CHARLAND FARMERS' ADAPTATION STRATEGIES TOWARDS ADVERSE EFFECTS ON THEIR FOOD SECURITY UNDER BRAHMANBARIA DISTRICT

SADIA SULTANA

DEPARTMENT OF AGRICULTURAL EXTENSION &

INFORMATION SYSTEM

SHER-E-BANGLA AGRICULTURAL UNIVERSITY

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SADIA SULTANA

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APPROVED BY:

(Dr. Mohummed Shofi Ullah Mazumder) Supervisor Professor Dept. of Agril. Ext. and Info. System Sher-e-Bangla Agricultural University	**(Dr. Md. Rafiquel Islam)** Co-Supervisor Professor Dept. of Agril. Ext. and Info. System Sher-e-Bangla Agricultural University

Prof. Dr. Mohammad Zamshed Alam
Chairman
Examination Committee
Dept. of Agricultural Extension and Information System
Sher-e-Bangla Agricultural University

Department of Agricultural Extension and Information System
Sher-e-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka-1207

CERTIFICATE

This is to certify that the thesis entitled **"CHARLAND FARMERS' ADAPTATION STRATEGIES TOWARDS ADVERSE EFFECTS ON THEIR FOOD SECURITY UNDER BRAHMANBARIA DISTRICT"** submitted to the department of Agricultural Extension and Information System, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka in partial fulfillment of the requirements for the degree of Master of Science (M.S.) in Agricultural Extension, embodies the result of a piece of bona fide research work carried out by **SADIA SULTANA, Registration No. 19-10069** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information, as has been availed of during the course of this investigation has been duly acknowledged by the Author.

Dated:

Dhaka, Bangladesh

Dr. Mohummed Shofi Ullah Mazumder
Supervisor
Department of Agricultural Extension
and Information System
Sher-e-Bangla Agricultural University

DEDICATED

TO

MY BELOVED

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ABBREVIATIONS

Ag. Ext. Ed.	Agricultural Extension Education
β	Multiple Regression
BBS	Bangladesh Bureau of Statistics
GDP	Gross Domestic Product
DAE	Department of Agricultural Extension
et al.	All Others
FAO	Food and Agriculture Organization
CCC	Community Counseling Center
GoB	Government of Bangladesh
MoA	Ministry of Agriculture
DoE	Department of Environment
MoYS	Ministry of Youth and Sports
NAPA	National Adaptation Plan of Action
MoEF	Ministry of Environment and Forest
BINA	Bangladesh Institute of Nuclear Agriculture
GHGs	Emission of Greenhouse Gases
IPCC	Intergovernmental Panel for Climate Change
CC	Climate Change
UAO	Upazila Agriculture Officer
SAU	Sher-e-Bangla Agricultural University
SPSS	Statistical Package for Social Sciences
BRRI	Bangladesh Rice Research Institute
DCRMA	Disaster and Climate Risk Management in Agriculture
AAS	Agriculture Advisory Society
RVCC	Reducing Vulnerability to Climate Change

CHARLAND FARMERS' ADAPTATION STRATEGIES TOWARDS ADVERSE EFFECTS ON THEIR FOOD SECURITY UNDER BRAHMANBARIA DISTRICT

SADIA SULTANA

ABSTRACT

Food security is a condition related to the supply of food, and individuals' access to it. The research was designed to investigate farmers' food security status. The purpose of the study were to describe socio-economic profile of the farmers; to determine farmers' extent of adaptation strategies towards adverse effects on their food security and to explore the contributing factors that influence farmers' adaptation strategies towards adverse effects on their food security. The study was purposively conducted at Nabinagar upazila under Brahmanbaria district. Validated and well-structured interview schedule (questionnaire) was used to collect data from 103 farmers during February 20 to March 20, 2021. Descriptive statistics, multiple regressions were used for analysis. The majority (66.99%) of the farmers had medium adaptation strategies compared to 8.74 percent had high and 24.27 percent had low adaptation strategies, respectively. Among ten selected characteristics of the farmers four characteristics, namely education, farming experience, professional training experience and agricultural extension media contact had significant positive contribution to their adaptation strategies towards adverse effects on their food security. The rest six characteristics namely age, family size, farm size, annual family income, organizational participation, food availability and food stock ability had no significant contribution to their adaptation strategies towards adverse effects on their food security. Based on the findings, it is recommended that respective authorities should implement and popularize farmers projects on a massive scale for achieving household food security status of the farmers.

CHAPTER 1
INTRODUCTION

1.1 General Background of the Study

Charland farmers experience adverse impacts on living, livelihood, and their development and the situation is worst in the underprivileged rural areas of developing countries (Bhuiyan *et al.,* 2017; Malakar and Mishra, 2017). Natural hazards are not only an environmental issue but also a vital development issue for a developing country. It is believed that climate change increases such hazardous events, which has detrimental effects on socio-economic development and living communities (Islam *et al.,* 2015; Panthi *et al.,* 2016 and Simotwo *et al.,* 2018). Every community develops their own way of survival following the characteristics of natural hazards, and the pattern of changes in both biotic and abiotic components of the environment (Panthi *et al*., 2016). Usually community copes up with those changes in long term through the development of its socio-economic components (Pinho *et al.,* 2014 and Sherman et al., 2015). But, the recent changing of climatic variables significantly affect the ways of living in a community (IPCC, 2007).

Climate change is a natural phenomenon, as it is changing since the origin of the earth (Smith, 2007). However, the rate of climate change in nature is very slow where the species of lives would have enough time to cope up the change. If the change is accelerated by anthropogenic activities, then, it would take place in higher rate, which will not allow species to adapt with that rapid changes (Ayanlade *et al.,* 2018).

Charland farmers risks, including extreme events such as cyclones, excessive rainfall, and consequent flooding and waterlogging, soil salinity, and river bank erosion, have been widely acknowledged to negatively affect rural livelihoods in South Asia's coastal regions (Dastagir, 2015; Karim and Mimura, 2008). The geographical location of Bangladesh with its relatively low-lying, flat

topography, renders it one of the most vulnerable countries in the world to climate risks (IPCC, 2007). Without adaptation and improvements in coastal embankment systems, a one-meter rise in sea level resulting from longer-term climate change could flood 18% of the country's land area (Khan *et al.*, 2010). Riverine flooding and waterlogging resulting from high-intensity rainfall events also adversely affect the livelihood of rural communities (Ruane *et al*., 2013; Thomas *et al.*, 2013). With a 32 cm rise in sea level, and consequent salinization processes, the area suitable for the cultivation of rainfed "aman" rice (i.e., the main season rice) that provides most of the calories consumed in Bangladesh could decline by up to 60% (Pender, 2008).

Almost six million people are already exposed to soil and water salinity in the coastal region, which is affected by upstream water diversions and can be accelerated with sea-level rise and climate change (Krupnik *et al.*, 2017). By 2050 and 2080, unchecked progress in salinity could affect the life and livelihood of 13.6 and 14.8 million people, respectively (Khan *et al.*, 2010). Extreme weather events are predicted to become more frequent and intense in the future, with potentially serious negative consequences on the livelihood of millions of farmers in Bangladesh (Dastagir, 2015; Dewan, 2015; IPCC, 2007; Karim and Mimura, 2008).

Impacts of these climatic risks are particularly severe for smallholder farmers that make up the bulk of the rural population in Bangladesh. As the agriculture sector contributes 13% of the country's gross domestic product and employs 48% of the labor force (World Bank, 2019), adaptation to climatic risks requires special attention. In addition to the immediate problems associated with developing more climate-resilient agricultural systems, institutional inefficiencies, poorly developed infrastructure, and the region's generally high population pressure pose additional development challenges. The degree to which rural communities are vulnerable to these risks not only depends on their initial severity, but also on secondary effects including new pests and diseases

that result from changes in the climate, in addition to the adaptive capacity of the farming community (Baker *et al.,* 2012). Given that farmers can use several strategies to deal with climate risks, in this study, we examine the major climate risks faced by farmers in the southwestern coastal region of Bangladesh and discuss major adaptation strategies they adopt to minimize vulnerability.

Though climate change affects all farmers, it is expected to disproportionately affect poor and marginalized communities that depend entirely on agriculture for their livelihoods and who have a low level of resource endowment and capacity to adapt to such changes (FAO, 2012 and World Bank, 2011). Female farmers in developing countries are most vulnerable to climate risk due to their low capacity to adapt arising from limited access to livelihood assets such as financial, physical, social, and human capital. These effects may also be important to understand the adaptation decisions made by farmers, and the ways in which farmers with different levels of assets, livelihood strategies, and how men and women differentially mitigate climate risks. Review of the impacts of climate change on major cereal crops in Bangladesh shows that it is generally negative, and thus, adaptation to climate change is crucial to reduce the vulnerability of the farming communities (Aryal *et al.,* 2019). Trans-disciplinary studies on climate change adaptation are proposed, with emphasis on socially-relevant topics that can affect public policy because much of the available literature focuses on economic considerations, with the less comprehensive literature on the environmental and social consequences of climate change (Rahman *et al.*, 2018).

In addressing these issues, an understanding of the ways in which farm households choose adaptation strategies is equally crucial as it has implications for development programs that improve access to resources and information (Bryan *et al*., 2009; Deressa and Hassan, 2009; Deressa *et al.*, 2011, 2009; Partey *et al.,* 2020 and World Bank, 2012). The socially constructed role of women as primary domestic providers in Bangladesh exerts a strong influence

on these challenges, as women's liberty to appear in public, migrate, own property, or make agricultural decisions can render them more vulnerable to climate shocks and disasters, and gendered experience of climate stress (Dilley *et al.,* 2005; Jordan, 2019 and Reggers, 2019). In Bangladesh, women are disproportionally affected by extreme climatic events, including cyclones (Kabir *et al.,* 2016). Further, gender norms may also restrict women from adapting to climate risks. Owing to different experiences, perspectives, and social capital, men and women's livelihoods and adaptation strategies are also likely to be different (Akter *et al.*, 2016; Corcoran-Nantes and Roy, 2018 and Reggers, 2019). Besides the differential access to resources, the ability to take hold of livelihood diversification opportunities influences the adaptive capacity of men and women (Deressa *et al*., 2009; Djoudi and Brockhaus, 2011 and Partey *et al*., 2020).

Adaptation is essential measure to reduce the impacts of salinity on farmers' livelihood. Adaptation strategies are activities that reduce the negative effects of salinity 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 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).

Adaptation measures are therefore important to help these communities to better face extreme weather conditions and associated climatic variations (Adger *et al*., 2003). So, it can be said some practices that are followed by farmers in their farm level or off-firm level traditionally or by learning that reduce negative effects of this dangerous climatic variation which hampers agricultural productivity. The main goal of adaptation towards salinity effects is reducing vulnerability and builds resilience to the impact bought by salinity. It is very important to create awareness and motivate farmers to take adaptive measure to mitigate its effects.

