 3.1 Distribution of the population and sample of the respondents with reserve list

Name of Unions	Name of villages	Population (No. of total farmers)	Sample Size	Reserve list
Gangachara	Ichli	743	31	3
	Kashiabari	635	26	3
Barabil	Shankardaha	613	30	3
	Binbina	665	27	3
Total		2656	114	12

3.3 Data Collection Instrument

In a social research, preparation of an interview schedule for collection of information with very careful consideration is necessary. Keeping this fact in mind the researcher prepared an interview schedule carefully for collecting data from the respondents. Objectives of the study were kept in view while preparing the interview schedule.

The initially prepared interview schedule was pre-tested among 10 respondents of the study area. The pretest was helpful to find out gaps and to locate faulty questions and statements. Alterations and adjustments were made in the schedule on the basis of experience of the pretest. English version of the interview schedule is shown in appendix-A.

3.4 Collection of Data

The researcher collected data from the sample farmers with the help of a pretested interview schedule. Before starting collection of data, the researchers met with the local SAAOs of the respective blocks in order to explain the objectives of the study and requested them to provide necessary help and cooperation in collection of data. The local leaders of the area were also approached to render essential help. As a result of all these a good working atmosphere was created in the study area which was very helpful for collection of data by the researcher.

Before going to the respondents for interview they were informed earlier, so that they would be available in their respective area. The interviews were held individually in the house or farms of the respective respondent. The researcher established adequate rapport so that the respondents did not feel hesitant to provide actual information. Whenever any respondent faced difficulty in understanding a particular question, the researcher took care to explain the same clearly. No serious constraints were faced by the researcher in collecting data. Collection of data took 40 days from 5th February to 16th March 2020.

3.5 Variables of the Study

Adaptive capacity of rural poor towards climate variability was the main focus of this study and it was considered as the predicted variable.

For selection of independent variables, the researcher went through the past related literature as far as available. She discussed with the researcher, experts in the relevant fields and research fellows in agricultural and related disciplines. She also carefully noticed the various characteristics of the farmers of the study. Availability of time, money and other resources were also kept in view in selecting the variables. Characteristics of the farmers like age, level of education, farming experience, extension contact, duration of training, media ownership, extent of use of information sources towards weather events, content appropriateness and knowledge on weather events were selected as the dependent variables.

3.6 Measurement of Variables

In order to conduct the study in accordance with the objectives, it was necessary to measure the selected variables. This section contains procedures for measurement of both experimental as well as predicted variables of the study. The procedures followed in measuring the variables are presented below:

3.6.1 Measurement of independent variables

It was pertinent to follow a methodological procedure for measuring the selected variables in order to conduct the study in accordance with the objectives already formulated. The procedures for measuring the experimental variables are described below:

3.6.1.1 Age

Age of a respondent was measured in terms of years from birth to the time of interview which was found on the basis of response (Azad, 2014). A score of one (1) was assigned for each year of age. Question regarding this variable appears in item no. 1 in the interview schedule (Shown in Appendix-A).

3.6.1.2 Level of education

Education was measured in terms of one's year of schooling. One score was given for passing each year in an educational institution (Amin, 2004). For example, if the respondent passed the S.S.C. examination, his education score was given as 10, if passed the final examination of class Seven (VII), his education scores was given as 7. If the respondent did not know how to read and write, his education score was given as '0' (zero). A score of 0.5 (half) was given to that respondent who could sign his/her name only. Question regarding this variable appears in the item no. 2 in the interview schedule (Shown in Appendix-A).

3.6.1.3 Farming experience

Farming experience of a respondent was measured in terms of year passing related to farming activities at the time of interview which was found on the basis of response. A score of one (1) was assigned for each year of farming activities. No fraction of year was considered. Question regarding this variable appears in item no. 6 in the interview schedule (Shown in Appendix-A).

3.6.1.4 Extension contact

The extension contact of a respondent was measured in terms of his extent of contact with eight selected extension media. A scale was developed arranging the weights for 0, 1, 2, 3 and 4 for the responses of never, rarely, occasionally, frequently and regularly contact with these media respectively (Shown in Appendix-A).

3.6.1.5 Duration of training

Duration of training was measured by the total number of days a respondent received training in his/her life on conservative agriculture. A score of 1 (one) was given to a respondent for every day of training. A zero (0) score was assigned for no training exposure (Shown in Appendix-A).

3.6.1.6 Media ownership

Print or broadcast media are normally owned by individuals, government, group of individuals, etc. Ownership of the media is the paternity or possession of a medium of communication with five selected information media. Paternity here means the act of owning. A scale was developed arranging the weights for 1, 2 and 3 for the responses for no access, don't own but have access and own by myself assess to the media respectively (Shown in Appendix-A).

3.6.1.7 Extent of use of information sources for weather events

Extent of use of information sources of weather events means the technologies or other sources which are respondents used the most frequently for receiving weather-related information such as temperature, rainfall, cyclone, flood, drought, salinity, etc with ten selected information sources of weather events. A scale was developed arranging the weights for 0, 1, 2, 3 and 4 for the responses for never, rarely, occasionally, often and regularly used the most for receiving weather-related information (Shown in Appendix-A).

3.6.1.8 Content appropriateness

Content appropriateness means correctness of content or validity of content, regarding the appropriateness of the weather-related information that a respondent receives from BAMIS/BMD or local extension office with six selected information content of weather events. A scale was developed arranging the weights for 0, 1, 2, 3 and 4 for the responses for not at all, rarely appropriate, somewhat appropriate, appropriate and very appropriate in case of receiving weather-related information.

3.6.1.9 Knowledge on weather events

Knowledge on weather events of the farmers referred to the knowledge gained by the respondent with weather variability. A scale consisting of 14 questions was used to determine the weather variability knowledge score of the respondents. The questions were selected from different dimensions of weather events after thorough consultation with the relevant experts and review of relevant literatures as shown in Appendix A. The score allotted for each question was 2. A respondent could get 2 score against each question for correct response and 0 for wrong or no response and partial score was assigned for partially correct answer. Thus, weather events knowledge score of the respondents could range from 0 to 28, where 0 indicated very low knowledge and 28 indicated very high knowledge on weather events. This variable appears in item number ten (10) in the interview schedule as presented in Appendix.

3.6.2 Measurement of adaptive capacity towards climatic variability

Adaptive capacity towards climatic variability was the dependent variable in this study. It was measured by using 5 point rating scale. The respondents were asked to indicate their adaptive capacity towards recommended 6 impact of weather-related information received.

The method of assigning scores to the five alternatives in each statement was as follows:

Extent of adaptive capacity	**Scores assigned**
Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

The extent of adaptive capacity scores of a respondent was measured by adding the score of all the 6 statements about the impact of weather related information's shown in item number 13 of the Interview schedule as presented in Appendix-A.

3.7 Statement of the Hypotheses

3.7.1 Research hypotheses

In the light of the objectives of the study and variables selected, the following research hypotheses were formulated to test them in. The research hypotheses were stated in positive form, the hypotheses were as follows:

"Each of the nine selected characteristics of the farmers have significant relationship with their adaptive capacity towards climatic variability."

3.7.2 Null hypotheses

In order to conduct statistical tests, the research hypotheses were converted to null form. Hence, the null hypotheses were as follows:

"Each of the nine selected characteristics of the farmers have no relationship with their adaptive capacity towards climatic variability."

3.8 Data Processing

3.8.1 Editing

The collected raw data were examined thoroughly to detect errors and omissions. As a matter of fact, the researcher made a careful scrutiny of the completed interview schedule to make sure that necessary data were entered as complete as possible and well arranged to facilitate coding and tabulation. Very minor mistakes were detected by doing this, which were corrected promptly.

3.8.2 Coding and tabulation

Having consulted with the research supervisor and co-supervisor, the investigator prepared a detailed coding plan. In case of qualitative data, suitable scoring techniques were followed by putting proper weight age against each of the traits to transform the data into quantitative forms. These were then tabulated in accordance with the objective of the study.

3.8.3 Categorization of data

Following coding operation, the collected raw data as well as the respondents were classified into various categories to facilitate the description of variables. These categories were developed for each of the variables by considering the nature of distribution of the data and extensive literature review. The procedures for categorization have been discussed while describing the variables under consideration in chapter IV.

3.9 Statistical Analysis

Data collected from the respondents were analyzed and interpreted in accordance with the objectives of the study. The analysis of data was performed using statistical treatment with SPSS (Statistical Package for Social Sciences) computer program, version 20. Statistical measures as a number, range, mean, standard deviation was used in describing the variables whenever applicable. Regressions of coefficient test were used to determine the contribution and among the categories of farmers with regard to their adoption to sunflower production technologies based on selected characteristics. Throughout the study the 0.01 and 0.05 levels of probability were used as the basis of rejection or accepting a null hypothesis.

CHAPTER IV

RESULTS AND DISCUSSION

The recorded observations in accordance with the objective of the study were presented and probable discussion was made of the findings with probable justifiable and relevant interpretation under this chapter. It has three (3) sections. The first section of this Chapter deals with the characteristics of the farmers. The second section deals with the farmers' adaptive capacity towards climatic variability. The third section deals with the contribution between individual characteristics of the farmers and their adaptive capacity towards climatic variability.

4.1 Selected Characteristics of the Farmers

In this section the findings of the farmers' selected characteristics have been discussed in Table 4.1. The selected characteristics are i) age ii) education iii) gender iv) farming experience v) extension contact vi) training exposure vii) media ownership viii) information sources of weather events ix) content appropriateness and x) knowledge on weather events.

Table 4.1 The salient features of the selected characteristics of the farmers

Categories	Measuring unit	Range		Construct Mean	S.D
		Possible	Observed		
Age	Actual years	Unknown	23-80	49.19	11.005
Level of education	Schooling years	Unknown	.5-17	9.654	3.64
Farming experience	Actual years	Unknown	3-50	23.80	10.043
Extension contact	Score			1.255	.537
Duration of training	Number of days	Unknown	0-10	.21	1.076
Media ownership	Score	0-2	.60-2.00	1.1614	.27249
Extent of use of information sources for weather events	Score			1.1807	.43718
Content appropriateness	Score			3.19	.429

knowledge on weather events	Score	0-28	16-18	21.23	2.637
Adaptive capacity	Score	1-5	1.83-5	3.88	.642

4.1.1 Age

Age of the respondents varied from 23 to 80 years, the average being 49.19 years with the standard deviation of 11.01. According to their age, the respondents were classified into three categories as “young aged”, “middle aged” and “old aged”. The distribution of the farmers according to their age is shown in Table 4.2.

Table 4.2 Distribution of the farmers according to their age

Category	Number of Farmers	%	Observed Range	Mean	S.D
Young Aged (up to 35 years)	16	14.0	23-80	49.19	11.01
Middle Aged (36 to 50 years)	48	42.1			
Old Aged (Above 51 years)	50	43.9			
Total	**114**	**100**			

Table 4.2 reveals that the old-aged farmers comprised the highest proportion (43.9 percent) followed by young aged category (42.1 percent) and the lowest proportion were made by the young aged category (14.0 percent). Data also indicated that the middle and old aged category constitute 86.0 percent of total farmers. The old and middle aged farmers were generally more involved in farm activities than the young.

4.1.2 Level of education

The level of educational scores of the farmers ranged from 0.5 to 17 with a mean and standard deviation of 9.654 and 3.64, respectively. Based on the educational scores, the farmers were classified into five categories. The distributions of farmers according to their level of education are presented in Table 4.3.

Table 4.3 Distribution of the farmers according to their level of education

Category	Number of Farmers	%	Observed Range	Mean	S.D
Can Sign Only (0.5)	3	2.6	.5-17	9.654	3.64
Primary Level (1-5)	19	16.7			
Secondary Level (6-10)	56	49.1			
Above Secondary	36	31.6			
Total	**114**	**100**			

Table 4.3 shows that farmers under secondary education category constituted the highest proportion (49.1 percent) followed by above secondary education (31.6 percent). On the other hand, the lowest 2.6 percent in can sign only category followed by primary category 16.7 percent respondents were can sign only category. Education broadens the horizon of outlook of farmers and expands their capability to analyze any situation related to adopt and use of modern technologies. An educated farmer is likely to be more responsive to the modern facts, ideas, and information wither related technologies. To adjust with the same, they would be progressive minded to adopt and use modern technologies for adaptation towards Climate Variability.