1.2 Statement of the Problem

In our country salinity is emerged as a devastating problem due to climatic hazards. Due to rising sea level resulting from climate change every year it gives an alarm to us the effects of climatic variations which include salinity intrusion. Salinity is increasing day by day in coastal region in our country. Like other country the people of coastal areas are suffering by its impacts. Around 37 million of people living in the coastal districts and 70 percent of them are engaged in farming activities (BBS, 2003). Every year farmers of the coastal region are facing new problems in crop production due to the boisterous effects of salinity and even they give up their regular farming activities and engaged in off firm activities. Finally, they are facing low income which leads to poor economic status. From this short discussion it can be said that salinity problem in Bangladesh is certainly a crucial development challenge and we need deeper understanding of people's adaption strategies and responses to mitigate climate effects and their adaptation extent towards the effects in agriculture. The study aimed at providing information about the following queries:

i. What is the scenario of socio-economic profile of farmers in study area?
ii. What is the extent of adaptation strategies of farmers towards adverse effects on their food security?

iii. Is there any contribution between the selected characteristics of farmers to their extent of adaptation strategies?

1.3 Specific Objectives of the Study

Specific objective(s) are pre-requisite for conducting any research work which gives a guideline to researcher to obtain concerned goal. From the above statement of problem, the researcher had set the following specific objectives:

i. To describe socio-economic profile of the farmers;
ii. To determine farmers' extent of adaptation strategies towards adverse effects on their food security; and
iii. To explore the contributing factors that influence farmers' adaptation strategies towards adverse effects on their food security.

1.4 Justifications of the Study

The main aim of the study was to determine the extent of farmers' adaptation strategies towards adverse effects on their food security under Brahmanbaria district. In our country salinity problem causes tremendous effects and it hampers our agricultural production in study areas. People do not cultivate crop comfortably for this problem. Salinity rise is a boisterous component of climate change which affects farmers seriously in socio-economic aspects. It is now recurrent phenomenon which is now an alarming discussion to every country in the world. People are taking indigenous adaptive measure against salinity effects which need to be enhanced scientifically to reduce its impact.

In our country Government and Non-Government organization has carried out different policies to mitigate the problem by enhancing and adopting some important adaptive measures by the farmers. Various studies were conducted about climate change, climatic hazards and its variation, adaptation of climate change in agriculture, but lack of study has conducted specifically on adaptation strategies towards effects of salinity problem which is a boisterous problem resulting from climate change effects. In our country farmers are

facing various problems in agriculture due to salinity and it is very important to challenge against the problem by adapting some measures. Considering the above circumstances, the researcher became interested to undertake a study entitled, 'Farmers' extent of adaptation strategies towards adverse effects on their food security under Brahmanbaria district.

1.5 Assumptions of the Study

The following assumptions have been taken into consideration for the present study: The researcher who acted as an interviewer was well aware of the social and cultural environment of the study area. Hence, the data collected by the researcher were free from bias and the respondents furnished their opinions without hesitations.

i. Respondent responses, views and opinions were the representative views and opinions of the whole target population.
ii. The respondents selected for the study were decent to satisfy, the exploration of research and their responses were reliable.
iii. The items, questions and scales used for measuring the variables were reasonably adequate to reflect the respondents' real answers.
iv. The findings of the study would be useful for planning and implementation of the program of extension services.

1.6 Limitations of the Study

Researcher had some limitations considering budget, time and other resources are noted below:

i. The study was confined to three villages in Nabinagar upazila under Brahmanbaria district.
ii. Characteristics of the farmers were many and varied. Only (10) ten characteristics were selected as independent variables for this study.
iii. Researcher was depended on only farming practices as adaptation strategies where farmers had also off-firm strategies towards adverse effects.

iv. In the study area around 15-20 farm practices was regularly or irregularly followed by farmers from where researcher was taken only ten (10) adaptation practices for determining adaptation extent.
v. For information about the study, the researcher has to depend on the data furnished by the selected respondent's instant memory during the interview time.
vi. Time allocation and budget was also limitation in this study.

1.7 Definition of related terms

In this study, the certain terms have been frequently used. These are defined and explained below for clarity of understanding to the investigator and readers.

Age: Age of the respondent refers to the period of the time in actual years from his birth to the time of interview.

Educational background: It was defined to the development of desirable changes in knowledge, skill and attitudes in an individual through reading, writing, working, observations and others activities. It was measured on the basis of classes passed from a formal educational institution by the respondents.

Farm size: The term related to the hectare of land owned by a respondent on which he carried out his farming activities, the area being estimated in terms of full benefit to the farmers. A farmer was considered to have full benefit from cultivated area either owned by her/ him or got lease from others and obtain half benefit from the area which was either cultivated by him on *borga* or given to others for cultivation on *borga* basis.

Farming experience: Farming experience refers to the experience of a farmer in agricultural works and expressed in years.

Annual family income: The term annual family income referred to the total earning by the earning members from agriculture, livestock, fisheries and other accessible sources (business, service, daily labor etc.) during a year. It was expressed in Thousand Taka.

Training experience: Training experience refers to the extent of participation of the farmers to any kind of training program offered by different organizations and agencies up to the time of interview.

Agricultural extension contact: It is a communication about agriculture-related information among agricultural stakeholders and between agricultural and non- agricultural stakeholders.

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

CHAPTER 2
REVIEW OF LITERATURE

An exertion was made in this Chapter to represent a brief review of related research information which gives a very clear direction to the researcher for selection research issue by identifying research gap. Review of literature forms a linkage between a past and present research works related to problem that helps an investigator to draw a satisfactory conclusion. However, no study was found systematic and directly related to the present study. Therefore, an attempt has been made to review and document closely related literatures in this Chapter available from books, journals, review papers, concept note, daily news papers, magazines, etc. Relevant literatures have been reviewed and illustrated in different sections as stated below:

2.1 Concept of Adaptation

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 (Finan, 2009). Sometimes it is 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 short- term 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).

2.2 Impact of Climate Change on Crop Production

Global atmospheric concentrations of greenhouse gases have significantly increased relative to pre-industrial times (Belay *et al.,* 2017 and Liang, 2018). As a result, greenhouse gas forcing is the main cause of the warming of the atmosphere during the past decades (Clapp *et al.,* 2018). This warming is expected to substantially alter the climate system and change global food production, mainly because temperatures are predicted to increase which in turn will alter the precipitation pattern and increase the frequency of extreme events such as drought (Lobell *et al.*, 2005; Fellmann, 2018; Abbas, 2017 and Ahmad, 2016). Man-made greenhouse gas emissions as a result of industrialization and urbanization have made significant contributions to global warming and further changes in the global climate. As a result, global temperature rose by 0.83°C from 1906 to 2010 (IPCC, 2007). Global warming also causes changes in precipitation levels and patterns due to higher evapotranspiration and water vapor amounts in the atmosphere with several

implications for the global hydrological cycle (Yang *et al*., 2017 and Jones, 2015). As the major water consumer of the developing world and some developed countries, agriculture is one of the most vulnerable water sectors to climate change (Asseng, 2017 and Ahmad *et al*., 2019). Dramatic population growth, associated with reduction of productive land area and water resources, exerts extra pressure on the agricultural sector. To ensure sustainability of agriculture, studying the possible climate change impacts on this sector is essential Ahmad *et al.,* 2018; Gupta *et al.*, 2017 and Lipper, 2014).

Rate of plant growth and development is dependent upon the temperature surrounding the plant and each species has a specific temperature range represented by a minimum, maximum, and optimum (Chen *et al*., 2015; Adhikari, 2016 and Campbell, 2016). The expected changes in temperature over the next 30–50 years are predicted to be in the range of 2–3°C Intergovernmental Panel for Climate Change (IPCC, 2007). Heat waves or extreme temperature events are projected to become more intense, more frequent, and last longer than what is being currently been observed in recent years (Reddy, 2002 and Amouzou *et al*., 2018). Extreme temperature events may have short-term durations of a few days with temperature increases of over 5°C above the normal temperatures (Rahman, 2018). Extreme events occurring during the summer period would have the most dramatic impact on plant productivity. A recent review by Barlow (2015) on the effect of temperature extremes, frost and heat, in wheat (*Triticum aestivum* L.) revealed that frost caused sterility and abortion of formed grains while excessive heat caused reduction in grain number and reduced duration of the grain filling period. Analysis by Meehl (2007) revealed that daily minimum temperatures will increase more rapidly than daily maximum temperatures leading to the increase in the daily mean temperatures and a greater likelihood of extreme events and these changes could have detrimental effects on grain yield. If these changes in temperature are expected to occur over the next 30 years then understanding the potential impacts on plant growth and development will help develop

adaptation strategies to offset these impacts (Diarra *et al.*, 2017 and Lesk *et al.*, 2016).

Previous studies of climate change impacts on agriculture, using crop yield simulation models (Ahmad *et al.*, 2018; Ewert, 2015; Williams *et al.*, 2015 and Ahmad *et al.*, 2018) or statistical models suggest that climate change will substantially affect productivity of major staple food crops such as maize, because growth and development of crops are mainly dependent on sunlight, temperature, and water (Aggarwal and Mall, 2002; Battisti, *et al.*, 2007 and Deutsch, 2018). Climate change may modify precipitation, soil water, runoff, and may reduce crop maturation period and increase yield variability and could reduce areas suitable for the production of many crops (Saseendran *et al.*, 2000; Deryng *et al.*, 2014 and Schlenker and Lobell, 2010). Climate change might limit crop production (the amount of a crop that is harvested in a farm, region, state, or country in kilograms or tons) in many areas (Kumar and Sharma, 2014; Carvalho, 2015 and Zhao and Li, 2015).