4.1.3 Farming experiences

Score of farming experiences of rural farmers ranged from 3 to 50 with mean and standard deviation of 23.80 and 10.043, respectively. On the basis of faming experience scores, the rural farmers were classified into three categories (Mean ± Standard Deviation) namely ‘low’, ‘medium’ and ‘high’ experience. The distribution of the rural poor farmers according to their farming experiences is given in Table 4.4.

Table 4.4 Distribution of the farmers according to their farming experiences

Category	Range (years)		Farmers		Mean	SD
	Score	Observed	Number	Percent	($\bar{x}$)	(σ)
Low experience	Up to 14	3-50	18	15.8	23.80	10.043
Medium experience	15-35		78	68.4		
High experience	Above 35		18	15.8		
Total			114	100		

Table 4.4 reveals that the majority (68.4 percent) of the rural farmer fell in medium farming experience category, whereas 15.8 percent in low experience category and 15.8

percent in high farming experience category. The findings of the present study reveal that around 84.2 percent of the rural poor farmers in the study area had low to medium farming experiences. Thus, low and high had same percentage of farming experience.

4.1.4 Extension contact

The observed extension media contact scores of the respondents ranged from .13 to 2.50. The average extension media contact score was 1.256 and the standard deviation was 0.537. Based on the possible range of extension media contact score (0 - 4). The categories and distribution of the respondents were shown in Table 4.5.

Table 4.5 Distribution of the farmers according to their extension media contact

SL NO.	Items	Never	Rarely	Occasionally	Very Often	regularly	Overall index
1	Neighbor/ fellow farmers/ friends/ relatives	2 (1.8%)	28 (24.6%)	10 (1.8%)	28 (24.6%)	46 (40.4%)	316
2	Input dealers	3 (2.6%)	57 (50.0%)	27 (23.7%)	24 (21.1%)	3 (2.6%)	195
3	Group leaders/ progressive farmers	19 (16.7%)	58 (50.9%)	35 (30.7%)	2 (1.8%)	0	134
4	Local extension worker	4 (3.5%)	80 (70.2%)	12 (10.5%)	7 (6.1%)	11 (9.6%)	169
5	Local extension officials	41 (36.0%)	60 (52.6%)	7 (6.1%)	2 (1.8%)	4(3.5%)	96
6	Farmers' meeting at upazila/district	57 (50.0%)	49 (43.0%)	8 (7.0%)	0	0	65
7	Attend farmers' field days or agricultural fair	36 (31.6%)	70 (61.4%)	8 (7%)	0	0	86
8	Attend method or result demonstration	41 (36.0%)	62 (54.4%)	11 (9.6%)	0	0	84

As it is shown in Table 4.5, 40.4% of the respondents regularly contacted with neighbor/ fellow farmers/ friends/ relatives while 50% of the respondents rarely contact input dealers for weather related agricultural information. Majority of the respondents rarely contacted to local extension officials for upcoming agricultural vulnerabilities related to agricultural productivity. On the contrary, 9.6% respondents regularly contacted to local extension workers for their farming. In case of farmers' meeting at upazila/district, attend farmers' field days or agricultural fair, attend method or result demonstration showed that majority percentage of respondents (50%, 61.4%, and 54.4% respectively) never to rarely used these media for weather related variability. From overall index, we notice that neighbor/ fellow farmers/ friends/ relatives for agricultural extension purpose was mostly used and attend method or result demonstration was used the least.

4.1.5 Duration of training

Training duration score of the farmers ranged from 0 to 10 with a mean and standard deviation of .21 and 1.076, respectively. Based on the duration of training score, the farmers were classified into three categories namely 'no training', 'low' and 'moderate' training exposure. The distribution of the farmers according to their training exposure is presented in Table 4.6.

Table 4.6 Distribution of the farmers according to their duration of training

Category	Range (days)		Farmers		Mean	SD
	Score	Observed	Number	Percent	($\bar{x}$)	(σ)
No training	0	0-10	106	92.9	.21	1.076
Low training	1-3		6	5.3		
Moderate training	Above 3		2	1.8		
Total			114	100		

Table 4.6 indicates that the highest proportion (93 percent) of the rural farmers had no training received compared to 5.3 percent received low and 1.8 percent received moderate training. Training makes people skilled and helps them to acquire deep knowledge about the respected aspects. Trained rural farmers can face any kind of challenges about the adverse situation in their cultivation. Since BAMIS is a new system of weather information, farmers need to be provided with sufficient trainings on it, so they may encourage more to use the system and get them updated with accurate and timely weather information for their farming.

4.1.6 Media ownership

The media ownership of the farmers score ranged from 0.60 to 2.00 with an average of 1.1614 and standard deviation .2724. Depending on media ownership status farmers are classified into three categories which are shown in Fig.4.7

Table 4.7 Distribution of the farmers according to their status of media ownership

SL NO.	Items	No access	Don’t own but have access to, and use when necessary	Self-access
1	Mobile phone	0	1 (.9%)	113 (99.1%)
2	Internet connectivity	65 (57.0%)	37 (32.5%)	12 (10.5%)
3	Television	1 (.9%)	0	113 (99.1%)
4	Radio	54 (47.4%)	22 (19.3%)	38 (33.3%)
5	Computer	69 (60.5%)	40 (35.1%)	5 (4.4%)

Table 4.7 reveals that almost 99% of the respondents had access to mobile phone while nearly 1% had shared access to mobile phone where 41 respondents had smart phone and 72 farmers had featured phone. However, more than half of the respondents (57%) had no access to the Internet. Similarly, 60% respondents did not own any computer devices. Interestingly, majority of the respondents owned Television (99.1%) compared to radio (33.3%). Thus, 57.0% of the respondents have no access to Internet connectivity where as 32.5% and 10.5% of the respondents have shared access and self access respectively. Forty-three (43%) of the respondents have either full or shared access to the Internet compared to almost everyone own mobile phone. Therefore, clearly a mobile-enabled information systems might be a better option to disseminate critical and time-sensitive weather information to the rural farmers.

4.1.7 Extent of use of information sources for weather events

The observed extent of use of information sources scores of the respondents ranged from .40 to 2.90. The average extent of use of information sources score was 1.181 and the standard deviation was 0.437. The categories and distribution of the respondents were shown in Table 4.8

Table 4.8 Distribution of the farmers according to their extent of use of Information sources of weather events

SL NO.	Items	Never	Rarely	Occasionally	Often	Regularly	Overall index
1	Mobile phone (e.g., SMS, Voice Call)	44 (38.6%)	35 (30.7%)	6 (5.3%)	0	29 (25.4%)	163
2	Television news	1 (.9%)	13 (11.4%)	10 (8.8%)	10 (8.8%)	80 (70.2%)	383
3	Radio news	20 (17.5%)	50 (43.9%)	9 (7.9%)	1 (.9%)	34 (29.8%)	207
4	Friends/ relative/ fellow farmers	2 (1.8%)	66 (57.9%)	20 (17.5%)	17 (14.9%)	9 (7.9%)	193
5	SAAO from the local extension office	18 (15.8%)	72 (63.2%)	17 (14.9%)	2 (1.8%)	5 (4.4%)	132
6	Weatherboard / digital dashboard	113 (99.1%)	1 (.9%)	0	0	0	1
7	Social media	85 (74.6%)	18 (15.8%)	0	0	11 (9.6%)	62
8	Announcement from local administrative office like Upazilas	56 (49.1%)	55 (48.2%)	2 (1.8%)	1 (.9%)	0	62
9	Weather-related mobile app (e.g., BAMIS Portal, BMD Weather app)	111 (97.4%)	1 (.9%)	0	0	2 (1.8%)	9

Table 4.8 shows the opinion of the respondents about the extent of use of information sources. From the statistics it is revealed that respondents still mostly depend on the traditional mass media like Television (70.2%) and Radio (29.8%) for weather information. Despite mobile phone access is the highest among the respondents, around one-fourth of them (25.4%) used it for receiving weather information. Almost no respondent used weatherboard/digital board for weather information. This tells respondents either do not aware that much about the mobile/web-enabled weather information service or they have other constraints which require further careful investigation. In addition to that, it would be also pertinent to carry out this survey in

other parts of the country, particularly the regions which are frequently affected by severe climate events and compare the findings to have better picture of this phenomenon.

4.1.8 Content appropriateness

The observed Content appropriateness scores of the respondents ranged from 2.00 to 4.00. The average Content appropriateness score was 3.1915 and the standard deviation was 0.429. The categories and distribution of the respondents were shown in Table 4.9

Table 4.9 Distribution of the farmers according to content appropriateness

SL NO.	Items	Not at all	Rarely appropriate	Somewhat appropriate	Appropriate	Very appropriate	Index
1	Rainfall forecasting	0	0	9 (7.9%)	63 (55.3%)	42 (36.8%)	375
2	Drought related information	0	0	16 (14.0%)	75 (65.8%)	23 (20.2%)	349
3	Flood forecasting	0	0	7 (6.1%)	62 (54.4%)	45 (39.5%)	380
4	Cyclones/storm forecasting	0	0	13 (11.4%)	58 (50.9%)	43 (37.7%)	372
5	Thunderstorm forecasting	0	2 (1.8%)	26 (22.8%)	66 (57.9%)	20 (17.5%)	332
6	Pest and disease-related forecasting	1 (1.8 %)	0	9 (7.9%)	59 (51.8%)	45 (39.5%)	372

From Table 4.9 it can be said that respondents were found to be satisfied with the quality of the contents received from various information sources regarding weather related events. That signifies the improvement of weather forecasting system in Bangladesh. However, there is still scope to make the forecasting nearly perfect particularly for thunderstorm and pest- and -disease-related forecasting.

4.1.9 Knowledge on weather events

Knowledge on weather events scores of the farmers ranged from 16 to 28 against possible score of 0 to 28. The average score and standard deviation were 21.23 and 2.64, respectively. Based on the weather events knowledge scores, the farmers were classified into two categories (Mean ± Standard Deviation) namely medium knowledge and high knowledge (Table 4.10).

Table 4.10 Distribution of the farmers according to their knowledge on weather events

Category	Range (years)		Farmers		Mean	SD
	Score	Observed	Number	Percent	($\bar{x}$)	(σ)
Medium knowledge	10-18	16-28	18	15.8	21.23	2.64
High knowledge	Above 18		96	84.2		
Total			114	100		

Data presented in Table 4.10 reveals that 84.2 percent of the farmers had high weather related knowledge where 15.8 percent had medium knowledge related to weather events. Thus, an overwhelming majority (84.2%) of the farmers had high knowledge. This lead to understanding that weather events knowledge would be reflected more by high knowledge on weather events group in the present study. Knowledge on weather events of the farmers is definitely affected by the education of the farmers because education helps to enhance the eagerness to be acquainted with new variety or technology. In addition, knowledge on weather events of the respondent is definitely affected by the extension contact because with the increase of the communication exposure to new thing. Knowledge on weather events is very important aspects for ensuring adaptive capacity towards climatic variability. Farmers lives on farming. Hence, they must require skill and modern knowledge to get more yield and profit to minimize climatic variability effects.

4.2 Extent of adaptive capacity towards climatic variability

The observed score of Extent of adaptive capacity towards climatic variability ranges from 1.83 to 5.00. The average and standard deviation were 3.88 and 0.6422 respectively. The categories and distribution of the respondents were shown in Table 4.11.

Table 4.11 Distribution of the farmers according to their adaptive capacity towards climatic variability

SL NO.	Items	SD	D	N	A	SA	Overall index
1	I am better able to get weather-related information using BAMIS/ BMD apps	0	1 (.9%)	33 (28.9%)	65 (57.0%)	15 (13.2%)	436
2	Receiving information earlier helps me to adopt useful	0	1 (.9%)	32 (28.1%)	58 (50.9%)	23 (20.2%)	445

	strategies against the weather-based events						
3	I am now better informed about weather-based events than I used to before	0	1 (.9%)	37 (32.5%)	60 (52.6%)	16 (14.0%)	433
4	Receiving weather information earlier helps to reduce economic loss	0	2 (1.8%)	35 (30.7%)	55 (48.2%)	22 (19.3%)	439
5	Timely and accurate weather information helps me to plan my farming activities better (e.g., sowing, irrigating, pesticide application, harvesting)	0	2 (1.8%)	26 (22.8%)	54 (47.4%)	32 (28.1%)	458
6	Overall, I am now more confident (i.e., more resilient and less vulnerable) about the weather concerning my farming (e.g., which crop to grow, when to grow, crop rotation, crop calendar)	1 (.9 %)	1 (.9%)	28 (24.6%)	63 (55.3%)	21 (18.4%)	444