Temperature increases affect most plants, leading to crop yield reduction and complex growth responses (Masutomi *et al.*, 2009; Jones *et al.*, 2015 and Challinor *et al.*, 2014). Nevertheless, the impact of increasing temperatures can vary widely between crops and regions. For example, a 1°C increase in the growing period temperature may reduce wheat production by about 3–10% (You *et al.*, 2009), winter wheat productions may be decreased by 5–35%, respectively, under the future warmer and drier conditions (Özdoğan, 2011 and Bregaglio, 2017), and corn yield may be reduced by 2.4–45.6% due to higher temperatures (Iizumi *et al.*, 2011 and Tao and Zhang, 2010). Even if precipitation is unchanged, the crop production may decrease by 15% on average due to the reduction in crop growth period and increased water stress as the result of higher temperature and evapotranspiration (Schlenker and Lobell, 2010 and Yang *et al.*, 2017; Khanal *et al.*, 2018) expected precipitation reductions in arid and semiarid regions of the world, where water is already

limited, can have dramatic impacts on crop production (Araya *et al*., 2015 and Tong *et al*., 2016; Shi and Tao, 2014; Xiao and Tao, 2016). For example, in northwestern Turkey, winter wheat yield may decline more than 20% under future climate change because the growth periods can be shortened as a result of increased temperature, exacerbated by a reduction in precipitation (Özdoğan, 2011 and Srivastava *et al.,* 2018; Rurinda *et al*., 2015 and Xu *et al*., 2016). Higher reduction in wheat yield of 50% was found in Pakistan. In some other areas, climatic change might have positive influences on agricultural crop yield, i.e., in dry areas rainfall enhances under wet climatic warming can lead to improved crop productions like in Mexico the wheat yield would be increase by 25% in future. Maize, rice, winter wheat and potato crop yield can be enhanced with increasing air temperature and rainfall in the Plain of North China (Chavas *et al*., 2009).

2.3 Adaptation Strategies for Agronomic Crops

Climate change adaptation is the action to global warming, which helps to reduce the vulnerabilities in the social and biological system. The main objective of adaptation strategy is to build the resilient in societies against climate change (Smit and Wandel, 2006).

Agriculture sector is highly vulnerable to changing climate. Extreme weather conditions and changing patterns of precipitation affects the crop development, growth and yield of crops. High temperature at critical growth stages could reduce the grain filling duration caused the grains sterility and consequently yields reduction (Ahmad *et al.,* 2018). To avoid the risks in agriculture associated with climate change (CC), adaptation is the key factor that could help to mitigate the negative of climate change. Adaptation strategies provide an opportunity to address the CC challenges and to sustain the crop production (Fischer *et al*., 2002).

In the recent year, climate change adaptation has been explored by the farmers in many ways. For example, in Pakistan and Brazil farmers has adapted the climate change variability by adjustment of planting tine and optimization of plant populations (Ahmad *et al*., 2018 and Ahmad *et al.*, 2018). Adjustment of planting date is important to explore the fully potential of crop. High temperature at grain filling stage, reduce the time for grain filling that lead to decrease the yield. Adjusting the planting time with the onset of rains and heat waves would decrease the yield losses. Number of plants per unit area plays a vital role for higher yield in crops especially wheat. The number of productive tillers dies or remains unproductive due to variation in temperature and moisture stress. The optimum plant population compensates the yield loss. The development of improved varieties such as early maturing, drought and heat tolerant are necessary to sustain the productivity under changing climate. The new cultivars would increase the production per unit area under moisture stress and extreme temperatures (Deressa *et al*., 2009).

Methane gas is produced form the flooded rice. Flood water in rice blocks the oxygen to penetrate in soil that creates the favorable condition for bacteria that emit the methane gas. So new methods of planting like direct seeded rice and system of rice intensification with Alternate wetting and draying reduce the methane emission and increase the water use efficiency (Latif *et al.*, 2005).

Precision management of nutrients can increase the resilience in the crops by increasing the efficiency of fertilizers. Precision management of fertilizers in crops especially maize reduced the use of fertilizers that would enhance the production and soil health that led to decrease the emission of greenhouse gases (GHGs) (Srinivasan, 2006). Ratoon crop of sugarcane is more adaptive to climatic vulnerabilities. Fuel consumption is less for tillage practices, and less soil is disturbed that lead to reduce the GHGs emission. Pit planting is new evolutionary method in sugarcane. In this methods sugarcane seedling are grown in a small pit under field condition. This method improved the aeration

and solar radiation that led to increase the quality of cane juice and number of canes for milling (Yadav, 2004). Weeds are serious issue in the chickpea cultivation. Weeds compete with the chickpea plants for water and nutrients that reduce the growth and yield of chickpea. So integrated weed control improves the yield. GHGs emissions are also reduced due to less use of synthetic weedicides (Pedde *et al*., 2013).

2.4 Climate Related Issues

Bangladesh is a disaster-prone country and due to these unwanted events, the country experiences disasters of one kind or another (such as tropical cyclones, storm surges, coastal erosion, salinity intrusion, floods, and droughts) almost every year causing heavy loss of life and resources and jeopardizing the development activities (NAPA, 2005). Climate change has emerged as one of the greatest environmental challenges facing the world today (IPCC, 2007; Anik and Khan, 2012).

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 (MoEF, 2005; DoE, 2007; Shahid and Behrawan, 2008 and Pouliotte *et al*., 2009).

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 is most occurring factor of salinity (Yu *et al*., 2010).

Sea level rise has increased coastal flood frequency which caused salinity intrusion in coastal area (Ali, 2005). World Bank (2000), showed 0.10 m, 0.25 m and 1 m rise in sea level by 2020, 2050 and 2100; affecting 2%, 4% and 17.5% of total land mass respectively 1.0 centimeter per year sea level rise in Bangladesh which develops salinity. Salinity intrusion is a growing problem in around the globe, especially in the low-lying developing countries. The rate of salinity intrusion in coastal Bangladesh is faster than it was predicted a decade ago (Agrawala *et al*., 2003). The problem becomes exacerbated particularly in the dry season when rainfall is inadequate and incapable of lowering the concentration of salinity on surface water and leaching out salt from soil.

It has been found that the sea level rise of 0.5 m over the last 100 years has eroded approximately 162 km of Kutubdia, 147 km of Bhola and 117 km of Sandwip (CCC, 2007). Maximum soil salinity was observed in pre-monsoon, whereas, minimum was in monsoon in all coastal districts. It was observed that soil salinity starts increasing from post-monsoon and continued to increase in pre-monsoon when it reaches the highest level. Highest (1.14 ds/cm) soil salinity was measured in pre-monsoon at Shahporir Dwip of Cox's Bazar district while lowest (0.82 ds/cm) was in monsoon at Alaipur union of Khulna district (Hossain *et al*., 2012).

Salt occurs naturally in many of the world's wetland systems, whether it is from the ocean in estuaries and tidal marshes or from the ground and atmosphere in inland potholes and playas. Coastal wetlands are dominated by NaCl salts derived from the oceans, whereas inland wetlands may contain various salt combinations leached from bedrock and surface material, deposited from atmospheric salts and agricultural run-off. In addition to salt composition, inland wetlands may vary in salt concentration (Topping and Scudder, 1977).

2.5 Effects of Climate Change on Agriculture

Even though salinity intrusion is a slow process, but the effects are devastating. Based on observable symptoms, it is therefore assumed that agricultural lands in the coastal area will be affected by salinity (Sarwar, 2005). Sikder (2010) studied on long-term climatic and crop productivity data, regional climatic scenarios and impact analysis of different aspects of climate change on agriculture. The study reveals that the crop yield would be negatively impacted by salinity.

Soil salinization has been worldwide recognized as being among the most important problems for crop production in arid and semi-arid regions (FAO, 2008). Soil salinization affects an estimated 1 to 3 million hectares in Europe, mainly in the Mediterranean countries. It is regarded as a major cause of desertification and therefore is a serious form of soil degradation being salinization and sodification among the major degradation processes endangering the potential use of European soils. For instance, in Spain 3% of the 3.5 million hectares of irrigated land is severely affected, reducing markedly its agricultural potential while another 15% is under serious risk (EC, 2012). It is estimated that up to 20 % of irrigated lands in the world is affected somehow by different levels of salinity. In Iran for example, about 15% of lands, that is about 25 million ha, are suffering from this problem, including 0.32 million hectare of lands in Isfahan province (Feizi, 1993). Robertson *et al*., (2007) discussing dry land salinity problem in Western Australia found that "salinity was a second order issue for many landholders, particularly those higher in the catchments and it was mentioned as a pressing threat mostly by landholders in the valley floor and is not expected to greatly worsen in the catchments, so many landholders see little merit in investing in salinity prevention when the benefits are typically small" and it was perceived to be a problem that only gradually would effect on farm profitability. They identified lack of knowledge on salinity management as a great constraint of the farmers.

Being an agrarian country, 60% people of Bangladesh are directly or indirectly dependent on agriculture for their livelihood, with the contribution of 20 percent to its GDP (BBS, 2011). The dominant land use in coastal Bangladesh is also agriculture. Even though gross and net-cropped areas in the coastal zone of Bangladesh are 144,085 and 83,416 hectare respectively (Islam, 2004), but net- cropped area of coastal zone has been showing a decreasing trend over the years due to a combination of factors. Coastal agro-lands often suffered from saline intrusion that prevented crop production in dry season (Gowing *et al*., 2006).

Increased salinity alone from a 0.3 meter level sea rise will cause a net reduction of 0.5 million metric tons of rice (World Bank, 2000). In recent cyclone *Sidr*, among the productive sectors, damage was highest (USD 0.43 Million) in agriculture. Latest estimates shows; about 800,000 to 1300,000 MTs (metric tons) of paddy have been destroyed in *Sidr* which created severe food insecurity among the affected people (GoB, 2008). In last thirty years', salinity intrusion has degraded land quality and farmers can't grow any agricultural crops in their fields. Thus farmer's become zero productive land owners, in one sense landless with their existing saline land. Size of land which is the firm of shrimp with Transplanted Amon (rice) decrease 15294 hectares to 10000 hectares cause of salinity (Hasan *et al*., 2013).

In general, soil salinity is believed to be mainly responsible for low land use as well as cropping intensity (Rahman & Ahsan, 2001). This problem is not only reducing the agricultural productivity, but is also putting far reaching effects on the livelihood strategies of small farmers (Tanwir *et al.*, 2003). Due to sea level rise related effect particularly salt water intrusion can destroy all kinds of livelihood of the coastal population where 100 million people could be affected; (Finan, 2009).

Salinity also affects farmer's socio-economic status. It is estimated that salinity of irrigated lands causes annual global income loss of about US$ 12 billion (Ghassemi *et al*., 1995). Generally, the worst salinity effects occur where farming communities are relatively poor and face economic difficulties. In severe cases, salinity causes occupational or geographic shifting of the affected communities, with the male population seeking alternate off-farm income opportunities (Abdel-Dayem, 2005).

2.6 Adaptation Practices in Agriculture

Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation (Haddad, 2005). The born rice fully dependent on the irrigation water or the short duration variety of Aus rice is often cultivated by local people taking water from the kharies, canals (locally called khal) and ponds (Muller, 2009).

Mini pond for supplementary irrigation (dry seedbed) practice with minimal supplemental irrigation), homestead gardening, Jujube cultivation, cultivation of chickpea after T. Aman, the utilization of fallow land by establishing homestead garden to cultivate year-round homestead vegetables, preparing the mini nursery and established nursery, linseed production as less water loving crop cultivated in rain fed area. This technology had been induced to farmers and peasant's communities have been practicing some extent (Hasan *et al*., 2011).

Saline tolerate rice varieties like BINA dhan - 8, BINA dhan - 10, BRRI dhan - 47, BRRI dhan-55 are cultivated by more than one million farmers in Bangladesh. BINA dhan-8 and BINA dhan-10 have been cultivated by farmers in Satkhira, Khulna and Bagerhat districts of south-west coastal region in Boro season. Farmers cultivate BRRI dhan-47 variety that requires less water and tolerance capacity to saline soil is quite high (Alam *et al*., 2013). BINA dhan-8

varieties have salt tolerance capacity are cultivated by farmers in those regions (DCRMA, 2011).

Floating bed is a popular practice in Gopalganj, Madaripur, Barisal, Pirojpur and Jhalokhathi districts where land remain submerged most of the time in a year. Farmers are raising seedlings and producing vegetables, spices and more than thirty crops using floating gardens in pond or other places where there is no saline water intrusion occurs (AAS, 2012). Cultivated vegetables in floating bed include okra, cucumber, bitter guard, kholrabi, pumpkin, water gourd, turmeric, ginger, karalla, arum, tomato, turturi and potato (Alauddin & Rahman, 2013).

Shallow depth sorjans are suitable for the year-round cultivation of vegetables and monsoon rice, where the sorjans with higher depths also allow rice-fish or rice-duck farming along with the year-round vegetables cultivation on raised beds. This sorjan system is very popular among the farmers in this coastal region of Patuakhali and annul net return from investment in sorjan system is very high (Sattar & Abedin, 2012).

Homestead gardening is a widely accepted practice in Bangladesh and mainly managed by women in saline area. It ensures food security and additional income by enhancing livelihoods of poor people. Leafy vegetables such as kangkong, batisak, sweet tasting stem, amaranth (Ktoradanta) are grown in homestead gardens (FAO, 2008).

Salt tolerant sugarcane variety ISWARDI-40, BINA sarisa-5 and BINA sarisa-6, sweet potato varieties like BARI SP-6 and BARI SP-7, BARI Mung and 6, BARI Sweet Gourd-1 and 2, spinach, BARI Tomato-1, Knolkhol and beet are being cultivated as adaptive options in the coastal areas.

2.7 Conceptual Framework of the Study

This study is concerned with the charland farmers' adaptation strategies towards adverse effects on their food security under Brahmanbaria. Thus, the adaptation strategies were the main focus of the study and ten selected characteristics of the farmers were considered as those might have relationship with adaptation strategies. Farmers' adaptation strategies towards adverse effects may be influenced and affected through interacting forces of many independent factors. It is not possible to deal with all the factors in a single study. Therefore, it was necessary to limit the factors, which included age, education, family size, farm size, annual family income, farming experience, professional training experience, agricultural extension media contact, organizational participation and food availability. The conceptual framework of the study has been presented in Fig. 2.1.

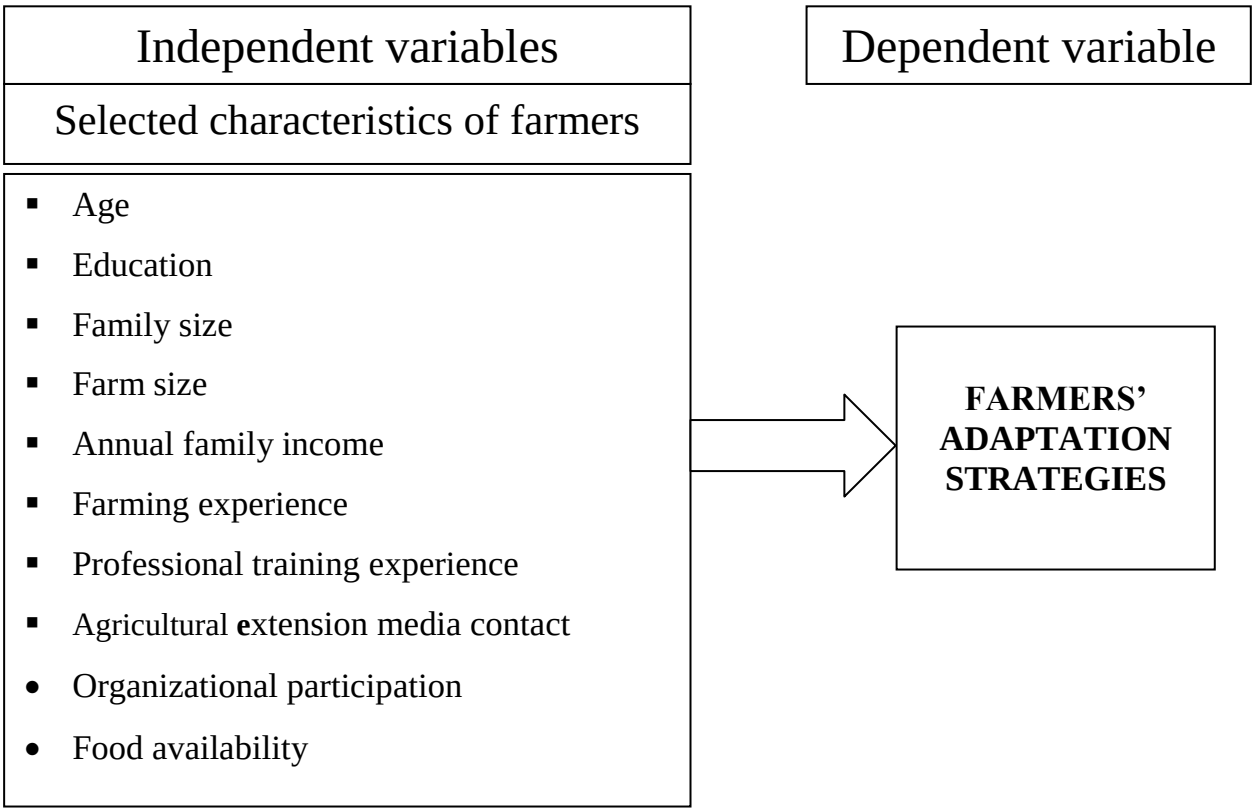

Figure 2.1 Conceptual framework of the study

CHAPTER III
METHODOLOGY

Methods and procedures used in conducting research need very careful consideration. Methodology enables the researcher to collect valid information and to analyze the same properly to arrive at correct decisions. The methods and procedures followed in conducting this research are being described below.

3.1 The Locale of the Study

The study was purposively conducted at Nabinagar upazilla under Brahmanbaria district. Two unions named Biddyakut and Natghar were selected purposively. Brahmanbaria is a district in eastern Bangladesh located in the Chittagong Division. Geographically, it is mostly farmland and is topographically part of the Gangetic Plain. It is bounded by the districts of Kishoreganj and Habiganj to the north, Narsingdi District and Narayanganj to the west, Comilla to the south, and the Indian state of Tripura to its east. All farmers from the selected three villages were constituted as the population of the study. The selected villages were Biddyakut, Salimnagar from Biddyakut union and Kurighar and Rosulpur from Natghar union were selected randomly. A map of Brahmanbaria district showing Nabinagar upazila is presented in Figure 3.1. A map of Nabinagar upazila showing the study area is presented in Figure 3.2.

3.2 Population and Sample

The farmers under selected three villages were considered as the population of the study. A list of farmers who are currently cultivating crops was prepared with the help of Upazila Agriculture Officer and his field staffs. The number of farmers of the selected three villages was 1026 which constituted the population of the study. About 10 percent of the population was selected proportionally from the selected villages as the sample random sampling method. Thus, the total sample size was 103.

Fig. 3.1 A map of Brahmanbaria district showing Nabinagar upazila

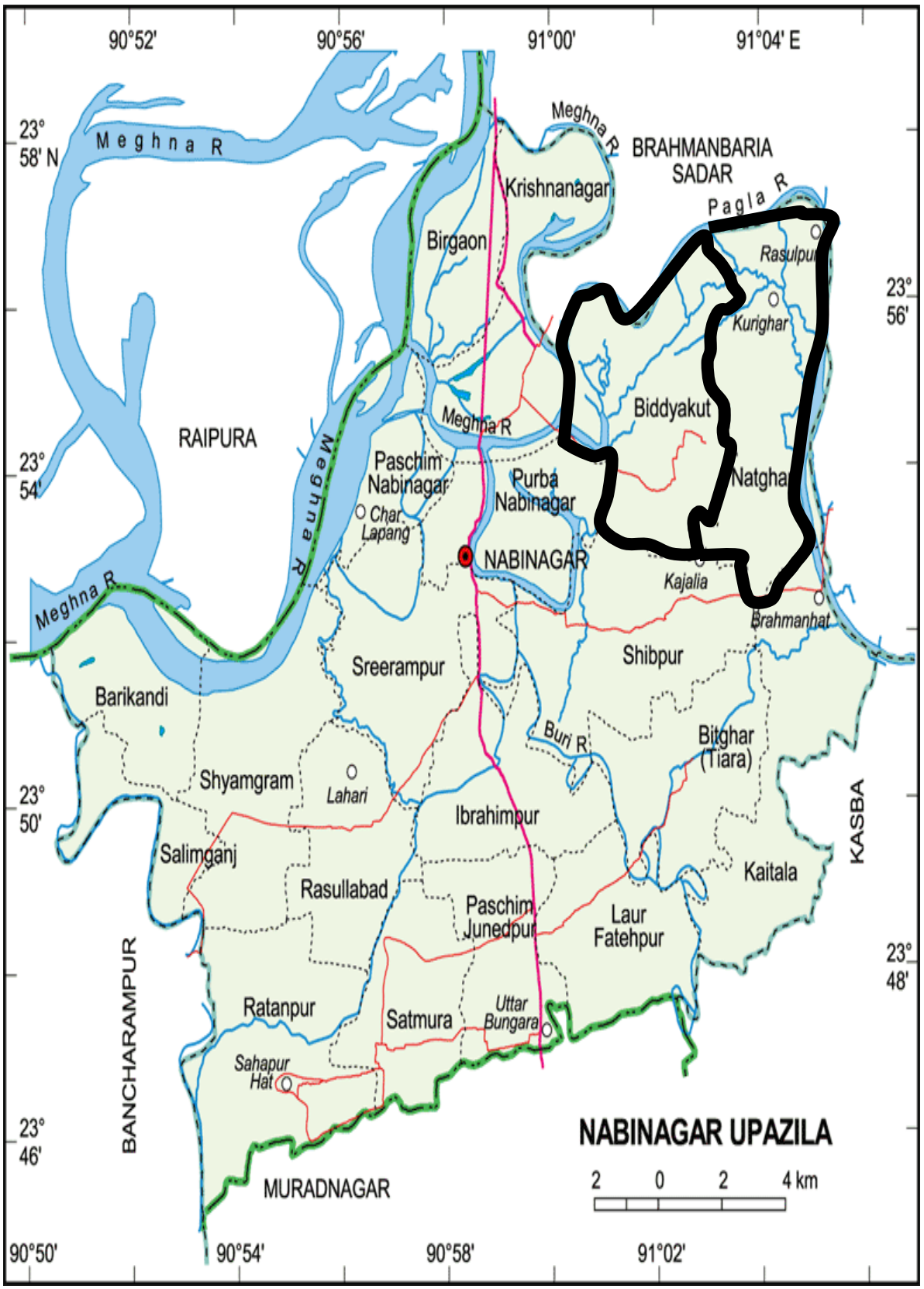

Fig. 3.2 A map of Nabinagar upazila showing the study area

Moreover, a reserved list of ten farmers was prepared for use when the farmers under sample were not available during data collection. The distribution of the selected farmers with reserve list of the selected villages is shown in Table 3.1.