The information gained from the field study (Table 4.11) shows the opinion of the respondents about the adaptive capacity, where it was strongly agreed by 57.0% respondents that they were better able to use BAMIS/ BMD apps to update weather-forecasting information which can save time and mental stress about upcoming natural abnormalities behavior as well as help to take necessaries precautions. Furthermore, 52.6% respondents agreed that receiving information in advance helps them to adopt useful strategies against the weather-based events. Besides, 48.2% acknowledged that receiving weather information earlier helps to reduce economic loss thorough taking useful strategies. Furthermore, nearly half of them (47.4%) agreed to be benefitted thorough timely and accurate weather information which helps them to plan their farming activities better (e.g., sowing, irrigating, pesticide application, harvesting). Apparently, majority of them were found more confident to handle adverse impact of weather events, if they receive timely weather information.

4.3 The Contribution of the selected characteristics of the respondents to their adaptive capacity towards climatic variability

In order to estimate the farmers adaptive capacity towards climatic variability, the multiple regression analysis was used which is shown in the Table 4.12.

Table 4.12 multiple regression coefficients of the contributing variables related to the adaptive capacity towards climatic variability

Dependent variable	Independent Variable	β	P	R^2	Adj. R^2	F
Adaptive capacity towards climatic variability	Age	-.136	.192	.426	.376	8.581
	Level of education	-.112	.198			
	Farming experience	.231	.035*			
	Extension contact	.245	.007**			
	Duration of training	.131	.119			
	Media ownership	.324	.002**			
	Extent of use of Information sources	.052	.609			
	Content appropriateness	.225	.006**			
	knowledge on weather events	.122	.224			

- ** Significant at $p<0.01$; *Significant at $p<0.05$

Among the nine variables, four variables namely farming experience, extension contact, media ownership and content appropriateness were found to be the significant positive influence to the extent of adaptive capacity towards climatic variability for agricultural farming. The remaining five variables, age, level of education, duration of training, extent of use of information sources and knowledge on weather events while did not find significant at 5% and at 1% level of significance. All the variables to some extent influence farmers' adaptive capacity towards climatic variability. These variables altogether contribute 42.6% of the variance of their adaptive capacity towards climatic variability (adj. R^2= 37.6%). The overall model was found significant (F=8.581).

Contribution of farmers' farming experience to their adaptive capacity towards climatic variability

The contribution of farming experience to farmers' adaptive capacity towards climatic variability was measured by testing the following null hypothesis; "there is no level of contribution of farming experience to farmers' adaptive capacity towards climatic variability".

The adjusted p value of the concerned variable was found 0.035. The following observations were made on the basis of the value of the concerned variable of the study under consideration.

 The contribution of education was significance at 5% level. So, the null hypothesis could be rejected.

Unstandardized coefficients are the 'raw' coefficients created by the regression analysis when the analysis is performed on the original unstandardized variables. The unstandardized coefficient represents the amount of change of the dependent variable Y due to the change of 1 unit of the independent variable X. A standardized beta coefficient compares the strength of the influence of each independent variable to the dependent variable. The higher the absolute value of the beta coefficient, the stronger the effect. From the Table 4.12 standardized beta coefficient .231 which clearly represent the positive effect of farming experience on the extent of adaptive capacity towards climatic variability of the farmers. As higher the farming experience, the extent of adaptive capacity towards climatic variability of the farmers is higher and lower the farming experience, lower the adaptive capacity towards climatic variability of the farmers.

Based on the above finding, it was concluded that a respondent had more farming experience increased his/her adaptive capacity towards climatic variability. Experience broadens the horizon of knowledge and its surroundings. An experience farmer can take right decision in mitigating climate change effect in a timely manner.

Contribution of extension contact to farmers' adaptive capacity towards climatic variability

The contribution of extension contact to farmers' adaptive capacity towards climatic variability was measured by testing the following null hypothesis; "there is no level of contribution of extension contact to farmers' adaptive capacity towards climatic variability."

The adjusted p value of the concerned variable was found 0.007. The following observations were made on the basis of the value of the concerned variable of the study under consideration.

 The contribution of ICT ownership was significance at 1% level. So, the null hypothesis could be rejected.

Unstandardized coefficients are the 'raw' coefficients created by the regression analysis when the analysis is performed on the original unstandardized variables. The unstandardized coefficient represents the amount of change of the dependent variable

Y due to the change of 1 unit of the independent variable X. A standardized beta coefficient compares the strength of the influence of each independent variable to the dependent variable. The higher the absolute value of the beta coefficient, the stronger the effect. From the Table 4.12, standardized beta coefficient .245 which clearly represent the positive effect of extension contact to farmers' adaptive capacity towards climatic variability. As much the extension contact, farmers' adaptive capacity towards climatic variability is higher and lesser the extension contact, lower the farmers' adaptive capacity towards climatic variability.

Based on the above finding, it was concluded that a respondent had more extension contact increased their adaptive capacity towards climatic variability. Extension contact enhances the abilities of the farmers to adopt a new technology at a short time than others. In fact, extension contact make up-to-date the farmers. Therefore, they can make more consent decision regarding adoption of adaptation strategies related to weather events.

Contribution of media ownership to farmers' adaptive capacity towards climatic variability

The contribution of media ownership to farmers' adaptive capacity towards climatic variability was measured by testing the following null hypothesis; "there is no level of contribution of media ownership to farmers' adaptive capacity towards climatic variability".

The adjusted p value of the concerned variable was found 0.002. The following observations were made on the basis of the value of the concerned variable of the study under consideration.

- The contribution of media ownership was significance at 1% level. So, the null hypothesis could be rejected.

Unstandardized coefficients are the 'raw' coefficients created by the regression analysis when the analysis is performed on the original unstandardized variables. The unstandardized coefficient represents the amount of change of the dependent variable Y due to the change of 1 unit of the independent variable X. A standardized beta coefficient compares the strength of the influence of each independent variable to the dependent variable. The higher the absolute value of the beta coefficient, the stronger the effect. From the Table 4.12, standardized beta coefficient .324 which clearly represent the positive effect of media ownership on extent of adaptive capacity towards climatic variability of the farmers. As much the media ownership, farmers' adaptive capacity towards climatic variability of the farmers is higher and lesser the media ownership, lower adaptive capacity towards climatic variability of the farmers.

Based on the above finding, it was concluded that a respondent had more media possession increased farmers' adaptive capacity towards climatic variability. Media ownership enhances the abilities of the farmers to adopt a new technology at a short time than others. In fact, ICT/media ownership make them up-to-date the farmers. Therefore, they can make more consent decision regarding technology (BAMIS, BMD, etc) use as well as adopt proper adaptation strategies.

Contribution of content appropriateness to farmers' adaptive capacity towards climatic variability

The contribution of content appropriateness to farmers' adaptive capacity towards climatic variability was measured by testing the following null hypothesis; "there is no level of contribution of content appropriateness to farmers' adaptive capacity towards climatic variability".

The adjusted p value of the concerned variable was found 0.006. The following observations were made on the basis of the value of the concerned variable of the study under consideration.

 The contribution of content appropriateness was significance at 1% level. So, the null hypothesis could be rejected.

Unstandardized coefficients are the 'raw' coefficients created by the regression analysis when the analysis is performed on the original unstandardized variables. The unstandardized coefficient represents the amount of change of the dependent variable Y due to the change of 1 unit of the independent variable X. A standardized beta coefficient compares the strength of the influence of each independent variable to the dependent variable. The higher the absolute value of the beta coefficient, the stronger the effect. From the Table 4.12, standardized beta coefficient .225 which clearly represent the positive effect of content appropriateness on extent of adaptive capacity towards climatic variability of the farmers. As much the appropriateness of weather related update from weather related apps (like BAMIS, BMD, etc.), farmers' adaptive capacity towards climatic variability is higher and lesser the appropriateness of provided weather based information, lower adaptive capacity towards climatic variability.

CHAPTER V

SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

This chapter presents summary of findings, conclusions and recommendations of the study.

5.1 Summary of Findings

5.1.1 Selected factors that influence farmers' extent of adaptive capacity towards climatic variability

Findings in respect of the 9 (nine) selected factors that influence farmers' extent of Adaptive capacity are summarized below:

Age

An overwhelming majority (43.9%) of the respondents was old aged and 42.1% was middle aged and 14.0% was young aged. The standard deviation was 11.01 and mean was 49.19.

Education

Almost all of the farmers had different level of education. Among them 49.1% of the respondents were comprised of secondary education, 31.6 percent had higher secondary education, 16.70% were primary education, and rest 2.6% were can sign only education level.

Farming experience

Farming experience of the farmers in the study area varied from 3 to 50. The average farming experience was 23.80 and standard deviation of 10.043. The majority (68.4 percent) of the rural farmer fell in medium farming experience category, whereas 15.8 percent in low experience category and 15.8 percent in high farming experience category.

Extension contact

The observed Extension contact scores of the respondents ranged from 0.00 to 4.00. The average perceived usefulness score was 1.255 and the standard deviation was 0.537. 40.4% of the respondents regularly contacted with neighbor/ fellow farmers/ friends/ relatives while 50% of the respondents rarely contact input dealers for weather related agricultural information. On the contrary, 9.6% respondents regularly contacted to local extension workers for their farming. In case of farmers' meeting at upazila/district, attend farmers' field days or agricultural fair, attend method or result demonstration showed that majority percentage of respondents (50%, 61.4%, and 54.4% respectively) never to rarely used these media for weather related variability.

Duration of training

Training duration score of the farmers ranged from 0 to 10 with a mean and standard deviation of .21 and 1.076, respectively. Highest proportion (93 percent) of the rural farmers had no training exposure compared to 5.3 percent in low training exposure and the lowest proportion (1.8 percent) had moderation training exposure.

Media ownership

Among the farmers 99% of the respondents had access to mobile phone while nearly 1% had shared access to mobile phone where 41 respondents had smart phone and 72 farmers had featured phone. However, more than half of the respondents (57%) had no access to the Internet. Similarly, 60% respondents did not own any computer devices. Interestingly, majority of the respondents owned Television (99.1%) compared to radio (33.3%). Thus, 57.0% of the respondents have no access to Internet connectivity where as 32.5% and 10.5% of the respondents have shared access and owned by myself respectively. Forty-three (43%) of the respondents have either full or shared access to the Internet compared to almost everyone own mobile phone.

Extent of use of Information sources

It is revealed that respondents still mostly depend on the traditional mass media like Television (70.2%) and Radio (29.8%) for weather information. Despite mobile phone access is the highest among the respondents, around one-fourth of them (25.4%) used it for receiving weather information. Almost no respondents used weatherboard/digital board for weather information.

Content appropriateness

Respondents were found to be satisfied with the quality of the contents received from various information sources regarding weather related events. The opinion of the respondents about the Content appropriateness, where it was responded by 55.3% respondents that they get appropriate information from various media related to weather events (rainfall), Furthermore, 65.8% respondents agreed that they seemed that there received information quite satisfactory with latest weather related information from BAMIS or local extension office. Besides all of these 54.4% farmers agreed that they got effective information in case of Cyclones/storm forecasting through BAMIS or local extension office and also 50.9% respondents agreed that appropriateness of information through BAMIS portal is satisfactory level.

Knowledge on weather events

Findings revealed that 84.2% of the farmers had high knowledge where 15.2% had higher knowledge on weather events.

Extent of adaptive capacity towards climatic variability of the farmers

57.0% of the respondents agreed that they were better able to use BAMIS/ BMD apps to update weather-forecasting information where 28.6% respondents' response that they were no opinion, Furthermore, 52.6% respondents agreed that their received information earlier helps him/her to adopt useful strategies against the weather-based events. Besides all of these 48.2% people agreed that receiving weather information earlier helps to reduce economic loss and also 47.4% respondents agreed to be benefitted thorough timely and accurate weather information.

5.1.2 Contribution of the factors to farmers' Extent of adaptive capacity towards climatic variability

Multiple regression analysis revealed that nine (9) selected factors altogether explained 42.6% (R^2 = .426) of the variance of Farmers' adaptive capacity towards climatic variability. Among the factors, respondents' farming experience, extension contact, media ownership and content appropriateness were found to be positive and significantly contribute to their extent of adaptive capacity towards climatic variability while rest of the factors were found to be non-significant.