Table 3.1 Distribution of the sampled farmers in the study area

Upazila	Union	Villages	Population	Sample size	Reserve list
Nabinagar	Biddyakut	Biddyakut	301	30	3
		Salimnagar	296	30	3
	Natghar	Kurighar	226	23	2
		Rosulpur	203	20	2
Total			1026	103	10

3.3 Measurement of Variables

The various characteristics of the farmers might have influence on their farmers' adaptation strategies towards adverse effects on their food security under Brahmanbaria district. These characteristics were age, education, family size, farm size, annual family income, farming experience, professional training experience, agricultural extension media contact and organizational participation. Farmers' adaptation strategies towards adverse effects on their food security under Brahmanbaria district were the main focus of the study. Measurement of all the factors of the farmers and their adaptation strategies towards adverse effects on their food security under Brahmanbaria district are discussed in the following sub sections:

3.3.1 Age

Age of the farmers was measured in terms of actual years from their birth to the time of the interview, which was found on the basis of the verbal response of the rural people. A score of one (1) was assigned for each year of one's age.

3.3.2 Education

The education of farmers was measured by the number of years of schooling completed in an educational institution. A score of one (1) was given for each year of schooling completed. If a farmer didn't know how to read and write, his

education score was zero, while a score of 0.5 was given to the farmers who could sign his name only. If a farmer did not go to school but studied at home or adult learning center, his knowledge status was considered as the equivalent to a formal school student. This variable appears in item number two (1) in the interview schedule as presented in Appendix-A.

3.3.3 Family size

Family size was measured by computing total number of members in the family. A family normally consists of head of household, wife, unmarried sons and other dependent relations who jointly live and eat together during interview. One score was assigned to each member of the family. This variable appears in item number three (3) in the interview schedule as presented in Appendix-A.

3.3.4 Farm size

The farm size of a farmer referred to the total area of land on which his/her family carried out farming operations, the area being in terms of full benefit to his/her family. The farm size was measured in hectares for each farmer using the following formula:

FS=A+B+1/2 (C+D) +E

Where,

FS= Farm size

A = Homestead area

B= Own land under own cultivation

C= Land given to others as borga

D= Land taken from others as borga

E= Land taken from others as lease

This variable appears in item number four (4) in the interview schedule as presented in Appendix-A.

3.3.5 Annual family income

Annual family income of farmers was measured in Thousand Taka. The total yearly earning from agricultural (field crops, vegetables, fruits, spices, livestock and fisheries) and nonagricultural sources (service, business, and others) by the respondent himself/herself and other members of his family was determined. Thus, yearly earning from agricultural and nonagricultural sources were added together to obtain annual family income of a farmers. A score of one was given for each Tk. 1,000 to compute the annual income scores of the respondents. This variable appears in item number five (5) in the interview schedule as presented in Appendix-A.

3.3.6 Farming experience

Farming experience of a respondent was measured by asking questions related to how many years involved in cultivation. It was expressed in year. However, a unit score of one (1 year) was assigned for each one year of time. This variable appears in item number six (6) in the interview schedule as presented in Appendix-A.

3.3.7 Professional training experience

Professional training experience of a farmer was measured by the total number of days he/she participated in different agricultural training programmes. A score of one (1) was assigned for each day of training received. This variable appears in item number seven (7) in the interview schedule as presented in Appendix-A.

3.3.8 Agricultural extension media contact

This variable was measured by computing an extension media contact score on the basis of a respondent's extent of contact with eight selected media as obtained in response to item no. 9 of the interview schedule (Appendix A). Each respondent was asked to indicate the frequency of his contact with each of the selected media. With four alternative responses as 'regularly', 'often',

'occasionally', 'rarely' and 'never' basis and weights were assigned as 4, 3, 2, 1 and 0, respectively. The extension contact score of a respondent was determined by summing up his/her scores for contact with all the selected media. Thus, possible extension media contact score could vary from zero (0) to 24, where zero indicated no extension contact and 24 indicated the highest level of extension contact. This variable appears in item number eight (8) in the interview schedule as presented in Appendix-A.

3.3.9 Organizational participation

Organizational participation of a respondent was measured by computing agricultural organizational participation score according to his/her nature and duration of participation in three (3) selected different organizations upto the time of interview. Organizational participation score was evaluated for each respondent on the basis of his/her membership with those organisations. The following scale was used for computing organizational participation score. Organizational participation score = PxD

Where,
P- Participation Score
D- Duration (no. of years)

Following scores were assigned for nature of participation:

Nature of participation	Scores assigned
No participation	0
Participation as ordinary member	1
Participation as executive committee member	2
Participation as president/secretary	3

This variable appears in item number nine (9) in the interview schedule as presented in Appendix-A.

3.3.10 Food security

3.3.10.1 Food availability

It was defined as one's available source of food. Food availability of a farmer was measured by computing score on the basis of available source of cereal, vegetables, meat, fish and fruits. Each farmer was asked to indicate available food source with five alternative responses, like more available, sufficient, less and no food availability than sufficient, less available and always with shortage basis to each of the five food types and score of five, four, three, two, one and zero were assigned for those alternative responses, respectively. These five options for each medium were defined specially to each medium considering the situation, rationality and result of pre-test. Food availability of the farmers was measured by adding the scores of five selected source of food. Thus, food availability score of a farmer could range from 5 to 25, where five indicated always with shortage food availability and twenty-five indicated more available of food. This variable appears in item number 10.1 in the interview schedule as presented in Appendix-A. Based on the information cited by the farmers, they were classified into three categories (Mean ± Standard Deviation) namely low, medium and high food availability.

3.4 Measurement of the Dependent Variable

The dependent variable of the study was farmers' adaptation strategies towards adverse effects on their food security under Brahmanbaria district. The variable was measured on the basis of 10 (ten) adaptation strategies by the farmers. The strategies are stated below:

i) Cultivating short duration crops
ii) Practicing crop diversification
iii) Raised bed planting
iv) Practicing intercropping
v) Early maturing cultivars
vi) Adjustment of planting dates
vii) Mulching

viii) Alternative irrigation system

ix) Use of heat tolerant cultivars

Every farmer was asked about mentioned each strategy whether she/he followed or not as adaptation strategies in her/his farm level activities while his/her faced problem to overcome from its bad effects. Adaptation score was made in percentage based on her/his response (yes/no) against each strategy. Score one (01) was given to 'yes' and zero (0) was given to 'no' response.

In this study nine (9) strategies were selected by pre survey technique and if one respondent follows or adapt 1 (one) strategy in her/his farm level activities then her/his adaptation score would be 10 and (Peal, 2015) using the following equation:

$$\frac{1}{10} \text{ x } 100=10\%$$

3.5 Instruments for Data Collection

Data were collected using a structured interview schedule. Both open and closed form questions were included in the schedule based on the measurement procedures discussed earlier in section 3.3.

Before finalization, the interview schedule was pre-tested with farmers of the study area. On the basis of the pre- test experiences necessary corrections, modifications and alterations were made before finalizing the interview schedule for final data collection. During modification of the schedule, valuable suggestions were received from the research supervisor and relevant experts. The interview schedule was then printed in its final form and multiplied. A copy of interview schedule in English version is placed in Appendix A.

3.6 Collection of Data

Data were collected personally by the researcher herself through face to face interview. To familiarize with the study area and for getting local support, the researcher took help from the local leaders and the field staffs of Upazila Agriculture Office. The researcher made all possible efforts to explain the purpose of the study to the farmers. Rapport was established with the farmers prior to interview and the objectives were clearly explained by using local language as far as possible. Data were collected during the period of February 20 to March 20, 2021.

3.7 Data Processing and Analysis

After completion of field survey, all the data were coded, compiled and tabulated according to the objectives of the study. Local units were converted into standard units. All the individual responses to questions of the interview schedule were transferred in to a master sheet to facilitate tabulation, categorization and organization. In case of quantitative data, appropriate scoring technique was followed to convert the data into quantitative form.

3.8 Statement of Hypothesis

As defined by Goode and Hatt (1952) a hypothesis is a proposition, which can be put to a test to determine its validity. It may prove correct or incorrect of a proposition. In any event, however, it leads to an empirical test. Hypothesis are always in declarative sentence form and they relate either generally of specifically variables to sentence form and they relate either generally or specifically variables to variables. Hypothesis may be broadly divided into two categories, namely, research hypothesis and null hypothesis.

3.8.1 Research hypothesis

The following research hypothesis was put forward to test contribution of the selected characteristics of the farmers' adaptation strategies towards adverse effects on their food security. The research hypothesis was "each of the"

selected characteristics of the farmers have significant contribution to their "adaptation strategies towards adverse effects on their food security under Brahmanbaria district".

3.8.2 Null hypothesis

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

"Each of the selected characteristics of the farmers had no significant contribution to their adaptation strategies towards adverse effects on their food security under Brahmanbaria district"

3.9 Statistical Analysis

Regression analysis was used to identify the linear combination between independent variables used collectively to predict the dependent variables (Miles and Shevlin, 2001). Regression analysis helps us understand how the typical value of the dependent variable changes when any one of the independent variables is varied, while the other independent variables are held fixed. Ordinary Least Squares (OLS) is used most extensively for estimation of regression functions. In short, the method chooses a regression where the sum of residuals, ΣUi is as small as possible (Gujarati, 1995). The factors that contribute to the farmers' adaptation strategies status of the farmers are analyzed using a regression model.

The data were analyzed in accordance with the objectives of the proposed research work. The factors that contribute to the attitude of rural women towards livestock rearing are analyzed using a regression model, multiple regression analysis (B) was used. Throughout the study, five (0.05) percent and one (0.01) percent level of significance were used as the basis for rejecting any null hypothesis. If the computed value of (B) was equal to or greater than the designated level of significance (p), the null hypothesis was rejected and it was

concluded that there was a significant contribution between the concerned variable. Whenever the computed value of (B) was found to be smaller at the designated level of significance (p), the null hypothesis could not be rejected. It was concluded that there was no contribution of the concerned variables. The model used for this analysis can be explained as follows:

$$Yi = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + b_9x_9 + b_{10}x_{10} + e; (i=1,2,3)$$

Where,

Yi= is the farmers' adaptation strategies

Of the independent variables, x_1 is the farmer's age, x_2 is education, x_3 is family size, x_4 is farm size, x_5 is annual family income, x_6 is farming experience, x_7 is professional training experience, x_8 is agricultural extension media contact, x_9 is organizational participation and x_{10} is food security. b_1, b_2, b_3, b_4, b_5, b_6, b_7, b_8, b_9 and b_{10} are regression coefficients of the corresponding independent variables, and e is random error, which is normally and independently distributed with zero mean and constant variance.

CHAPTER IV
RESULTS AND DISCUSSION

In this chapter the findings of the study and its interpretation are presented in three sections according to the objectives of the study. The first section deals with the selected characteristics of the farmers, while the second section deals with the extent of the farmers' adaptation strategies towards adverse effects on their food security and the third section deals with the contribution to their adaptation strategies towards adverse effects on their food security.

4.1 Selected Characteristics of the Farmers

In this section the results of the farmers selected characteristics have been discussed. The salient feature of the respondents with their ten selected characteristics has been presented in Table 4.1.

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

characteristics	Measuring unit	Rang		Mean	S D
		possible	observed		
Age	Years	-	28-66	43.36	8.10
Education	Year of schooling	-	00-16	6.05	3.17
Family Size	Person	-	3-12	7.32	1.93
Farm Size	Hectare	-	0.20-.81	.36	.13
Annual family income	('000' tk)	-	33-470	180.03	78.72
Farming experience	Years	-	6-45	22.66	8.19
Professional training experience	Days	-	0-8	3.09	1.57
Agricultural extension media contact	Score	0-40	11-28	17.35	3.31
Organizational participation	Score	-	5-12	9.41	1.55
Food security					
Food availability	Score	9-36	36-110	24.49	3.82

4.1.1 Age

The age score of the farmers ranged from 28 to 66 with an average of 43.36 and a standard deviation of 8.10. Considering the recorded age farmers were classified into three categories namely young, middle and old aged following (MoYS, 2012). The distribution of the farmers in accordance of their age is presented in Table 4.2.

Table 4.2 Distribution of the farmers according to their age

Categories (years)	Farmers		Mean	SD
	Number	Percent		
Young aged (up to 35)	20	19.42	43.36	8.10
Middle aged (36-50)	69	66.99		
Old aged (above 50)	14	13.59		
Total	**103**	**100**		

Table 4.2 indicates that the majority (66.99 percent) of the respondents were the middle-aged category while 19.42 percent and 13.59 percent were found young and old categories respectively. The mean value (43.36) rightly indicates the reality. Data also indicates that the middle and young aged category constitute almost 86.41 percent of total farmers. Young and middle aged farmers were generally more involved in farming than the older due to their energetic, enthusiastic nature. Noman (2016) found almost similar findings.

4.1.2 Education

Education of the respondents has been categorized as done by Alauddin & Rahman (2013). Education of the farmers ranged from 0 to 16 years of schooling having an average of 6.05 years with a standard deviation of 3.17. On the basis of their education, the respondents were classified into five categories as shown in Table 4.3

Table 4.3 Distribution of the farmers according to their education

Categories (Score)	Farmers		Mean	SD
	Number	Percent		
Illiterate (0)	2	1.94	6.05	3.17
Can sign only (0.5)	10	4.76		
Primary education (1-5 class)	43	41.75		
Secondary education (6-10 class)	44	42.72		
Above secondary level (above 10)	4	3.88		
Total	**103**	**100**		

Data contained in Table 4.3 indicates the majority 42.72 percent of the farmers were secondary level of education. It was found that 41.75 percent were primary level of education, 4.76 percent were can sign only and 3.88 percent were above secondary level of education. Only 1.94 percent was illiterate categories. Education broadens the horizon of outlook of farmers and expands their capability to analyze situation related to adaptation strategies. To adjust with same, they would be progressive minded to secure their adaptation strategies and involve with modern cultural, processing and marketing facilities of farm products. Alauddin & Rahman (2013) found almost similar findings.

4.1.3 Family size

To describe the family size of the respondents, the category has been followed as represented by Noman (2016). Family size scores of the farmers ranged from 3 to 12 with an average of 7.32 and standard deviation of 1.93. According to family size the farmers were classified into three categories (Mean ± Standard Deviation) viz. small, medium and large family. The distribution of the cultivators according to their family size is presented in Table 4.4.

Table 4.4 Distribution of the farmers according to their family size

Categories (Score)	Farmers		Mean	SD
	Number	Percent		
Small family (up to 5)	23	22.33	7.32	1.93
Medium family (6 -9)	65	63.11		
Large family (above 9)	15	14.56		
Total	**103**	**100**		

Data contained in Table 4.4 indicates that the most (63.11%) of the farmers had medium family while 14.56 percent of them had large family and 22.33 percent of them had small family. Thus, about above two third (77.67%) of the farmers had medium to large family. The trend of nuclear family has been rising in the study area and subsequently the family member becoming smaller than the extended family. Noman (2016) found almost similar findings.

4.1.4 Farm size

Land possession of the respondents varied from 0.20 to 0.81 hectare and the average being 0.36 hectare and standard deviation of 0.13. Depending on the farm size of the respondents were classified into two categories according to DAE (1999) as appeared in Table 4.5.

Table 4.5 Distribution of the farmers according to their farm size

Categories (Hectare)	Farmers		Mean	SD
	Number	Percent		
Marginal land (upto 0-0.20 ha)	6	5.83	0.36	0.13
Small land (0.21-1 ha)	97	94.17		
Total	**103**	**100**		

Similar result was observed Noman (2016) where highest respondents were small farm sized. Data contained in Table 4.5 indicates the 94.17 percent of the farmers had small land and only 5.83 percent of them were marginal farmer. The average farm size of the farmers of the study area (0.36 ha) was lower than that of national average (0.60 ha) of Bangladesh (BBS, 2021). Due to the enhancing the economic status of the farmers, the farmers are likely to motivate to buy the land. Noman (2016) found almost similar findings.

4.1.5 Annual family income

The annual family income of the farmers ranged from Tk. 33 thousand to Tk. 470 thousand with an average of Tk. 180.03 thousand and standard deviation of 78.72 thousand. On the basis of number of earning members scores of the farmers, the farmers were classified into three categories (Mean ± Standard Deviation) namely small, medium and high number of earning members at family. The distribution of the farmers according to the number of earning members of their family is given in Table 4.6.

Table 4.6 Distribution of the farmers according to their annual family income

Categories ('000' Tk.)	Farmers		Mean	S D
	Number	Percent		
Low income (up to 102)	17	16.50	180.03	78.72
Medium income (103-258)	68	66.02		
High income (above 258)	18	17.48		
Total	103	100		

Hasan et al. (2011) found the similar result where highest number of respondents were medium annul income. From Table 4.6 it was observed that the highest portion (66.02 percent) of the farmers had medium annual family income compared to 16.50 percent having low and only 17.48 percent had high annual family income. Overwhelming majority (82.52 percent) farmers have low to medium annual family income. Hasan et al. (2011) found almost similar findings.

4.1.6 Farming experience

Farming experience of the respondents has been categorized as done by Alam *et al.* (2013). The observed farming experience of the farmers ranged from 6-45, the mean being 22.66 and standard deviation of 8.19. According to their observed ranged of farming experience scores, the farmers were classified into three categories (Mean±SD) as shown in Table 4.7.

Table 4.7 Distribution of the farmers according to their farming experience

Categories (Score)	Farmers		Mean	SD
	Number	Percent		
Low experience (upto 14)	7	6.80	22.66	8.19
Medium experience (15-30)	82	79.61		
High experience (above 30)	14	13.59		
Total	**103**	**100**		

Similar result was observed Alam et al. (2013) where highest respondents were large farming experience. Data presented in Table 4.7 indicated that 79.61 percent of the farmers had medium farming experience compared to having 6.80 percent low and

13.59 percent high farming experience. Findings again revealed that almost all (93.20 percent) of the farmers had medium to high farming experience. Alam et al. (2013) found almost similar findings.

4.1.7 Professional training experience

The score of training experience of the farmers ranged from 0 to 8 days, the mean being 3.09 and standard deviation of 1.57. Based on observed range, the farmers were classified into three categories as shown in Table 4.8.

Table 4.8 Distribution of the farmers according to their training experience

Categories (Days)	Farmers		Mean	SD
	Number	Percent		
No training (0)	4	3.88	3.09	1.57
Low training (up to 4)	82	79.61		
Medium training (above 4)	17	16.50		
Total	**103**	**100**		

Data contained in Table 4.8 indicates that 79.61 percent of the farmers had low training experience; while 3.88 percent of the farmer's had no training and 16.50 percent had medium training experience**.** Thus, about 96.11% of farmers had low to medium training experience. Alam et al. (2013) found almost similar findings.

4.1.8 Agricultural extension media contact

Agricultural extension media contact of the respondents has been categorized as done by Hossain *et al*. (2012). The observed extension contacts scores of the farmers ranged from 11-28 against the possible range of 0 to 40, the mean being 17.35 and standard deviation of 3.31. According to their observed ranged of extension contact scores, the farmers were classified into three categories (Mean±SD) as shown in Table 4.9.

Table 4.9 Distribution of the farmers according to extension media contact

Categories (Score)	Farmers		Mean	SD
	Number	Percent		
Low contact (upto 14)	17	16.50	17.35	3.31
Medium contact (15-20)	66	64.08		
High contact (above 20)	20	19.42		
Total	**103**	**100**		

Similar result was observed Hossain *et al*. (2012) where highest respondents were medium extension contact. Data presented in Table 4.9 indicated that 64.08 percent of the farmers had medium extension contact compared to having 16.50 percent low and 19.42 percent had high extension contact. Findings again revealed that almost all (81.58 percent) of the farmers had low to medium extension contact. From Table 4.9, it might be concluded that majority of the farmers had medium extension contact. It could be concluded that extension agent or media of the study area were available to the farmers. The finding was interesting but logical because in general the farmers in the rural areas of Bangladesh are less cosmopolite in nature and less exposed to different information sources. Agricultural extension media contact pertains to ones contact with multifarious sources of farming knowledge and information. The farmers of the study area receive information from their neighbors, relatives and workmates etc. which reflects in the study result. Hossain *et al*. (2012) found almost similar findings.

4.1.9 Organizational participation

The score of organizational participation of the farmers ranged from 5 to 12, the mean being 9.41 and standard deviation of 1.55. Based on observed range, the farmers were classified into four categories as shown in Table 4.10.

Table 4.10 Distribution of the farmers according to organizational participation

Categories (Scores)	Farmers		Mean	SD
	Number	Percent		
Low participation (upto 8)	25	24.27	9.41	1.55
Medium participation (9-10)	56	54.37		
High participation (above 10)	22	21.36		
Total	**103**	**100**		

Data contained in Table 4.10 indicates that 54.37 percent of the farmers had medium participation; while 24.27 percent of the farmer's had low organizational participation and 21.36 percent had high organizational participation. Thus, about 78.64% of farmers had low to medium organizational participation. Hasan et al. (2011) found almost similar findings.

4.1.10 Food security

4.1.10.1 Food availability

Food availability scores of the farmers ranged from 16 to 32 against possible score of 9 to 36. The average score and standard deviation were 24.49 and 3.82, respectively. Based on the scores, the farmers were classified into three categories namely low, medium and high food availability (Table 4.11).

Table 4.11 Distribution of the farmers according to their food availability

Categories (scores)	Farmers		Mean	SD
	Number	Percent		
Low food availability (upto 21)	26	25.24	24.49	3.82
Medium food availability (22-27)	58	56.31		
High food availability (above 27)	19	18.47		
Total	**103**	**100**		

Results presented in Table 4.11 reveals that the food availability of the farmers were highest in medium level, it was 56.31 percent and medium food availability was closer to the low food availability as 25.24 percent. The high food availability category constituted by 18.47 percent farmers. The economic status and good agricultural production by the farmers help to get this result where most of the farmers in medium food availability category. Peal (2015) found almost similar findings.

4.2 Farmers' Adaptation Strategies towards Adverse Effects on their Food Security

The observed farmers' adaptation strategies towards adverse effects on their food security scores of the farmers ranged from 40-80 against the possible range of 0 to 100, the mean being 61.23 and standard deviation of 9.53.

Farmers' adaptation strategies was categorized into three categories: low adaptation strategies (score up to 52), medium adaptation strategies (score 53-70) and high adaptation strategies (score above 70) considering Mean ±1sd. According to their observed ranged of adaptation strategies scores, the farmers were classified into three categories (Mean±SD) as shown in Table 4.12.

Table 4.12 Distribution of the farmers according to farmers' adaptation strategies

Categories (Score)	Farmers		Mean	SD
	Number	Percent		
Low adaptation strategies (upto 52)	25	24.27	61.23	9.53
Medium adaptation strategies (53-70)	69	66.99		
High adaptation strategies (above 70)	9	8.74		
Total	**103**	**100**		

Similar result was observed Peal (2015) where highest respondents were medium adaptation strategies. Data presented in Table 4.12 indicated that the majority 66.99 percent of the farmers had medium adaptation strategies compared to having 8.74 percent high and 24.27 percent had low adaptation strategies. Findings again revealed that almost all (91.26 percent) of the farmers had low to medium adaptation strategies.

4.3 The Contribution of the Selected Characteristics of the Respondents on their Farmers' Adaptation Strategies towards Adverse Effects on their Food Security

In order to estimate the farmers' adaptation strategies towards adverse effects on their food security, the multiple regression analysis were used which is shown in the Table 4.13**.**

Table 4.13 Multiple regression coefficients of the contributing variables related to farmers' adaptation strategies towards adverse effects on their food security

Dependent variable	Independent Variables	B	SEB	β	t-value	P	R^2	Adj.R^2	F
Farmers' adaptation strategies towards adverse effects on their food security	Age	.011	.148	.009	.074	.941	0.421	0.351	6.014
	Education	.988	.305	.329	3.243	.002**			
	Family Size	.464	.465	.094	.997	.321			
	Farm Size	3.073	7.653	.042	.402	.689			
	Annual family income	.012	.012	.099	.961	.339			
	Farming experience	.341	.147	.293	2.316	.023*			
	Professional training experience	1.195	.553	.197	2.159	.033*			
	Agricultural extension media contact	.573	.266	.199	2.154	.034*			
	Organizational participation	.295	.598	.048	.493	.623			
	Food Security	.042	.232	.017	.180	.858			

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

Table 4.13 shows that education, farming experience, professional training experience and agricultural extension media contact of the respondents had significant positive contribution to their adaptation strategies towards adverse effects on their food security. Of these, education, were the most important contributing factors (significant at the 1% level of significant) and farming experience, professional training experience and agricultural extension media contact of the respondents were less important contributing factors (significant at 5% level of significant) to their adaptation strategies towards adverse effects to their food security. Coefficients of other selected variables do not have any contribution to their adaptation strategies towards adverse effects on their food security.

The value of R^2 is a measure of how of the variability in the dependent variable is accounted by the independent variables. So, the value of $R^2 = 0.421$ means that independent variables account for 42% of the variation with their

adaptation strategies towards adverse effects on their food security. The F ratio is 7.102 which is highly significant ($p<0$).

However, each predictor may explain some of the variance in respondents their adaptation strategies towards adverse effects on their food security simply by chanced. The adjusted R^2 value penalizes the addition of extraneous predictors in the model, but value 0.351 is still show that variance is their adaptation strategies towards adverse effects on their food security can be attributed to the predictor variables rather than by chanced (Table 4.13). In summary, the models suggest that the respective authority should be consider the farmers' education, farming experience, professional training experience and agricultural extension media contact of the respondents on their adaptation strategies towards adverse effects on their food security and in this connection some predictive importance has been discussed below:

4.3.1 Significant contribution of education on the farmers' adaptation strategies towards adverse effects on their food security

The contribution of education to the farmers' adaptation strategies towards adverse effects on their food security was measured by the testing the following null hypothesis;

"There is no contribution of education to the farmers' adaptation strategies towards adverse effects on their food security".

The following observations were made on the basis of the value of the concerned variable of the study under consideration.

a. The contribution of the education was at 1% significance level (.002)

b. So, the null hypothesis could be rejected.

c. The direction between education and adaptation strategies was positives.

The β-value of level education is (0.988). So, it can be stated that as education

increased by one unit, the farmers' adaptation strategies towards adverse effects on their food security increased by 0.988 units.

Based on the above finding, it can be said that farmers' education increased the farmers' adaptation strategies towards adverse effects on their food security. So, education has significantly contributed to the farmers' adaptation strategies towards adverse effects on their food security. Education plays an important role to reduce problems in adaptation strategies towards adverse effects on their food security in many cases. Education enhances knowledge on many aspects such as training, participation, extension contact and so on.

4.3.2 Contribution of farming experience of the farmers' adaptation strategies towards adverse effects on their food security

From the multiple regression, it was concluded that the contribution of farming experience to the adaptation strategies towards adverse effects on their food security was measured by the testing the following null hypothesis;

"There is no contribution of farming experience to the farmers' adaptation strategies towards adverse effects on their food security".

The following observations were made on the basis of the value of the concerned variable of the study under consideration.

a. The contribution of the farming experience was significant at 5% level (.023)
b. So, the null hypothesis could be rejected.
c. The direction between farming experience and adaptation strategies was positive.

The β-value of farming experience is (0.341). So, it can be stated that as farming experience increased by one unit, farmers' adaptation strategies

towards adverse effects on their food security increased by 0.341 units.

Based on the above finding, it can be said that farmers had more farming experience increased farmers' adaptation strategies towards adverse effects on their food security. So, farming experience has high significantly contributed to the adaptation strategies towards adverse effects on their food security increased. Farming experience increase farmer's knowledge about various aspects which helps farmers make enough reduce their problem in adaptation strategies.

4.3.3 Significant contribution of professional training experience on the farmers' adaptation strategies towards adverse effects on their food security

From the multiple regression, it was concluded that the contribution of professional training experience to the farmers' adaptation strategies towards adverse effects on their food security was measured by the testing the following null hypothesis;

"There is no contribution of professional training experience to the farmers' adaptation strategies towards adverse effects on their food security".

The following observations were made on the basis of the value of the concerned variable of the study under consideration.

a. The contribution of the professional training experience was significant at 5% level (0.033)
b. So, the null hypothesis could be rejected.
c. The direction between professional training experience and adaptation strategies was positive.

The β-value of training exposure was (1.195). So, it can be stated that as professional training experience increased by one unit, farmers' adaptation strategies towards adverse effects on their food security increased by 1.195

units.

Based on the above finding, it can be said that farmers had more professional training experience increased the adaptation strategies towards adverse effects on their food security. So, professional training experience has high significantly contributed to the farmers' adaptation strategies. Professional training experience helps farmers to gather more knowledge on adaptation strategies which ultimately help farmers to reduce their problems in different crops cultivation.

4.3.4 Significant contribution of extension contact of the farmers' adaptation strategies towards adverse effects on their food security

From the multiple regression, it was concluded that the contribution of extension contacts of the farmers' adaptation strategies towards adverse effects on their food security was measured by the testing the following null hypothesis;

"There is no contribution of extension contact to the farmers' adaptation strategies towards adverse effects on their food security".

The following observations were made on the basis of the value of the concerned variable of the study under consideration.

a. The contribution of the extension contact was significant at 5% level (.034)

b. So, the null hypothesis could be rejected.

c. The direction between extension contact and adaptation strategies was positive.

The β-value of extension contact was (0.573). So, it can be stated that as extension contact increased by one unit, the farmers' adaptation strategies towards adverse effects on their food security increased by 0.573 units.

Based on the above finding, it can be said that farmers had more extension contact increased farmers' adaptation strategies towards adverse effects on their food security. So, extension contact has high significantly contributed to the farmers' adaptation strategies towards adverse effects on their food security increased.

CHAPTER V
SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

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

5.1 Summary of Findings

5.1.1 Selected characteristics of the farmers

Findings in respect of the 10 selected characteristics of the farmers are summarized below:

Age

The majority (66.99 percent) of the respondents were the middle-aged category while 19.42 percent and 13.59 percent were found young and old categories respectively.

Education

The majority 42.72 percent of the farmers were secondary level of education. It was found that 41.75 percent were primary level of education, 4.76 percent were can sign only and 3.88 percent were above secondary level of education. Only 1.94 percent was illiterate categories.

Family size

The most (63.11%) of the farmers had medium family while 14.56 percent of them had large family and 22.33 percent of them had small family.

Farm size

The majority 94.17 percent of the farmers had small land and only 5.83 percent of them were marginal farmer.

Annual family income

The highest portion (66.02 percent) of the farmers had medium annual family income compared to 16.50 percent having low and only 17.48 percent had high annual family income.

Farming experience

The majority 79.61 percent of the farmers had medium farming experience compared to having 6.80 percent low and 13.59 percent high farming experience.

Professional training experience

The majority 79.61 percent of the farmers had low training experience; while 3.88 percent of the farmer's had no training and 16.50 percent had medium training experience**.**

Agricultural extension media contact

The majority 64.08 percent of the farmers had medium extension contact compared to having 16.50 percent low and 19.42 percent had high extension contact.

Organizational participation

The majority 54.37 percent of the farmers had medium participation; while 24.27 percent of the farmer's had low organizational participation and 21.36 percent had high organizational participation.

Food availability

The food availability of the farmers was highest in medium level, it was 56.31 percent and medium food availability was closer to the low food availability as 25.24 percent. The high food availability category constituted by 18.47 percent farmers.

5.1.2 Farmers' adaptation strategies towards adverse effects on their food security

The observed farmers' awareness on environmental pollution scores of the farmers ranged from 40-80 against the possible range of 0 to 100, the mean being 61.23 and standard deviation of 9.53. The majority 66.99 percent of the farmers had medium adaptation strategies compared to having 8.74 percent high and 24.27 percent low adaptation strategies.

5.1.3 The Contribution of the selected characteristics of the respondents on their adaptation strategies towards adverse effects on their food security

In order to estimate the farmers' adaptation strategies towards adverse effects on their food security, the multiple regression analysis were used. Result shows that education, farming experience, professional training experience and agricultural extension media contact of the respondents had significant positive contribution with their farmers' adaptation strategies towards adverse effects on their food security. Of these, education, were the most important contributing factors (significant at the 1% level of significant) and farming experience, professional training experience and agricultural extension media contact of the respondents were less important contributing factors (significant at 5% level of significant) with their adaptation strategies towards adverse effects on their food security. Coefficients of other selected variables do not have any contribution on their adaptation strategies towards adverse effects on their food security.

5.2 Conclusions

Following conclusions were drawn on the basis of findings, logical interpretation and other relevant facts of the study:

1. The findings of the study revealed that vast majority of the farmers (91.26 percent) had low to medium adaptation strategies. Therefore, it may be concluded that it would be a wiseful thinking to improve the

overall situation of adaptation strategies by taking care of the factors related to the increase of adaptation strategies among the farmers.

2. About half (42.72 percent) of the farmers were secondary level of education. There existed a positive significant contribution with their adaptation strategies towards adverse effects on their food security. Therefore, it may be concluded that an appreciable proportion of the farmers will continue to face problems in adaptation strategies, if suitable steps are not taken to remove illiteracy from the farmers.

3. Almost 81.58 % of the farmers had low to medium extension media contact. Findings expressed that extension media contact of the farmers had significant positive contribution with their adaptation strategies towards adverse effects on their food security. So, it may be concluded that if the farmer come in more contact of extension provider, electronics, and printed media and extends their organizational participation they will face less problems in adaptation strategies.

4. Professional training experience of the respondents had positive contribution with their adaptation strategies towards adverse effects on their food security. This leads to the conclusion that higher professional training experience enhances the adaptation strategies towards adverse effects on their food security.

5. Most of the farmers (82.52%) had low to medium farming experience. Findings expressed that farming experience of the farmers had significant positive contribution to their adaptation strategies towards adverse effects on their food security. So, it may be concluded that increase experience the more the adaptation strategies towards adverse effects on their food security and vice-versa.

5.3 Recommendations

Recommendations based on the findings and conclusions of the study have been presented below:

5.3.1 Recommendation for policy implication

1. The findings indicated that an overwhelming majority (91.26%) of the farmers had low to medium adaptation strategies. For adaptation towards adverse effects on their food security, farmers need to be motivated towards adaptation in an appropriate way. Experts GO and NGO representatives in collaboration with the farmers can play a key role in this regard and their knowledge and communication exposure should be improved through individual and group discussions.

2. The findings of the study indicated that education had significant positive contribution to their adaptation strategies towards adverse effects on their food security. Therefore, it may be recommended that the concerned authorities should take the special mass education program for the illiterate and low lettered farmers for increasing their adaptation strategies.

3. The findings extension media contact had a significant positive contribution with their adaptation strategies towards adverse effects on their food security. So, it may be recommended that the extension workers of the concerned authority should increase the contact with farmers personally and motivate them to be connected with electronic and printed media that can help them to exchange related information which will increase their adaptation strategies.

4. The findings revealed that the farming experience had a significant positive contribution to their adaptation strategies towards adverse effects on their food security. So, it may be recommended that the concerned authority should increase farming experience to develop skills of the farmers technologically so that they can maximize their adaptation strategies.

5. The findings indicated that professional training experience had a positive significant contribution to their adaptation strategies towards adverse effects on their food security. Therefore, it may be recommended that the extension provider of concerned authority should select those farmers with priority that has more attraction, eagerness and attention toward new technologies so that they can increase their adaptation strategies.

5.3.2 Recommendations for further study

- ✓ The present research was undertaken in the Nabinagar upazila under Brahmanbaria district. The findings of the study are needed to be tested in the other areas of the country.
- ✓ The present research was undertaken to measure the adaptation strategies of the farmers. Further research should be conducted to assess the effect of adaptation strategies on livelihood.
- ✓ Contribution of only 10 selected characteristics of the respondents to the adaptation strategies was examined. It may be recommended for further research to examine the contribution of other socio-economic (knowledge, problem etc.) characteristics of the farmers to the adaptation strategies.
- ✓ In addition to adaptation strategies, the farmers also faced other problems such as social, economic, housing, sanitation, nutrition and domestic etc. Therefore, it may be recommended that research should be conducted relation to other issues of the farmers.
- ✓ The research was conducted to find out adaptation strategies of the farmers. Further research should be taken related to other issues like salinity, drought or others adaptation strategies.

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APPENDIX-A

(English Version of the Interview Schedule)

Department of Agricultural Extension and Information System

Sher-e-Bangla Agricultural University, Dliaka-1207

Interview schedule of the study on

"CHARLAND FARMERS' ADAPTATION STRATEGIES TOWARDS ADVERSE EFFECTS ON THEIR FOOD SECURITY UNDER BRAHMANBARIA DISTRICT"

(Please answer the following questions)

Sample No: .....

Name of the respondents: .....

Village: .....

Union: .....

Upazila: .....

District: .....

1. Age: What is your present age? ..... Years.

2. Education: Please mention your level of education.

a) 1 cannot read and write

b) I can sign only

c) I took non-formal education which is equivalent to….. class

d) 1 have studied up to class.....

3. Family size: Please mention your total number of family members.

a) Male .....

b) Female .....

c) Total .....

4. Farm size

Please mention your farm size

Sl. No.	**Types of land ownership**	**Area of land**		**Total Area** (Hectare)
		Local unit	Hectare	
1	Homestead area (Including pond) (A)			
2	Own land under own cultivation (B)			
3	Land given to others as borga (C)			
4	Land taken from others as borga (D)			
5	Land taken from others as lease (E)			
	Total=A+B+1\2(C+D)+E			

5. Annual family income

Mention your annual family income from the following sources

Income sources			Income in '000' Tk.
A.	**Agricultural sources**		
	1)	Crop	
	2)	Livestock	
	3)	Poultry	
	4)	Fisheries	
B.	**Non-Agricultural sources**		
	i)	Business	
	ii)	Job	
	iii)	Laborer	
	iv)	Others	
Total Income			

6. Farming experience: Please state the duration of your direct involvement in farming. ……years

7. Professional training experience:

Do you have any relevant training experience?

1. Yes 2.No

If yes, then please mention the following information

SL.NO	Name of the training course	Concerned organization	Duration of training
1			
2			
3			
	Total		

8. Agricultural extension media contact:

Please mention the extent of your contact with the following source

Sl. No	Sources	Extent of contact				
		Never	Rarely (1)	Occasionally (2)/	Often (3)	Regularly (4)
1	Model farmers	0	1 time /month	2-3 times /month	4 - 5 times /month	More than 5 times /month
2	Neighbors	0	1 time /month	2-3 times /month	4 - 5 times /month	More than 5 times /month
3	SAAO	0	1 time /month	2-3 times /month	4 - 5 times /month	More than 5 times /month

4	AAEO/AEO	0	1-2 times /year	3-4 times /year	5- 6 times /year	More than 6 times /year
5	UAO	0	1-2 times /year	3-4 times /year	5- 6 times /year	More than 6 times /year
6	Inputs dealers (Fertilizer, Pesticides, Irrigation)	0	1 time /month	2-3 times /month	4 - 5 times /month	More than 5 times /month
7	Agril. Info. Centre (eg. AISS, DISC)	0	1 time /month	2-3 times /month	4 - 5 times /month	More than 5 times /month
8	Agricultural program through electronic media (radio/TV)	0	1 time /month	2-3 times /month	4 - 5 times /month	More than 5 times /month
9	Agricultural features in printing media (daily newspaper, leaflet, booklet, magazine etc.)	0	1 time /month	2-3 times /month	4 - 5 times /month	More than 5 times /month
10	Agril. Based NGO worker	0	1 time /month	2-3 times /month	4 - 5 times /month	More than 5 times /month
	Total					

9. Organizational participation

Please mention the nature and duration of your participation with the following organization

SL. NO.	**Duration/Nature of the participation (yrs)**				
	Name of the organizations	No Participation (0)	Ordinary member (1)	Executive Committee Member (2)	Executive Committee Officer (3)
1	Farmers' cooperative association				
2	IPM club				
3	CIG				
4	Mosque/Madrashah/Mondir/Church/Pagoda committee				
5	NGO committee				
6	Union Parishad				
7	Youth Club				
8	Bazar Committee				
	Total				

10. Food security

i) Food availability: Please mention the availability of food among your family members

SI. No.	**Types of food**	**Availability of Food**				
		More available (4)	**Sufficient (3)**	**Less sufficient (2)**	**Less available (1)**	**No available (0)**
1.	Cereals					
2.	Vegetables					
3.	Fruits					
4.	Meat					
5.	Eggs					
6.	Fish					
7.	Pulse					
8.	Milk and milk products					
9.	Oils and fats					

11. Farmers' adaptation strategies towards adverse effects on their food security

Sl. No	**Name of the Practice**	**Response**	
		Yes	No
1	Cultivating short duration crops		
2	Practicing crop diversification		
3	Raised bed planting		
4	Practicing intercropping		
5	Early maturing cultivars		
6	Adjustment of planting dates		
7	Mulching		
8	Alternative irrigation system		
9	Use of heat tolerant cultivars		
	Total		

Date…….

Signature of the interviewer