5.2 Conclusions

Findings of the present study and the logical interpretation of other relevant facts prompted the researcher to draw the following conclusions:

1. Only 15.7% farmers had frequent to regular contact with local extension worker but majority percentage (73.7%) of the farmers had no remarkable contact with local extension worker. So, there is still a scope to enhance local extension

worker services, so that farmers can take appropriate information at the right time to take right action.

2. Here only 7.8% respondents had moderate to low training but 92.2% farmers had no exposed to training. So, It may be recommended that agricultural extension agencies especially the DAE and relevant NGOs should critically review their training programs and make sound provisions. The DAE and other non-governmental organizations should strengthen their extension program.
3. Media ownership has greatly led to the use of handheld communication media by respondents. It can therefore be suggested that Media ownership is one of the primary predictors of Media use, and higher Media ownership might lead to higher use of handheld communication media for gathering information on the weather related events for agricultural farming. 43.0% farmers had full access to share access to the Internet service for using weather related apps (like BAMIS, BMD, etc.) as extent of use of handheld communication media and 99.1% farmers use mobile phone on daily basis.
4. 69.7% of respondents had never to rarely use of mobile phone for weather related information gathering. So, there is still a scope to enhance ICTs based department services, so that farmers can use ICT related tools for information gathering sources effectively and efficiently. Nearly most of the respondents' (74.6%) responsed that social media could not play significant role in case weather related update. Country meteorological department can update weather related forecasting. At overwhelmingly majority of the responses (97.4%) did not use Weather-related mobile app (e.g., BAMIS Portal, BMD Weather app) yet. So, BWD and DAE should strengthen their extension service and motivational program should be enhanced so that farmers can adapt and use mobile app. Extent of use of information sources had a positive significant effect with their adaptive capacity towards climatic variability, and it is no surprise that more ICT used respondents find more solutions against weather – related events.
5. Content appropriateness significantly contributed to the respondents'- adoption capacity towards climatic variability. Therefore, it may be concluded that content appropriateness is one of the important predictors towards adaptation with climatic variability and higher content appropriateness will lead to higher use of weather - related apps positively for receiving weather related

information as well as helping to make adaptation strategies. Most of respondents were satisfied with appropriateness of delivered information which is received from various sources. But in case of drought and thunderstorm (14% and 11.4%) opinioned that it was somewhat appropriate.

6. Majority (84.2%) of the farmers had high knowledge. This lead to understanding that weather events knowledge would be reflected more by high knowledge on weather events group in the present study. Knowledge on weather events of the farmers is definitely affected by the education of the farmers because education helps to enhance the eagerness to be acquainted with new variety or technology. In addition, knowledge on weather events of the respondent is definitely affected by the extension contact because with the increase of the communication exposure to new thing. Knowledge on weather events is very important aspects for ensuring adaptive capacity towards climatic variability. Hence, they must require skill and modern knowledge to get more yield and profit to minimize climatic variability effects.
7. 57.0% respondents that they thought that they were better able to get weather information using BAMIS which can save time and mental stress about upcoming natural abnormalities behavior as well as help to take necessaries precautions.

5.3 Recommendations

5.3.1 Recommendation for policy formulation

On the basis of the findings revealed from the study, the following recommendations are put forwarded that might guide the policy formulation:

1. Media ownership had a significant contribution on their adaptive capacity towards climatic variability and almost all the respondents either had direct or shared access to handheld weather related apps, particularly mobile phone. Therefore, more mobile-phone enabled applications should be designed and implemented so that small-scale farmers can easily access to those applications and receive updated weather related information.
2. Extension contact had a significant positive contribution on adaptation capacity of respondents towards climatic variability. It may be recommended that agricultural extension agencies especially the DAE and relevant NGOs should

critically review their extension programs and make sound provisions so that the farmers understand the benefits of use of weather related apps like BAMIS / BMD apps . The DAE and other non-governmental organizations should strengthen their extension.

3. Since content appropriateness is very important for a user to use the weather related apps like BAMIS / BMD, etc, Bangladesh Meteorological Department and Bangladesh Water Development Board of Government of the People's Republic of Bangladesh along with private sectors should promote ICT self-efficacy training to the rural clienteles. Therefore, rural farmers may upgrade their skills and enable them to minimize their economic loss due to weather related natural calamities. There is an opportunity to provide reliable Agro-Meteorological information to farming community effectively. Agro-Meteorological information for sustainable agricultural development is needed to disseminate information to the farmer in their understandable language to plan their farming activities more efficiently.
4. Farmers should also learn about the usefulness of weather-related apps (like BAMIS/ BMD apps) that they could easily use to adopt useful strategies against the weather-based events and timely and accurate weather information helps them to plan their farming activities better. Therefore, extent of contact should be strengthen in the study area.

5.3.2 Recommendation for further study

1. The study was conduct Gangachara upazila of Rangpur District. Similar studies should be conducted in other parts of the country to get a clear picture of the whole country which will be helpful for effective policy formulation.
2. The present study was undertaken to explore contribution of nine selected drivers that influence to farmers' extent of use of weather related apps. Therefore, it could be recommended that further studies should be designed considering other agricultural and nonagricultural activities and including other characteristics of the farmers that might affect the extent of adaptation capacity towards climatic variability.
3. In the present study farming experience, extension contact, media ownership, content appropriateness had significantly contribute to farmers' adaptation

capacity towards climatic variability. In this connection, further verification is necessary for non-contributing characteristics.

4. It is difficult to determine actual extent of adaptive capacity of the farmers towards climatic variability. Measurement of extent of adaptive capacity towards climatic variability of the farmers is not free from questions. Therefore, more reliable measurement of concerned variable is necessary for further study.
5. Research should also be undertaken to identify to other factors causing hindrance to the extent of adaptive capacity towards climatic variability.

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APPENDIX-A

An English Version of the Interview Schedule

Department of Agricultural Extension & Information System

Sher-e-Bangla Agricultural University

Dhaka-1207

Interview Schedule for data collection for the Research on

"Adaptive Capacity of Rural Farmers Towards Climate Variability: Role of Mobile-enabled Weather Information Systems"

(This interview schedule is entitled to a research study. Collected data will only be used for research purpose and will be published aggregately)

Serial no. Name of respondent………

Village………………….. Union…………… Thana ………….

District ……………. Mobile No…

(Please provide the following information. Give tick (√) marks if necessary. Your information will be kept confidential and will be used research purpose only.)

1. **Age:** Please mention your age ....years.

2. **Level of Education:** Please mention your educational level:

   a) Can't read and write……………………..

   b) Can sign only ……………...………..

   c) Up to or equivalent to class...........................

3. **Eexperience:** How long have you been engaged in farming activities?

……………….…………. (Years).

4. **Extension contact:** Please mention how frequently you contact with following sources for farm-related / cimate variability related information

Sl No.	Sources of contact	Extent of contact with different information sources				
		Not at all (0)	**Rarely (1)**	**Occasionally (2)**	**Very often (3)**	**Regularly (4)**
1	Neighbor/ fellow farmers/ friends/ relatives		1-2 times/ month	3-4 times/ month	5-6 times/ month	>6 times/ month
2	Input dealers (e.g., pesticide, irrigation, fertilizer)		1-2 times/ month	3-4 times/ month	5-6 times/ month	>6 times/ month
3	Group leaders/ progressive farmers		1-2 times/ month	3-4 times/ month	5-6 times/ month	>6 times/ month
4	Local extension worker (e.g., SAAO, NGO workers)		1-2 times/ month	3-4 times/ month	5-6 times/ month	>6 times/ month
5	Local extension officials (e.g., AAEO, AEO, UAO)		1-2 times/ 6 months	3-4 times/ 6 months	5-6 times/ 6 months	>6 times/ 6 months
6	Farmers' meeting at upazila/district		1-2 times/ 6 months	3-4 times/ 6 months	5-6 times/ 6 months	>6 times/ 6 months
7	Attend farmers' field days or agricultural fair		1-2 times/ 6 months	3-4 times/ 6 months	5-6 times/ 6 months	>6 times/ 6 months
8	Attend method or result demonstration		1-2 times/ 6 months	3-4 times/ 6 months	5-6 times/ 6 months	>6 times/ 6 months

5. Duration of training: Have you ever received any form of training and how long were passed for climate/ weather issues?

Yes ☐ **No** ☐ If yes, please furnish the following information

- **Name of the training:**
- **Duration of training:** (in days)
- **Name of the organization provided the training:**

6. Media ownership: Please mention the ownership status and access to the following media.

Sl No.	Information media	Own by myself (2)	Don't own but have access to, and use when necessary (1)	No access (0)
1	Mobile phone*			
2	Internet connectivity			
3	Television			
4	Radio			
5	Computer			

***Type of mobile phone: a) Smartphone b) Featured phone**

7. Information sources of weather events: Please mention which of the following sources that you use the most for receiving weather-related information such as temp, rainfall, cyclone, flood, drought, salinity.

Sl No.	Technologies (Info. sources)	Never (0)	Rarely (1)	Occasionally (2)	Often (3)	Regularly (4)
1	Mobile phone (e.g., SMS, Voice Call)					
2	Television news					
3	Radio news					

4	Friends/ reletive/ fellow farmers					
5	SAAO from the local extension office					
6	Weatherboard/ digital dashboard					
7	Social media					
8	Announcement from local administrative office like Upazilas					
9	Weather-related mobile app (e.g., BAMIS Portal, BMD Weather app)					
10	Circular letter from local extension office					

8. Content appropriateness: Please mention your opinion regarding the appropriateness of the weather-related information that you receive from BAMIS or local extension office that influences your farming decision. (Scale: Not at all appropriate (0) to Very appropriate (4))

Sl No.	Information content	Degree of appropriateness				
		Not at all (0)	Rarely appropriate (1)	Somewhat appropriate (2)	Appropriate (3)	Very appropriate (4)
1	Rainfall forecasting					
2	Drought related information					
3	Flood forecasting					
4	Cyclones/storm forecasting					

5	Thunderstorm forecasting					
6	Pest and disease-related forecasting					

9. Knowledge of weather events: How knowledgeable are you at several weather events? Please answer the following questions:

Sl No.	**Items**	**Full marks**	**Obtain marks**
A.	**Remembering**		
1	Name a few climate events?	**2**	
2	What are the differences between weather and climate?	**2**	
3	Could you please give an example related to climate change?	**2**	
B	**Understanding**		
4	How does climate change affect our health?	**2**	
5	Do you find any relation to increasing temperature, floods, and drought with climate change? If yes, what are the relations?	**2**	
C	**Applying**		
6	What strategy do you adopt when your crop fields are affected by drought?	**2**	
7	What measure do you practice in keeping soil moisture level optimum for your crop?	**2**	
8	In what weather conditions do you prefer to go early harvesting of your crop?	**2**	
D	**Analyzing**		
9	In what weather conditions, crops are more prone to pest and disease infestation?	**2**	
10	What is the impact of excessive use of groundwater for irrigation?	**2**	
E	**Evaluating**		

11	Do you think tree plantation help use to reduce the negative effect of climate change? How?	**2**	
12	Do you think crop rotation could be a technique that helps to make the best use of natural resources with regard to climate change? If yes, please explain how?	**2**	
F	**Creating**		
13	Mention two adaptive strategies you follow with regard to climate change such as flood, cyclone and salinity.	**2**	
14	Explain how timely access to weather information enables you to adopt better measures in minimizing economic loss.	**2**	
Total		**28**	

10. Building adapative Capacity: Please mention your agreement or disagreement with the following statements about the impact of weather-related information you are received from BAMIS/BMD for your farming activtities.

Your responses will be captured in a scale ranging from 'Strongly Disagree (1) to Strongly Agree (5).'

Sl No.	Statements	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
1	I am better able to get weather-related information using BAMIS/ BMD apps					
2	Receiving information earlier helps me to adopt useful strategies against the weather-based events					
3	I am now better informed about weather-based events than I used to before					
4	Receiving weather information earlier helps to reduce economic loss					

5	Timely and accurate weather information helps me to plan my farming activities better (e.g., sowing, irrigating, pesticide application, harvesting)					
6	Overall, I am now more confident (i.e., more resilient and less vulnerable) about the weather concerning my farming (e.g., which crop to grow, when to grow, crop rotation, crop calendar)					

Thanking You.

Name of the Enumerator:

Cell:

Contact No of the Respondent: