CLIMATE CHANGE VULNERABILITY ON FARMERS' FOOD SECURITY IN THE NORTHERN PART OF BANGLADESH

MD. ASIF KISAR

DEPARTMENT OF
AGRICULTURAL EXTENSION AND INFORMATION SYSTEM
SHER-E-BANGLA AGRICULTURAL UNIVERSITY
SHER-E-BANGLA NAGAR, DHAKA-1207

JUNE, 2018

CLIMATE CHANGE VULNERABILITY ON FARMERS' FOOD SECURITY IN THE NORTHERN PART OF BANGLADESH

BY

MD. ASIF KISAR

REGISTRATION NO.:12-04985

A Thesis

Submitted to the Faculty of Agriculture,
Sher-e-Bangla Agricultural University, Dhaka-1207
In Partial Fulfillment of the Requirements for the Degree of

MASTER OF SCIENCE (MS)

IN

AGRICULTURAL EXTENSION

SEMESTER: JANUARY - JUNE, 2018

Approved by

……..……

(Dr. Mohummed ShofiUllahMazumder)
Supervisor
Professor
Dept. of Agril. Ext. and Info. System
Sher-e-Bangla Agricultural University

……..……

(Dr. Md. Sekender Ali)
Co-Supervisor
Professor
Dept. of Agril. Ext. and Info. System
Sher-e-Bangla Agricultural University

….……..……

(Dr. Muhammad HumayunKabir)
Professor andChairman
Department of Agricultural Extension and Information System
Sher-e-Bangla Agricultural University, Dhaka

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

CERTIFICATE

This is to certify that the thesis entitled, **"CLIMATE CHANGE VULNERABILITY ON FARMERS' FOOD SECURITY IN THE NORTHERN PART OF BANGLADESH"**submitted to the faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **Master of Science (MS) in Agricultural Extension,** embodies the result of a piece of bona fide research work carried out by **Md. Asif Kisar**, Registration No. 12-04985, under my supervision and guidance. No part of this thesis has been submitted for any other degree ordiploma.

I further certify that any help or sources of information, as has been availed of during the course of investigation have been duly acknowledged.

Dated: June, 2018
Dhaka, Bangladesh

……..……..…….
(Dr. Mohummed ShofiUllah Mazumder)
Supervisor
Professor
Dept. of Agricultural Extension and Info. System Sher-e-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka-1207.

DEDICATION

LOVINGLY DEDICATED TO MY BELOVED PARENTS AND RESPECTED TEACHERS OF SHER-E-BANGLA AGRICULTURAL UNIVERSITY

ACKNOWLEDGEMENTS

All praises, thanks and gratitude are due to the Almighty Allah for his grace bestowed upon the author for accomplishing this research study. With boundless love and appreciation, the researcher would like to extend his heartfelt gratitude and appreciation to all who helped him bring this study into reality.

In particular, the researcher takes the opportunity to express thanks to his respectable supervisor **Dr. Mohummed ShofiUllah Mazumder**, Professor, Department of Agricultural Extension and Information System, Sher-e-Bangla Agricultural University, for his noble guidance, constructive criticism, constant stimulation and encouragement through supervision during the course of preparation of this thesis, without which this work would not have been possible. For his unwavering support, I am truly grateful. His insight and practical skill have left a distinct mark on this work.

The researcher also wishes to express sincere appreciation and heartfelt gratitude to his co-supervisor **Dr. Md. Sekender Ali**,Professor,Department of Agricultural Extension and Information System, Sher-e-Bangla Agricultural University, for his valuable suggestions, constant cooperation, inspirations and sincere advice to improve the quality of the thesis throughout the period of this research program.

The researcher also wishes to express sincere appreciation and heartfelt gratitude to all teachers, Department of Agricultural Extension and Information System, Sher-e-Bangla Agricultural University, for their valuable advice to improve the quality of the thesis throughout the period of this research program.

Heartfelt thanks and appreciations are also expressed to the**Kbd. Md. Khaledul Rahman**, Upazila Agriculture Officer of Chilmari Upazila of Kurigram district in the study area for their benevolent help and cooperation in data collection period. The researcher is especially grateful to all the respondents in the study area for their cooperation and help in accomplishing the objectives of this research work.

Last but not the least, the author expresses his immense indebtedness, deepest senses of gratitude to his beloved mother, elder brother and sisters who sacrificed all their happiness during the whole study period especially during his MS study. The wishes, heartfelt thanks and gratitude to extend to all his relatives, well-wishers especially friends for their inspiration, blessing, cooperation and encouragement in all phases of this academic pursuit from the very beginning to theend.

June,2018 **TheResearcher**

LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABBREVIATION AND GLOSSARY

Abbreviation	Full word
Ag. Ext. Ed.	Agricultural Extension Education
Ag. Ext. and Info. Sys.	Agricultural Extension and Information System
β	Multiple regression coefficient
BBS	Bangladesh Bureau of Statistics
BER	Bangladesh Economic Review
BIRTAN	Bangladesh Institute of Research and Training on Applied Nutrition
DAE	Department of Agricultural Extension
et. al	All Others
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agriculture Organization Statistics Government of Bangladesh
GOB	Government of Bangladesh
MoA	Ministry of Agriculture
MoF	Ministry of Food
MoYS	Ministry of Youth and Sports
OLS	Ordinary Least Squares
SAAO	Sub Assistant Agriculture Officer
SPSS	Statistical Package for Social Science
UNFCCC	United Nation Framework for Climate Change Conference

CLIMATE CHANGE VULNERABILITY ON FARMERS' FOOD SECURITY IN THE NORTHERN PART OF BANGLADESH

MD. ASIF KISAR

ABSTRACT

The purpose of the study was to ascertain the present status of farmers' food security and describe the socio-economic profile of the climate change affected farmers.The study was undertaken purposively in Chilmari Upazila under Kurigram district. A well-structured pretested interview schedule (questionnaire) was used to collect datafrom 93randomly selected farmers. Descriptive statistics, multiple regressions, problem facing index (PFI) were used for data analysis. Majority of the farmers had medium category of food security. Findings reveal that the farmers' level of education, family size and perception of climate change had significant contribution to change in food security including the dimensions of the food availability. Farmers' level of education, perception of climate change and knowledge on climate change had significant contribution to change in food security including the dimensions of the food stock security. Again farmers' age, their family size, agricultural extension contact and knowledge on food security had significant contribution to change in food security including the dimensions of the nutritional security. About two-third majority (66.6%) of the farmers faced medium level problems in achieving their food security. It is recommended that respective authorities should take initiative to implement and popularize differentdevelopment projects on a massive scale to achieve farmers' household food security status.

CHAPTER I
INTRODUCTION

1.1 GeneralBackground

Bangladesh is one of the most vulnerable countries to climate change because of geographic exposure, low income and greater reliance on climate sensitive sectors, particularly agriculture. People, exposed to the most severe climate-related hazards are often least able to cope with the associated impacts due to their limited adaptive capacity (Islam *et al*., 2011)and are expected to become more susceptible in future. It's been experiencing different types of natural disasters almost every year because of the global warming as well as climate change such as floods (almost 80% of the total area of the country is prone to flooding),cyclones and storm surges (South and South-eastern parts of the country were hit by tropical cyclones during the last few years), salinity intrusion (almost the whole coastal belt along the Bay of Bengal),extreme temperature and drought (North and North-western regions of the country).

Climate change has already impacted on the life and livelihoods of the people in the coastal areas and in the arid and semi-arid regions of Bangladesh (MoP, 2011). In particular, the effects of climate change on agriculture and other sectors are already evident. The agricultural sector is most likely to face significant yield reduction in future due to climate variability (Islam *et al*., 2011). Most importantly, crop agriculture is the most vulnerable to climate change among different sectors of the Bangladesh economy. One major determinant of fluctuations in crop yield is year-to year changes in climatic variables (Hazell, 1984; Anderson &Hazell, 1987). Over the last several decades, global warming has been observed on local, regional, and global scales. The Inter-governmental Panel on Climate Change report presents a detailed evaluation of long term worldwide observations on climate change and a sound physical analysis of the potential trends of change in climate (IPCC, 2007). The report concludes that global climate is very likely to get warmer in the near future. As scientific evidence becomes more convincing that increasing concentrations of greenhouse gases will warm the planet (IPCC, 2007). It has become ever more important to understand the impacts of global warming. The impacts on agriculture are among the largest and the best documented. Bosello and Zhang (2005) stated that

the relationships between climatechange and agriculture are complex and manifold. They involve climatic and environmental aspects, social and economic responses. These last can take either the form of autonomous reactions or of planned economic or technological policies. This picture is complicated further: indeed climate change and agriculture interdependencies evolve dynamically over time, they often span over a large time and space scale and are still surrounded by large uncertainties.

Agricultural development provides food security status of the people of a nation. One of the fundamental rights of the citizens stipulated in the constitution of Bangladesh is food security for all. Food security exists when all people, at all times, have access to sufficient, safe and nutritious food to maintain healthy and productive lives. The key elements of food security are: a) availability of enough food from domestic production and/or imports to meet the demand, b) access of the food to all people at all times through enough incomes and affordable prices, c) proper hygiene and sanitary practices and safe water for utilization of food to have optimum impact on health and nutrition, and d) a regulatory framework in place and its proper implementation for controlling contamination to ensure food safety.

Food security is the state achieved when food systems operate such that all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life (FAO, 2008). Food security is influenced by four key dimensions: availability of sufficient food; economic, physical and social access to the resources needed to acquire food; stability of this availability and access; and utilization, including nutrition, food safety and quality. The unprecedented impacts of climate change along with other environmental and geomorphologic changes make more concerns over food security especially, for the poor and marginal population (Gregory & Ingram 2000; Parry *et al*. 2001; Rosegran& Cline 2003).

Food security is a condition related to the supply of food, and individuals' access to it. Concerns over food security have existed throughout history. There is evidence of granaries being in use over 10,000 years ago, with central authorities in civilizations including ancient China and ancient Egypt being known to release food from storage in times of famine. At the 1974 World Food Conference the term 'food security' was

defined with an emphasis on supply. Food securityis the ‘availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices’ (FAO, 2003). Later definitions added demand and access issues to the definition. The final report of the 1996 World Food Summit states that food security ‘exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life’ (Patel, 2016). Household food security exists when all members, at all times, have access to enough food for an active, healthy life (USDA, 2016). Individuals who are food secure do not live in hunger or fear of starvation (FAO, 2013). Food insecurity, on the other hand, is a situation of limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways. According to the United States Department of Agriculture (USDA, 2016). Food security incorporates a measure of resilience to future disruption or unavailability of critical food supply due to various risk factors including droughts, shipping disruptions, fuel shortages, economic instability, and wars (Boeing, 2016). In the years (2011-2013), an estimated 842 million people were suffering from chronic hunger. The Food and Agriculture Organization of the United Nations, or (FAO), identified the four pillars of food security as availability, access, utilization, and stability. The United Nations (UN) recognized the Right to Food in the Declaration of Human Rights in 1948, and has since noted that it is vital for the enjoyment of all other rights (UNCESCR, 2016). In view of repeated experience of severe hunger and famine, food security in Bangladesh has long been synonymous with achieving self-sufficiency in rice, the dominant staple food. The Bangladesh economy has made respectable progress in rice, tripping production from 11 million tons in 1971 to 33 million in 2012 (BBS, 2014). The per capita rice production has increased substantially over the level at independence. The growth of production was achieved by fast adoption by farmers of higher yielding crop varieties developed by scientists, supported by rapid expansion of irrigation infrastructure through private investment in tube wells. Commercial import of wheat has however increased despite growth in domestic production till the 1990s, mainly due to the discontinuation of food aid and stagnation of domestic production after a rapid growth in the 1980s. The import has recently exceeded three million tons. It appears that even if Bangladesh achieves self-sufficiency in rice production the import of wheat will continue (Nath, 2015).

Bangladesh remains highly food insecure in spite of important economic progress. Bangladesh is ranked 129th out of 169 countries in the 2010 Human Development Index (HDI) (UNDP, 2010). About 60 million people consume less than the minimum daily recommended amount of food (HIES, 2010). According to International Food Policy Research Institute (IFPRI, 2009) Global Hunger Index-which is a combined measure of the proportion of undernourishment, child malnutrition and child mortality- food security has improved in Bangladesh since 1990, with country moving from an "extremely alarming" to an "alarming" level of hunger. The proportion of undernourished has fallen from 36 per cent of the population to 26 per cent in 2006. Despite this progress, Bangladesh's food security is still fragile and major challenges remain as well. The farmers of Bangladesh mainly depend on agriculture and agriculture related activities. Opportunities for off-farm activities are marginal. As a result of river erosion, cultivable land, crops and homestead are often damaged or devoured by rivers regularly. The level of awareness with respect to health, water and sanitation, environment, rights and gender is at a minimum. The life of char people in Bangladesh is very much uncertain and vulnerable to so many shocks of the environmental factors. But the need to secure food is a certain matter to continue their lives. Special emphasis also is to be placed on the landless people of char areas as they do not have their own land to produce enough food to meet household food demand. Development of farmers' livelihood, knowing of position of food security of farmers is essential where a major portion is secured by a landless people. If their state of food insecurity is revealed, careful and need-based interventions may possibly be taken properly to mitigate the crises. For this reason, it was deemed necessary to undertake this study.

The researcher intended to make an attempt to understand the status of farmers' food security in Bangladesh. Appreciating and analysing the aforesaid conditions the researcher has become interested in undertaking a research entitled, "Climate change vulnerability on farmers' food security in the northern part of Bangladesh".

1.2 Statement of the Problem

Food, in the hierarchy of needs, is the most basic need for sustenance of life and is the perennial problem issue for healthy and active life of mankind. Food security is not just an economic problem but also a social and political issue in as much as food

insecurity is a factor to create social and political instability in the country. Food security is a basic factor for development of human capital and starter for overall development of the society. Right to adequate and stable supply of safe food is a constitutional right of the people in Bangladesh. The Government of Bangladesh is firmly committed to the progressive realization of the right to food, as enshrined in the constitution. Food security, as put by FAO, involves four dimensions: availability, accessibility, food utilization and stability of components of food security. Nutrition, food safety and quality have attained considerable importance recently in Bangladesh. Ensuring food security for all is one of the major challenges that Bangladesh faces today. Despite significant achievements in food grain production and food availability, food security at national, household and individual levels remains a matter of major concern for the country and it's Government.

Since independence, Bangladesh has made significant progress in increasing domestic production of food grains. This, to a large extent, helped in overcoming the constraints of insufficient national food availability. Adequate food availability however was not a sufficient condition for ensuring national food security. Ensuring food security for all reportedly require a major effort at enhancing access to food and subsequent utilization of food by the poor and distressed households. Though hunger is the number one issue, malnutrition has become emerging problem for treatment. Along with underweight, overweight including obesity has become another problem of health related to food intake. In this situation, providing adequate, stable, safe and nutritious balanced food to all becomes a challenging task in the way of development ahead, and there is a serious need to develop a road map to achieve this visionary goal for a healthy society. The present research is designed to make an empirical analysis on components of food security status of farmers.

1.3 Specific Objectives of the Study

The following specific objectives were drawn in order to give proper direction to the study:

a) To describe the socio-economic profile of the climate change affected farmers; the characteristics were as follows:

- Age
- Education
- Family size
- Farm size
- Farming experience
- Annual family income
- Agricultural training exposure
- Agricultural extension media contact
- Farmers' perception of climate change
- Climate change vulnerability
- Knowledge on climate change
- Knowledge on food security

b) To ascertain the present status of farmers' food security of the climate affected farmers.

c) To explore the contribution of the selected characteristics of the farmers on their food security.

d) To identify the severity of problems faced by the affected farmers'.

1.4 Scope of the Study

a) The present study was designed to have an understanding of food security status of farmers and to estimate its contribution with their selected characteristics.

b) The findings of the study will be applicable to the study area namely; Thanahat and Chilmari Union under Chilmari Upazila of Kurigram district. The findings may also be applicable to other areas of Bangladesh where socio-cultural, psychological and economic status do not differ much than those of the study areas.

c) The findings of the study may also be helpful to the field worker of extension

service to improve their action strategies for food security.

d) The findings of the study will be helpful to accelerate the development in agriculture, farmers' logistic supports, information needs and the way of dissemination especially tuned to key role players in the society as well as ensuring food security of the farmers. The findings might also be helpful to the planners and policy makers, extension workers etc.

e) To the academicians, it may help in the further conceptualization of the systems model for analysing the food security status of farmers. In addition, the findings of this study may have other empirical evidence to all aspects of food security of farmers which may be used to build theory of food security.

1.5 Justification of the Study

Bangladesh has made substantial progress in enhancing food security by increasing production of food grains, particularly rice. Rice has contributed most to self-sufficiency in food grain. Rice production gains have been mainly driven by an increased use of irrigation water, expanded use of other agricultural inputs along with an increased coverage of high-yielding and modern rice varieties. However, the sustainability of domestic food grain production remains an issue. Rice cannot be expected to experience the growth rate of the past without net technological breakthrough. Furthermore, demographic pressures and increased urbanization have caused cultivated area to decline at a rate of 1 percent per year, whilst cropping intensity has virtually reached its limit. Small and marginal farmers represent more than 80% of all farmers. Only a limited percentage of crops circulate through commercial channels. This also results in a situation where, despite efforts, food grain procurement remains limited and size able food grain imports are needed for public distribution. In the last five years, total annual imports of food grains have ranged between 2 to 3 million tons. Imports consist mainly of wheat, whose production has been continuously reducing over the past years, with rice accounting for about half million tons per year.

It is notable that the emphasis placed on rice production has resulted in an increased dependency on imports for non-food grain commodities, such as pulses, oil seeds and fruits which remain unaffordable to many consumers, especially poor consumers. For

instance, 70% of the pulses and 66% of the edible oil (MoF, 2016) requirements are currently imported traditionally, the two most important non-cereal foods for the poor were fish and pulses.

Only a few researches have so far been conducted in Bangladesh on farmers' food security status. From the extension and overall national development point of view, a research study on farmers' food security status is important to understand and to get schematic knowledge about farmers' position in this society. The researcher intended to make an attempt to realize how the farmers' socio-economic condition could uplift their food security status. The researcher also aimed to know present condition of food security of the farmers. Therefore, the study "Climate change vulnerability on farmers' food security in the northern part of Bangladesh" has been undertaken.

1.6 Assumptions of the Study

An assumption is the supposition that an apparent fact or principle is true in the light of available evidence (Goode and Hatt, 1952). The researcher had considered the following assumptions while undertaking the study:

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

b) Views and opinions furnished by the respondents were the representative views and opinions of the whole population of the study.

c) The responses furnished by the respondents were reliable and they truly expressed their opinions on the climate change vulnerability on farmers' food security in the northern part of Bangladesh.

d) The data collected by the researcher were free from bias.

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

f) The respondents had almost similar background and seemed to be homogenous to a great extent.

g) The information sought by the researcher revealed the real situation to satisfy the objectives of the study.

h) The findings were useful in choosing the clients as well as for planning

execution and evaluation the extension programme.

1.7 Limitations of the Study

Considering the time, respondents, communication facilities and other necessary resources available to the researcher and to make the study manageable and meaningful, it became necessary to impose certain limitations as mentioned bellow-

a) The study was confined in two Unions (Thanahat and Chilmari) of Chilmari Upazila under Kurigram district. Chilmari Upazila consisted of 144 villages. Among the 144 villages, only five villages were selected purposefully for this study.

b) The study was restricted within the farmers who had some cultivable land under their own cultivation.

c) The population for the study was kept confined to the heads of the family who regularly cultivated their land.

d) There were many characteristics of the farmers but in the study only 12 of them were selected in this study.

e) For information about the study, the researcher depended on the data furnished by the selected respondents during their interview with him.

f) Major information, facts and figures supplied by the respondents were applicable to the situation prevailing in the locality during the year 2019.

CHAPTER II
REVIEW OF LITERATURE

The purpose of this chapter is to review the past studies and opinions of experts and social scientists having relevance to this investigation based on the major objectives of the study. Attempts have been made in this chapter to review that finding of past researches having relevance to the present study. But unfortunately, very few studies have been obtained which were directly related with "climate change vulnerability and farmers' food security" status in general or which explain the factors that influence the farmers' food security status in the northern part of Bangladesh. The researcher, therefore, made exhaustive effort to review the previous research works directly or indirectly related to the present study by different researcher in home and abroad. However, many studies could be found on food security problem confrontation, the result of which were indirectly related to the present study and also which focuses climate change vulnerability.

This chapter comprises with several sections. The concepts of climate change vulnerability have been presented in the first section. As certain fundamental, general observations on food security status or its related issues also have been presented subsequently. At last conceptual model of the study is presented in the last sections of the study.

2.1 Climate Change

The Inter-governmental Panel on Climate Change (IPCC, 2007) defines climate change as: "a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing or to persistent anthropogenic changes in the composition of the atmosphere or in land use". The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as "a

change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods", (UNISDR, 2009).

2.2 Climate Change and its Components

Bangladesh has a unique geography, situated on the Bay of Bengal and forming one of the largest deltas in the world with a dense network of tributaries of the Ganges, Brahmaputra and Meghna (GBM) Rivers. Most of the country is less than 10 m above sea level (and 10% is less than 1 m). Bangladesh has a monsoon type climate. It has three seasons:

- Hot, humid summers (March-June) with average maximum temperatures of 37 °C and relatively little rainfall and often drought
- Cooler monsoon seasons (June-September) with heavy rainfall frequently resulting in flooding for up to two-thirds of the country
- Dry, cooler winters (October-February) with average maximum temperatures of 28 °C. Karmalkar, A.; McSweeney, C.; New, M.; Lizcano, G. (2012)

2.2.1Temperature

According to World Bank (2011), the highest temperatures are in the southwest, the lowest in the northeast of the country. The average temperature ranges between 13 and 26 degrees °C during the cool season and 25 to 31 °C during the hot season. Latest IPCC predictions from their Fourth Assessment Report reveal that for the next twenty years warming at a rate of 0.2˚ C per decade is expected. While by the year 2100 best estimates predict between a 1.8˚ C and 4 ˚C rise in average global temperature, although it could possibly be as high as 6.4˚ C, (IPCC, 2007).

2.2.2 Rainfall

Rainfall in Bangladesh also differs based on season and location. The central west receives the least, less than 1,400 mm per year, while the northeast and southeast receive over 3,000 mm per year, Thomas *et al.* (2013). About 80% of all precipitation falls during the monsoon season, in heavy, torrential rains, Karmalkar*et al.* (2012).

2.2.3 Cyclone

Due to its topography and climate, Bangladesh is subject to devastating cyclones, mostly in April-May and September-November, Karmalkar*et al.* (2012). UNDP has

ranked Bangladesh first of all countries in the world in terms of vulnerability to tropical cyclones. The country is hit by a severe cyclone on average every three years, MoEF (2009). Ministry of Environment and Forests.

2.2.4Flood

Bangladesh is also vulnerable to flooding, with 80% of its surface forming a giant floodplain, (Ayers *et al.*,2014). Floods originate from precipitation in the whole of the GBM Basin, not just the 7% that lies within Bangladesh, and can therefore be of great magnitude, World Bank (2010). Almost every year floods occur in July and August, Sharmin, Z.; Islam, M.S. (2013). In an average year, about 25% of the country is inundated. During severe floods, occurring every 4-5 years, over 60% of the country is covered. These floods have devastating effects.

2.2.5River bank erosion

Riverbank erosion results in the loss of thousands of hectares of agricultural lands, and affects the population for decades, MoEF (2009). Moreover, floods contribute to further salinization of coastal lands, causing not only loss of harvests but also of productive agricultural land18. Out of 2.85 million hectares of coastal and offshore areas, about 1.2 million hectares of arable land are already affected by varying degrees of soil salinity, World Bank (2011).

2.2.6Drought

Every year Bangladesh experiences a dry period for seven months, from November to May, when rainfall is normally low. During this period about 2.7 million hectares of land in Bangladesh are vulnerable to annual drought; and according to the Government of Bangladesh there is about a 10% probability that 41-50% of the country experiences drought in a given year (Tanner *et al.*, 2007). While many parts of Bangladesh suffer from widespread and common floods, other parts experience seasonal droughts, Xenarios*et al.*,2014). These occur especially in the northwest of the country, and mostly in the months leading up to the November-December rice harvest for an overview of the different types of extreme climatic events and their distribution over the country, MoEF (2009).

Changes have been observed in the climate of Bangladesh. Overall, weather patterns

have been erratic and less predictable than before, (World Bank, 2011). Total annual rainfall for the country as a whole did not change significantly between 1960 and 2003, although there was a significant increase in some areas, most notably the west and northwest. There has also been a significant increase in certain seasons, including a 3.4% increase in country-wide rainfall during the pre-monsoon summer season and a 1.7% decrease in monsoon rainfall for a differentiation per season for different regions, Karmalkar*et al.* (2012). The rainy season has become shorter, and heavy rainfall occurs within a shorter period.

The cold and dry season has also decreased in length,Thomas *et al*. (2013). Average temperature shows an increasing trend, especially during the monsoon season (June-August) at 0.07°C per decade and during early winter (September-November) at 0.12°C per decade, Karmalkar*et al.* (2012). According to IPCC figures (2007), higher temperatures and erratic rainfall have in some areas contributed to wetlands drying up and ecosystems degrading, Al Mamun, A.; Al Pavel, M.A. (2014).

Climate change is directly related to its major components and natural hazards but, a limited number of similar researches have so far been conducted by the researcher. Systematic and comprehensive study is yet to be conducted. It is therefore, the researcher has been taken into consider for further study this piece of research.

2.3 Effects of Climate Change in Bangladesh

Bangladesh is one of the most climate change vulnerable country in the world. The main reasons for its vulnerability are due to (i) its location in the tropics, (ii) the dominance of floodplains, (iii) its low elevation from sea level and (iv) its high population density. (MOEF, 2005; DOE, 2007; Shahid&Behrawan 2008; Pouliotte*et al*. 2009; Hossain & Deb, 2011). The geographical location of the country has made the people very much depended on the environment and vulnerable to natural disasters. According to (IPCC, 2007) sea level in the coastal region of Bangladesh has been predicted to rise up to 80 cm by 2100. As people of Bangladesh will be affected by climate change directly or indirectly in all regions. Climate change is the biggest global health threat of the 21st century and increasingly recognized as a public health priority (WHO, 2008; Lancet, 2011, Young *et al*., 2002; Yongyut*et al*., 2009). Changes in climate generally involve changes in two major climate variables: temperature and rainfall. Its leads to increased temperatures, changing rainfall patterns

and amounts, and a higher frequency and intensity of extreme climate events such as floods, cyclone, droughts, and heat wave (IPCC, 2007; Tirado *et al.*, 2010; Roudier*et al.*, 2011). According to the International Panel for Climate Change (2007), an increase in the average global temperature will lead to changes in precipitation, and atmospheric moisture, sea level rise due to the changes in atmospheric circulation, and increases in evaporation, and water vapor. The effects of climate change are heterogeneous and region specific. For example, a rise in temperature with reduced and more variable rainfall has already affected the natural and physical ecosystems of Bangladesh, predominantly the northwest with its recurrent droughts and the southwest with rising soil salinity (Ahsan *et al.*, 2011).

Climate change vulnerability arises as vital issue to the Bangladeshi farmers since last two decades. As a result, a limited number of similar researches have so far been conducted by the researcher. Systematic and comprehensive study is yet to be conducted. It is therefore, the researcher has been taken into consider for further study this piece of research.

2.4 Effects of Climate Change in Bangladesh Agriculture

Bangladesh lies in the northeastern part of South Asia between 20°34′ and 26°38′ N latitude and 88°01′ and 92°41′ E longitude, one of the most densely populous countries (1033.5/sq.km) which 93.6% land and 6.4% is water resources, respectively. It is an agro based country which 20.0% of national GDP comes from agricultural production and employing 65.0% of total labor force in 2010 (Ruane*et al.*, 2013). Part of Bangladesh's vulnerability to the effects of climate change stems from its dependence on agriculture. Although the agricultural sector contributes only 16% to the country's GDP, almost half (47%) of the Bangladeshis are employed in the agricultural sector, with rice as most important product, BBS (2014-2015). Within the agricultural sector, the largest sub-sector is crop cultivation (8.73% of GDP), followed by fisheries (3.29%), livestock (2.07%) and forestry (1.42%), Thomas *et al.* (2013).

Consequence of climate change, agricultural sector of northern districts is suffering from increased spikelet sterility, higher infestation of pests and diseases, deficiency of water and soil moisture due to increase rate of evapo-transpiration and hampering the agricultural productions (rice, wheat, pulses, rape seed and coconut). On the other hand, southern coastal belt will be inundated and vulnerable for salinity intrusion

causing to reduce the existing crop productions. The 700 km long coastline of Bangladesh covers 2.5 million ha area in coastal area is supporting to 35 million people as their home and daily livelihood and expected to be reached to 40-50 million by 2050 (Agrawala*et al.*, 2003; Ahamad*et al.*, 2012). But 0.83 million ha land within these areas are vulnerable to sea level rise, suffering from salinity intrusion varying from 0 to 20 ppt deteriorating agro-resources and the distribution is gradually increasing (Uddin *et al.*, 2011).

Consequently, agricultural production is decreasing (0.3 m rise will cause a net reduction of 0.5 million metric tons) due to shortage of fresh water, soil degradation and terminative energy and germination rate of some plants (Krishnamurthy *et al.*, 2014). A recent research showed within 8.3 million ha there is 4.2 million ha of lands are droughts prone with different intensities. At present, 30 million tons food are producing yearly from irrigated agriculture (56.0%) in which 80.0% areas are irrigated from groundwater due to terrible shortage of surface and ground waters where eastern part will be suffered from loss of 14,000 tons grain production alone in 2030 and 252,000 tons by 2075 (Islam *et al.*, 1999; Minar*et al.*, 2013). The recent studies found that climate change causing the change in rainfall pattern will decrease 30.0% crop production in 2100 and 28.0% for rice and 68.0% for wheat respectively (Karim *et al.*, 2012). Furthermore, 1 meter sea level rise will lose up 15.0% of total land area that will create up to 30 million environmental refugees and also national GDP will decline between 27.0-57.0% (Agrawala*et al.*, 2003; Harasawa, 2006).

Livestock

Livestock sector is largely affected by climate change variability. Its production is also affected by the climate changes due to reduction in the quality and availability of feed, water, increased diseases and other environmental stresses. Analytical evidence on the impacts of climate change on livestock is relatively scanty in Bangladesh. Chowdhury and Karim (2009) indicated that livestock production could be affected by the climate changes due to reduction in the quality and availability of feed and water, heat and other environmental stresses, and preponderance of livestock parasites, pests, and diseases. The average temperature in Bangladesh is 18 °C in winter and 28°C in the summer. If global warming causes Bangladesh temperature to rise further 2°C by 2050, together with relative humidity of 60–95%, all most all

species of livestock will be under heat stress conditions. As a result of heat stress, animals suffer from elevated body temperature, increased respiration rates, increased maintenance energy requirement, increased feed nutrient utilization, decreased dry matter intake, reduced milk production and hampered reproductive performance. Heat stress reduces disease resistance and increases morbidity and mortality of animal species. Reductions in milk production and reproductive performance are economic losses to cattle, goat and sheep producers. Climate change is also likely to affect the livestock sector both by affecting the quantity and quality of feed and by affecting the frequency and severity of extreme climate events. There is a limited body of literature that deals with effect of climate changes on livestock, but livestock sector may be particularly vulnerable to the effects of climate change (Hoffmann, 2008).

Fisheries

The fisheries sector has also experienced an adverse effect because of the impacts of Climate. The fisheries sector contributes about 3.5% of the GDP in Bangladesh and people depend on fish products in order to meet up majority of their daily protein requirements. Climate change is likely to adversely affect both the fresh water and marine fishes in Bangladesh. It affects habitat's alteration, fish reproduction, fish migration, natural fish breeding and fish biology. Fish reproduction, growth and migration patterns are all affected by temperature, rainfall and hydrology (Ficke*et al.* 2007). Increased salinity and change in water quality can prompt a change in species composition and distribution especially in coastal areas. However, salinity intrusion threatened fresh water fish production, at the same time, creating opportunities for catching and cultivating brackish and marine species. In 2007, the cyclone 'Sidr' caused damages and losses of US$6.7 million to fisheries sectors. It is reported by Bangladesh Fisheries Development Corporation (BFDC) that the fishery resources in the EEZ area of the Bay of Bengal have declined by around 25-30 % over the last couple of decades. Moreover, FAO. (2009) reports that around 100 important fish species have disappeared from the Bay of Bengal over the last few decades. In recent years, natural fish stocks have declined due to natural and manmade catastrophes, degradation of aquatic environments and reduction of many wetlands and water areas. The flood plain fisheries are the main sources of fish resources of Bangladesh. But due to erratic behavior of seasonal flood, these fish resources will be worst hit. There is a considerable threat of losing over 4 million metric ton of fisheries by the year

2030. Timing, extent and duration of rains and floods greatly influence reproduction, migration and growth of fishes. Delay in onset of rains and floods may affect the breeding and maturation success of fish, which in turn will result in the reduced fish production from rivers and floodplain (NAPA, 2005). Moreover, increased aridity, reduced dry season precipitation and extended dry spell, particularly in northwest region of Bangladesh, will lead to the drying up of or retain too little water (not adequate for survival of fish) in floodplain fish pits, depressions, ditches etc. As a flood plain area, inland open water fisheries of Dhaka region is suffering from reduced fish production. Every year hundreds of culture ponds float due to floods resulting in loss of fish and poor fish farmers incur financial losses. This effect of climate variability is posing a great threat to the substance of pond fish culture as well. The combined effect of all climatic impacts would have severe consequences on the productivity of agriculture and thus the livelihoods of a large number of poor people, especially those who are already food insecure and vulnerable.

2.5 Climate Change Vulnerability

Climate change has on natural systems threatens the livelihoods, food intake and health of poor people. Climate change will mean that many semi-arid parts of the developing world will become even hotter and drier, with even less predictable rainfall. Climate-induced changes to crop yields (Rahman and Mallick, 2011). Various nature and climate change shocks affect coastal livelihoods differently and govern vulnerability and adaptive capacity. Some of the disasters are fast in coastal areas in terms of its sudden affects to coastal life and livelihoods like tropical cyclone and storm surges, where others are slow in events like salinity or inundation increase, but these have long-term impacts on social and economic functions (Nicholls *et al*., 2007). The adverse impacts of weather events and climate increasingly threaten and erode basic needs, capabilities, and rights, particularly among poor and disenfranchised people, in turn reshaping their livelihoods (UNDP, 2007; Leary *et al.*, 2008; Adger, 2010; Quinn *et al.*, 2011). Weather events and climate affect the lives and livelihoods of millions of poor people. Even minor changes in precipitation amount or temporal distribution, short periods of extreme temperatures, or localized strong winds can harm livelihoods (Douglas *et al.*, 2008; Ostfeld, 2009; Midgley and Thuiller, 2011; Bele*et al.*, 2013). Climatic and other stressors affect livelihoods at different scales: spatial (e.g., village, nation) or temporal (e.g., annual, multi-annual).

Both direct and indirect impacts are often amplified or weakened at different levels. Global or regional processes generate a variety of stressors, typically mediated by cross level institutions, that result in locally experienced shocks (Reid and Vogel, 2006; Thomas *et al.*, 2007; Paavola, 2008; Pouliotte*et al.*, 2009). Poor people generally depend more on ecosystem services and products for their livelihoods than wealthy people. The means by which a poor family gains an income and meets its basic needs are often met by multiple livelihood activities. They are therefore severely affected when the environment is degraded or their access to it restricted (NAPA, 2005). The tropical cyclone of 2007 caused loss of valuable mangroves, social and physical resources and livelihood bases that post-disaster recovery has not yet been possible in Bangladesh (Mallick*et al.*, 2011). With changing frequency of cyclonic wind and storm surges and inundation coastal agriculture and domestic fisheries and open fishing have been highly affected which are significant livelihoods sources to majority coastal people. Salinity level is slowly increasing over the time and causing serious threats to traditional agriculture farming and mangrove ecosystems (Moniruzzaman, 2012). Changes in temperature and rainfall may change the geographic range of vector-borne diseases such as malaria and dengue fever, exposing new populations to these diseases. Young children as well as pregnant women and their unborn children are especially vulnerable to malaria. Malaria contributes to prenatal mortality, low birth weight, and maternal anemia (WHO, 2002). Thomas *et al*. (2013) Bangladesh is extremely vulnerable to the impact of climate change because it is a low-lying, flat country subject to both riverine flooding and sea level rise, and because a large portion of its population is dependent on agriculture for its livelihood. The effect of the climate changes on farmers' livelihoods, poverty and family food security is significant. A gradual decline in yields affects the viability of agriculture as a dependable base for subsistence and income. An increase in extreme events causes yields to fall abruptly or total loss of crops (IFAD, 2013). Seasonal variations have also diverse influence on fishing, hatchery operations, fish production and livelihoods of a wide range of people (Haque, 2007).

Bangladesh has made remarkable progress in agricultural development and food production in the recent decades. But the emerging impacts of global climate change are posing serious threats to food security of the people, particularly of the poor and marginal people of the society. Since independence in 1971, the national food

production progress has been boosted through the use of high yielding varieties, fertilizer, irrigation and pesticide.

2.6 Food Security

Food security encompasses three elements: availability, accessibility and utilization (USAID, 1996). Food availability refers to the physical presence of food at various levels from household to national level, be that from own production or through markets. Food access refers to the ability to obtain an appropriate and nutritious diet and is in particular linked to resources at the household level. Food utilization refers to the proper use of food, which includes the existence of proper food processing and storage practices, adequate knowledge and application of nutrition and child care, and adequate health and sanitation services (FANTA, 2006).

Food security is a concept used to describe access to, and availability of food supply at different levels. Numerous definitions, with slight variations depending upon the source, have been established to describe food security and insecurity. As a working definition, food security a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 2001). Food insecurity is limited or uncertain access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. The World Food Summit of 1996 defines food security as existing "at the individual, household, national, regional and global levels". However, the concept has evolved; during 1970s the concern was regarding national and global food supplies while since the 1980s the focus shifted to the household and individual levels such shift was caused by AmartyaSen's entitlement theory (Maxwell & Smith, 1992). Food security is built on three pillars: 1) food availability, defined as having sufficient quantities of food available on a consistent basis; 2) food access, defined as having sufficient resources to obtain appropriate foods for a nutritious diet; and 3) food use, defined as appropriate use based on knowledge of basic nutrition and care, as well as adequate water and sanitation (FAO, 2012). In their review, Maxwell and Smith (1992) found four core concepts that are similar to the above described pillars: sufficiency of food -

similar to food availability; access to food- comparable to food access; security defined as the balance between vulnerability, risk and insurance; and time. In the next sections we will go into more detail about each one of the core concepts and pillars of food security. These concepts are hierarchical, with availability necessary but not sufficient to ensure access, which is, in turn, necessary but not sufficient for effective utilization.

2.7 Food Security Status in Bangladesh

Food security is multi-dimensional having interrelationships among availability, accessibility and utilization elements. There is a fourth exogenous dimension that has significant interface with food security, i.e. the nature. The natural disasters affect all the three dimensions of food security. Food availability by itself does not ensure adequate access to food, although it is a necessary precondition for access to food. If people have access to livelihood, they would have access to food and nutrition. Poor physical access to food leads to poor consumption and poor nutrition. The levels of food consumption depend mainly upon food availability and food access. Food production is linked to livelihood access and food consumption. Livelihood access in turn influences the demand for food and better prices and production thereof. Better livelihood access also leads to improved living standard, better education, better knowledge on health etc. The interrelationships among food availability, access, utilization and nature.

Although food grain production has more than doubled since independence in 1971, food insecurity both in national and household level remains a matter of concern for the government. About half of the population cannot reach the minimum dietary energy requirement (2122 kcal/capita/day) and one quarter of them subsist in extreme shortage of energy consuming less than 1800 kcal/capita/day (GOB, 2000). Apart from the prevailing deficit in total calorie intake, the normal diet of Bangladeshi people is seriously imbalanced, with inadequate shares of fat, oil and protein (GOB, 2000). Women and children are especially vulnerable due to their limited access to food. This dietary imbalance reflects insufficient domestic production of non-cereal foods (pulses, oilseeds, fruits, meat, milk and eggs), low incomes, food preferences and lack of nutrition knowledge. Past studies suggest that consumed cereal diets meet nutritional demand in terms of energy needs as well as protein requirements (Sukhatme, 1978 and Gopalan, 1968). Indeed, many vitamins and mineral

deficiencies would also be reduced if sufficient calories were consumed (Greer and Thorbecke, 1986). The cereals, particularly rice (currently over 470 g/person/day) in the diet is so high that their contribution to total dietary energy nears about 75-80% in Bangladesh (Yusuf, 1997). And over the period, the supply of cereals (mainly rice) increased (despite consumption of cereals even in excess of the set amount of 454 gm/person/day (Hossain *et al.*, 2005), but the country suffers sufficient consumption of balanced food which indicates the inadequateness of diet from nutritional point of view. Also, due to the low yield of production and lack of access to food turn the country to the problem of balanced diet alone with sufficient amount of calorie intake from cereals and non-cereals. Therefore, insufficient calories, energy and protein intake which can be supplemented by cereals and non-cereals intake are also a problem in Bangladesh.

2.8 Research Gap of the Study

There are lots of researches on climate change vulnerability on farmers' food security taking either climate change or food security separately considering the selected characteristics of the farmers but very few researches was so far conducted to ascertain the climate change vulnerability and farmers' food security together. Most of the researchers conducted their research on Bangladesh's aspect but my study is particularly focused on Kurigram district of Bangladesh. This is one of the research gaps of the study.

2.9 The Conceptual Framework of the Study

The contribution between the experimental variables and the main focus of the study can be clearly delineated with the help of conceptual framework of the study. The researcher was made an attempt to ascertain the climate change vulnerability on farmers' food security of Chilmari Upazila under Kurigram district as the main focus of the study. It was conceptualized in the research that the climate change vulnerability on rural farmers' food security may be influenced and affected by the interacting forces of many socio-economic and others characteristics of the farmers. To make the process conspicuously interpretable a conceptual framework has been presented in a schematic diagram, (Figure 2.1).

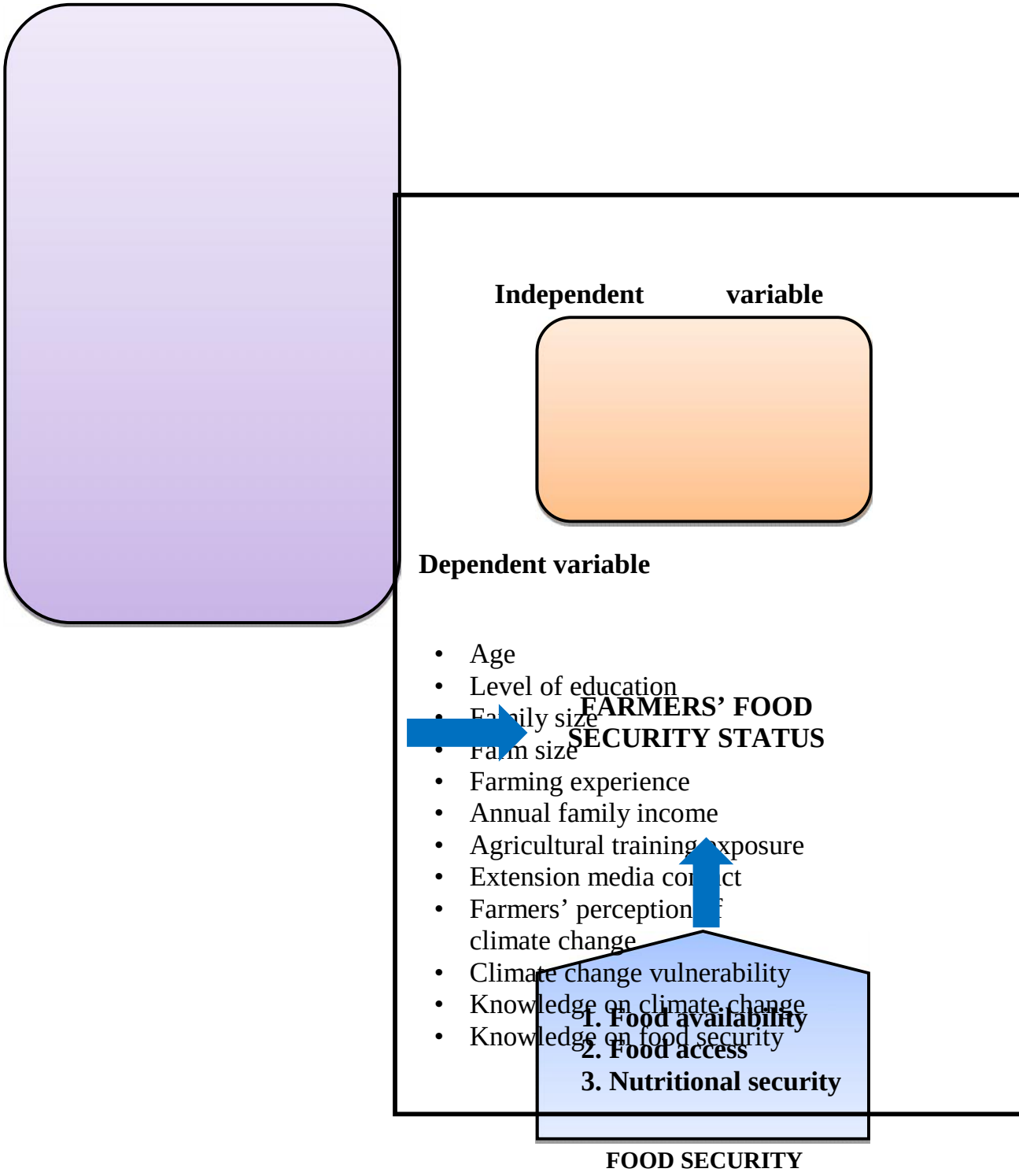
Independent variable
Dependent variable
Age
Level of education
Family size
Farm size
Farming experience
Annual family income
Agricultural training exposure
Extension media contact
Farmers' perception of climate change
Climate change vulnerability
Knowledge on climate change
Knowledge on food security
FARMERS' FOOD SECURITY STATUS
1. Food availability
2. Food access
3. Nutritional security
FOOD SECURITY

Fig. 2.1 The conceptual framework of the study

CHAPTER III
MATERIALS AND METHODS

The materials and methods used in conducting any research play a critically important role and deserve careful consideration by the researcher. The researcher was very much careful for using proper methods in all aspects of the investigation. Methods and procedures followed in conducting the study have been discussed in this chapter. Further, the chapter includes the operational format and comparative reflection of some variables used in the study. Also, statistical methods and their use have been mentioned in this chapter.

3.1 Locale of the Study

The study was conducted in Chilmari Upazila (Kurigram district), where the most of the people are engaged in farming activities. Chilmari is located at 25°26' to 25°40' North latitudes and in between 89°38' and 89°48' East longitudes. It has 1, 14,350 households and a total area equivalent to 224.97 km². The Upazila is situated in the Northern part of Bangladesh. It is located by the Indo-Bangladesh frontier. Chilmari

Upazila is intersected by the mighty Brahmaputra River. There are six unions in Chilmari Upazila and the present study was conducted in five selected villages of two Unions namely 'Thanahat' and 'Chilmari' based on the population size in the selected area. The map of the Kurigram district has been presented in Figure 3.1 and the specific study locations of three unions under Chilmari Upazila of Kurigram district have also been shown in Figure 3.2.

3.2 Population and Sampling

People who engaged in farming activities and permanently reside in the selected villages constituted the active population of this study. As all population of the study area could not possible to measure, head of the farm families of Thanahat and Chilmari Union of Chilmari Upazila under Kurigram district were the population of the study. However, representative of the population were takenfor collection of data following random sampling technique. One farmer (who mainly operated the farming activities of the family) from each of the farm families was considered as the farmers. Farm families of the five villages of two Unions were considered for interviews. For geographical location and pervious record analysis sampling procedure was followed to select one district from the whole of Bangladesh purposively, and same method was used to select the Upazila. By this procedure select the Fokirerhat, Matikata, Mojaidanga, Montola and Shakhahati villages of two unions as the study group location. The total number of individuals under study was estimated 931 in the study area which is shown in the following Table 3.1.

Table 3.1 Population of the study area

Name of the Upazila	Name of the unions	Name of the villages	Number of the farmers
Chilmari	Thanahat	Fokirerhat	175
		Matikata	207
		Mojaidanga	215
	Chilmari	Montola	169
		Shakhahati	165
Total			931

3.2.1 Determination of sample size

Total 931 populations, the farmers comprising 93 (10% of total population) farmers'

constituted the sample size. A reserve list of ten percent of the study population was also prepared. The reserve lists comprised of 9 farmers. Farmers in the reserve list were used only when a farmer in the original list was not available. The farmers of the two unions were measured according to the proportionate of the total sample size (93) farmers. The distribution of the sample farmers and those in the reserved list from the villages is shown in Table 3.2.

3.2.1 Distribution of the population of sample size

Table 3.2 Distribution of the farmers according to population and sample size

Name of villages	Population of farmers	Sample Size	Farmers number in the reserve list
Fokirerhat	175	17	2
Matikata	207	21	2
Mojaidanga	215	22	2
Montola	169	17	2
Shakhahati	165	16	1
Total	**931**	**93**	**9**

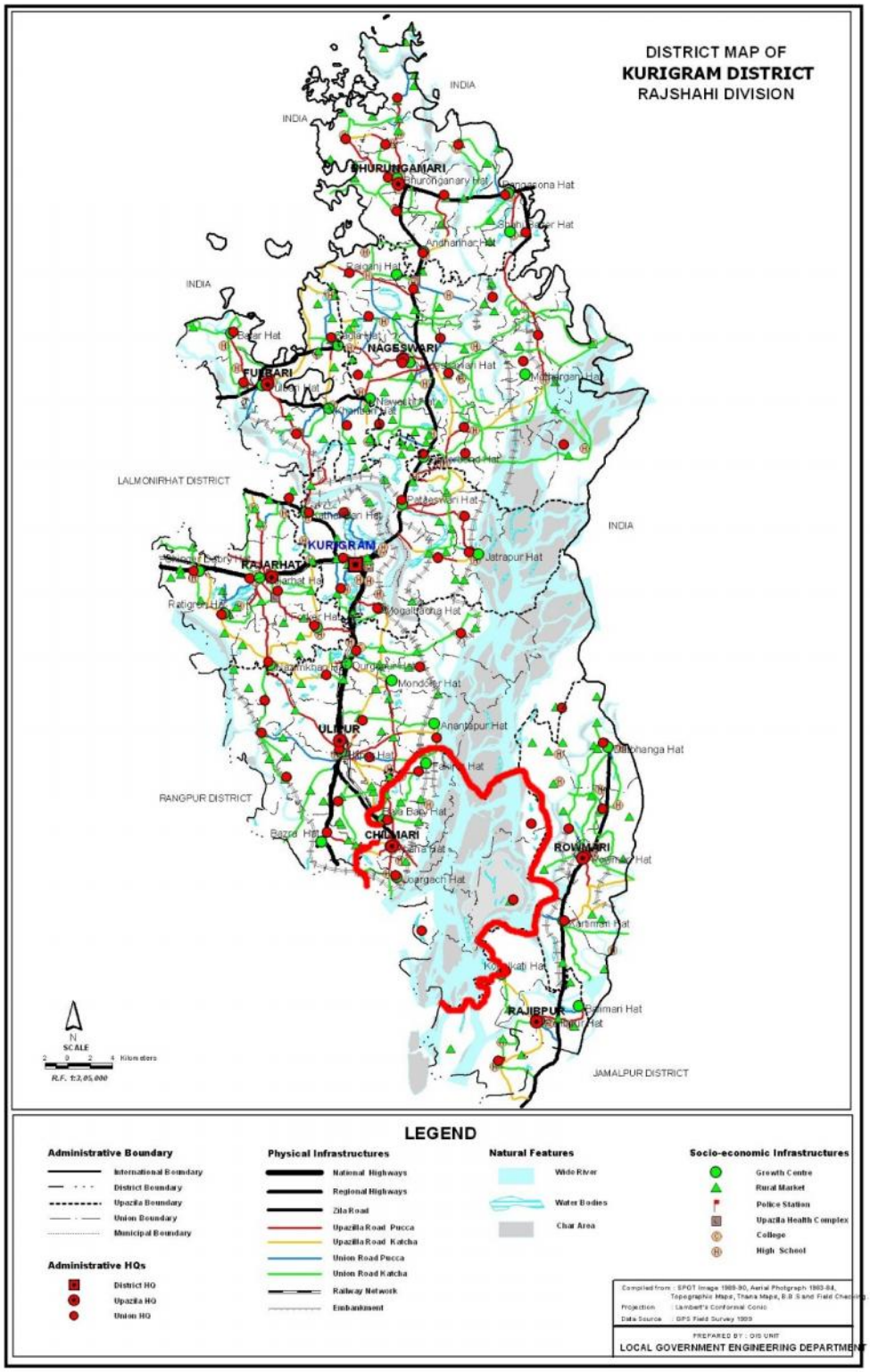

Figure 3.1 Map of Kurigram district showing Chilmari Upazila

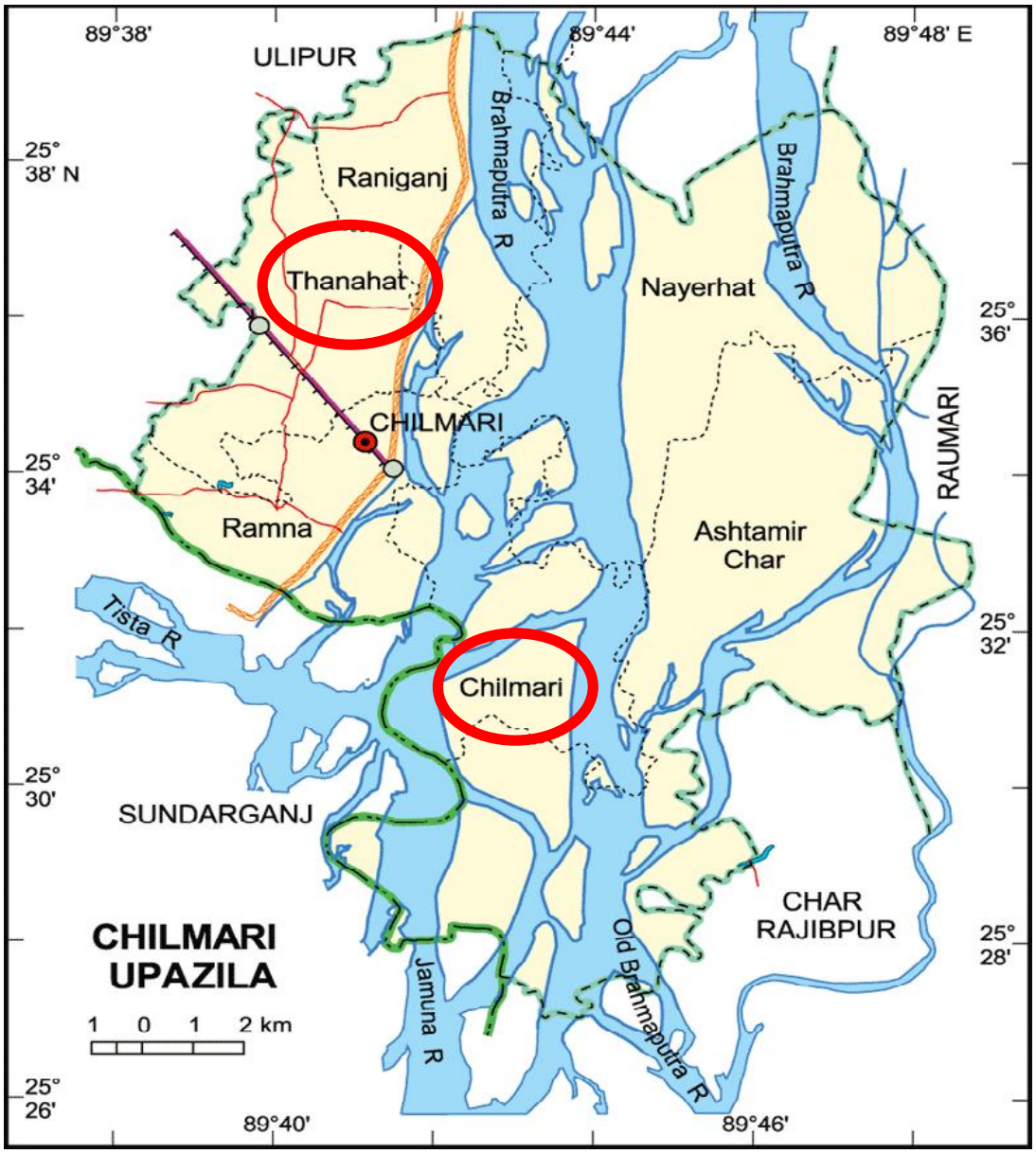

Figure 3.2 Map of Chilmari Upazila showing the study area (i) Chilmari, (ii) Thanahat Union

3.3 Variables and their Measurement Techniques

In a descriptive social research, selection and measurement of the variable is an important task. A variable is any characteristics which can assume varying or different values are successive individual's cases (Ezekiel and Fox, 1959). An organized research usually contains at least two identical elements i.e. independent and dependent variable. An independent variable is a factor which is manipulated by the researcher in his attempt to ascertain its relationship to an observed phenomenon. A dependent variable is a factor, which appears, disappears or varies as the

experimenterintroduces, removes or varies the independent variables (Townsend, 1953). According to the relevance of the research area, the researcher selected 12 characteristics of the farmers as the independent variables (e.g. age, level of education, family size, farm size, farming experience, annual family income, agricultural training exposure, and agricultural extension media contact, farmers' perception of climate change, climate change vulnerability, knowledge on climate change and knowledge on food security). On the other hand, ascertain the present status of farmers' food security of the climate affected farmers was dependent variable consisted of three dimensions i.e. food availability, food stock ability and nutritional security. The following sections discus about the measurement of dependent and independent variables of the study.

3.3.1 Measurement of independent variables

The independent variables of the study were age, level of education, family size, farm size, farming experience, annual family income, agricultural training exposure, agricultural extension media contact, farmers' perception of climate change, climate change vulnerability, knowledge on climate change, and knowledge on food security. The procedure followed in measuring the independent variables have been discussed in the subsequent sections.

3.3.1.1 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. This variable appears in item number 1.1 in the interview schedule as presented in Appendix-I. Based on the available information cited by the farmers, they were classified into three categories (MoYS, 2012).

Category (age)	Years
Young age	≤ 35
Middle age	36 to 50
Old age	> 50

3.3.1.2 Level of education

Education was measured by assigning score against successful years of schooling by a farmer. One score was given for passing each level in an educational institution (Rashid, 2014). For example, if a farmer passed the final examination of class five or equivalent examination, his/her education score has given five (5). Each farmer who cannot read and write was given a score of zero (0). A person not knowing reading or writing but being able to sign only was given a score of 0.5. If a farmer did not go to school but took non-formal education, his educational status was determined as the equivalent to a formal school student. This variable appears in item number two (2) in the interview schedule as presented in Appendix-I. Based on the available information cited by the farmers, they were classified into four categories.

Category	Education (year of schooling)
Illiterate	(0)
Primary education	1-5
Secondary education	6-10
Above secondary	>10

3.3.1.3 Family size

Family size of a farmer was determined by the total number of members in his family including him, children and other dependents. The scoring was made by the actual number of family members expressed by the farmers. For example, if a farmer had five members in his family, his score was given as 5. This variable appears in item number three (3) in the interview schedule as presented in Appendix-I.

3.3.1.4 Farm size

Farm size of a farmer referred to the total area of land on which his/her family carried out the farming operation, the area being in terms of full benefit to the family. The term refers to the cultivated area either owned by the farmer or cultivated on sharecropping, lease or taking from other including homestead area and measured using the following formula (Rashid, 2014):

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

Where,

FS = Farm size

A = Homestead area

B = Own land under own cultivation

C = Land taken from others as borga

D = Land given to other as borga

E = Land taken from others on lease

The data was first recorded in terms of local measurement unit i.e. bigha, or decimal and then converted into hectare. The total area, thus, obtained is considered as his farm size score (assigning a score of one for each hectare of land). This variable appears in item number four (4) in the interview schedule as presented in Appendix-I. Based on their total farm size, the farmers were classified into five categories according to Department of Agricultural Extension (DAE, 1999).

Category	Area (hectare)
Landless	≤ 0.020
Marginal farmer	0.021 to 0.20
Small farmer	0.21 to 1.00
Medium farmer	1.01 to 3.00
Large farmer	>3.00

3.3.1.5 Farming experience

In a measuring score of one (1) was assigned for each year of working experience of a respondent either in his own farm or to that of his parents. This variable appears in item number five (5) in the interview schedule as presented in Appendix-I.

3.3.1.6 Annual family income

Annual family income refers to the total financial return from different financial activities in one year. It was expressed in Taka. One score was given for 1000 taka. A score of 1 was assigned for Tk. 1000. For an amount less than Tk.1000, a fraction score was computed and added with the main score. This variable appears in item

number six (6) in the interview schedule as presented in Appendix-I.

3.3.1.7 Agricultural training exposure

Agricultural training exposure of a respondent was measured by the total number of days for which a respondent attended in different training programs on agriculture. If a respondent takes training for 5 days, he will get scores of 5. This variable appears in item number seven (7) in the interview schedule as presented in Appendix-I.

3.3.1.8 Agricultural extension media contact

It was defined as one's extent of exposure to different communication media related to farming activities. Agricultural extension media contact of a farmer was measured by computing agricultural extension media contact score on the basis of their nature of contact with nine agricultural extension media. Each farmer was asked to indicate his nature of contact with four alternative responses, regularly, frequently, occasionally, rarely and not at all basis to each of the nine media and score of 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. Logical frequencies were assigned for each of the five-alternative nature of contact. Agricultural extension media contact of the farmers was measured by adding the scores of seven selected source of information. Thus, agricultural extension media contact score of a farmer could range from 0 to 28, where zero indicated no agricultural extension media contact and twenty-eight indicated highest level of agricultural extension media contact. This variable appears in item number eight (8) in the interview schedule as presented in Appendix-I.

3.3.1.11 Farmers' perception of climate change

Farmers' perception of climate change was measured by asking him/her 3 statements related to different issues of weather, e.g. precipitation, temperature, extreme events etc. Each farmer was asked to indicate his name of statements with five alternative responses, like extreme, increased, reduced, no change and do not knew basis to each of the three-climate change perception and score of three, 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. Logical frequencies were assigned for each of the

five-alternative statements of perception. Farmers' perception of climate change was measured by adding the scores of three selected source of indicator. Thus, Farmers' perception of climate change score of a farmer could range from 0 to 56, where zero indicated no perception of climate change and 56 indicated highest level of climate change perception. This variable appears in item number nine (9) in the interview schedule as presented in Appendix-I.

3.3.1.10 Climate change vulnerability

Climate change vulnerability of a farmer was measured by asking him 7 hazardous related to different types of vulnerability, e.g. drought, flood, river erosion etc. score on the basis of their types of seven hazardous.Each farmer was asked to indicate his types of hazardous with five alternative responses, like extreme, high, medium, low and not ever basis to each of the seven hazardous and score of 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. Logical frequencies were assigned for each of the five alternative types of hazardous. Climate change vulnerability of the farmers was measured by adding the scores of seven selected source of information. Thus, climate change vulnerability score of a farmer could range from 0 to 28, where zero indicated no climate change vulnerability and 28 indicated highest level of climate change vulnerability. This variable appears in item number ten (10) in the interview schedule as presented in Appendix-I.

3.3.1.11 Knowledge on climate change

Farmers' knowledge on climate change was measured by asking him 10 questions related to different components of climate change, e.g. what is your idea about climate change, what are the elements of climate change etc. It was measured assigning weightage two (2) for each question. So, the total assigned scores for all the questions became twenty. The score was given according to response at the time of interview. Answering a question correctly an individual could obtain full score while for wrong answer or no answer he obtained zero (0) score. Partial score was assigned for partially correct answer. Thus, the climate change knowledge score of a farmer could range from zero (0) to twenty (20), where zero indicates no knowledge and twenty indicates highest knowledge on climate change. This variable appears in item number

eleven (11) in the interview schedule as presented in Appendix-I.

3.3.1.12 Knowledge on food security

Farmers' knowledge on food security was measured by asking him 10 questions related to different components of food security, e.g. relation between education and food security, benefits of achieving food security, role of food security in achieving a developed country, etc. It was measured assigning weightage two (2) for each question. So, the total assigned scores for all the questions became twenty. The score was given according to response at the time of interview. Answering a question correctly an individual could obtain full score while for wrong answer or no answer he obtained zero (0) score. Partial score was assigned for partially correct answer. Thus, the food security knowledge score of a farmer could range from zero (0) to twenty (20), where zero indicates no knowledge and twenty indicates highest knowledge. This variable appears in item number twelve (12) in the interview schedule as presented in Appendix-I.

3.3.2 Measurement of dependent variable

As stated earlier, the dependent variable of this study was "ascertain the present status of farmers' food security of the climate affected farmers". Three dimensions namely food access availability, food stock ability and nutritional security were considered to determine food security of farmers. The dimensions were individually categorized as 'low', 'medium', 'high' according to their value. All the major components were measured with the help of identified subcomponents. Each subcomponent was measured against the identified items, collected through the process of review of relevant literature, focused discussion with the officials, experts, experienced farmers.

3.3.2.1 Food access availability

It was defined as farmers' available source of food. Food availability per day of a farmer was measured by computing the value of foods on kcal/100g available source of cereal, vegetables, meat, fish and fruits respectively. Each farmer was asked to indicate available food consumed per day source with five alternative responses.The total nutritional value of the foods was converted into kcal/100g of foods. The nutritional value was determined according to Bangladesh Institute of Research and Training on Applied Nutrition (BIRTAN). One kcal nutrition consumption value was

assigned for score 1. This variable appears in item number 13(A) in the interview schedule as presented in Appendix-I.

3.3.2.2 Food stock ability

Food stock ability of a farmers' family was determined by the total number of meal stocked at his family. The measurement of food stock ability was followed by up to one day (up to 3 meals), up to one week (4 to 21 meals), up to one month (22 to 90 meals) and more than one month (>90 meals). The scoring was made by the 1 for each meal stock ability. For example, if a farmer had one-month food stock ability, his score was given as (90). This variable appears in item number 13(B) in the interview schedule as presented in Appendix-I.

3.3.2.3 Nutritional security

Nutrition security of the respondents was measured in score on the basis of his daily consumption of food. One thousand cal. nutrition consumption value was assigned for score 1. This variable appears in item number 13(B) in the interview schedule as presented in Appendix-I.

3.4 Measurement of problem faced by farmers

Problems faced by the farmers in achieving food security for climate change vulnerability were measured by asking their opinion on 10 selected problems. A five-point rating scale was used for computing the problem score of the farmers. For each problem score of four (4), three (3), two (2), one (1) and zero (0) was assigned to indicate extent of problem as 'severe', 'medium', 'low', 'very low' and 'not at all' respectively. For each of the problem faced in achieving food security was determined by summing-up scores obtained by farmers for the ten (10) concerned problems, while the overall problem faced of a farmer was computed by adding together the score. The possible range of food security, problem score could be zero (0) to forty (40), a total score of zero (0) indicated no problems while a score of forty (40) indicated highest difficulties with achieving food security. To ascertain the comparison among the problems of farmers, index for each item along with rank order Problem Facing Index (PFI) was computed (Afique, 2006) using the following formula:

$$PFI = (Ps \times 4) + (P_h \times 3) + (P_m \times 2) + (P_l \times 1) + (P_n \times 0)$$

Where,

PFI = Problem Facing Index;

Ps = Number of farmers having severe problem;

P_h= Number of farmers having high problem;

P_m = Number of farmers having medium problem;

P_l = Number of farmers having low problem;

P_n= Number of farmers having no problem at all;

Problem Facing Index (PFI) related to difficulties with achieving household food security could range from 0 to 484, 0 indicating no problem and 484 indicating very high problem with the particular problem. However, attempts were also made to seek out the suggestions from the farmers to overcome the problem identified. This variable appears in item number (14) in the interview schedule as presented in Appendix-I. The rank order on the basis of problem confrontation in achieving food security was formed according to score cited by the farmers.

3.5 Hypothesis of the Study

According to Kerlinger (1973) a hypothesis is a conjectural statement of the relation between two or more variables. Hypothesis are always in declarative sentence form and they are related, either generally or specifically from variables to variables. In broad sense hypotheses are divided into two categories: (a) Research hypothesis and (b) Null hypothesis.

3.5.1 Research hypothesis

Based on review of literature and development of conceptual framework, the following research hypothesis was formulated: “Each of the 12 selected characteristics (age, level of education, family size, farm size, farming experience, annual family income, agricultural training exposure, agricultural extension media contact, farmers’ perception of climate change, climate change vulnerability, knowledge on climate change, knowledge on food security) of the farmers has significant contribution on their food security”. However, when a researcher tries to perform statistical tests, then it becomes necessary to formulate null hypothesis.

3.5.2 Null hypothesis

A null hypothesis states that there is no contribution between the concerned variables. The following null hypothesis was formulated to explore the contribution of the selected characteristics on food security. In order to conduct tests, the earlier research hypothesis was converted into null form as follows:

“There is no contribution of the selected characteristics (age, level of education, family size, farm size, farming experience, annual family income, agricultural training exposure, agricultural extension media contact, farmers perception of climate change, climate change vulnerability, knowledge on climate change, knowledge on food security) of farmers on their food security.”

3.6 Instrument for Collection of Data

In order to collect reliable and valid information from the farmers, an interview schedule was prepared for collection of data from farmers keeping the objectives of the study in mind. The schedule was prepared in Bangla for a clear understanding to the farmers. The Bengali version of interview schedule was used to collect data. The question and statements contained in the schedule were simple, direct and easily understandable by the farmers. Simple and direct question, different scales, closed and open form statements and questions were included in the interview schedule to obtain necessary information. The draft 41 interview schedule was prepared in accordance with the objective of the study. The interview schedule was pre-tested with 15 farmers of the farmers in the study area during 01 to 03 February, 2019. The draft interview schedule was pretested in actual field situation before finalizing it for collection of data. The pre-test was helpful to identify inappropriate questions and statements in the draft schedule. Necessary addition, alternation and adjustments were made on the basis of the experience of the pretest. The interview schedule was then cyclostyled in its final form for the collection of data. The interview schedule was then printed in its final form. An English version of the interview schedule has been shown.

3.7 Data Collection

Data were collected personally by the researcher himself through personal interview schedule from the farm families of the selected villages. Before starting the collection of data; the researcher met the respective Upazila Agriculture Officer (UAO), Agriculture Extension Officer (AEO), Upazila Food Program Officer (UFPO), Assistant Health Inspector (AHI) and the concerned SAAOs. The researcher also

discussed the objectives of the present study with the farmers and above-mentioned officers and requested them to provide actual information. A rapport was established with the rural people so that they feel easy to answer the questions. The researcher took all possible care to establish rapport with the farmers so that they would not feel any indecision while starting the interview. Very good cooperation was obtained from the field extension workers and the local leaders. No serious difficulty was faced by the researcher during the collection of data. The interviews were made individually in the houses of farmers. Questions were asked in different ways so that the farmers could easily understand the questions. Whenever a farmer faced difficulty in understanding any questions, care was taken to explain the same clearly with a view to enabling him to answer it properly. Before going to the farmers' home for interviewing they were informed verbally to ensure their availability at home as per schedule date and time. In the case of failure to collect information from the farmers due to their other business, a revisit was made with prior appointment. If any farmers failed to understand, the researcher took great care to explain the issue. If the farmers could not clear about what was wanted to know then supplementary questions were asked for further clarification. The researcher received full cooperation from the farmers during the time of interview. Data were collected during 15 March, 2019 to 31 March, 2019.

3.8 Compilation of Data

After completion of field survey, data recorded in the interview schedules were coded, compiled, tabulated and analyzed in accordance with the objectives of the study. In this process, all the responses in the interview schedule were given numerically coded values. Local units were converted into standard units and qualitative data were converted into quantitative ones by means of suitable scoring whenever necessary. All the collected data were checked and cross-checked before transplanting to the master sheets. To facilitate tabulation, the collected data were properly coded and transferred from interview schedule to a master sheet. Tabulation and cross tabulation was done on the basis of categorization developed by the researcher.

3.9 Categorization of the Farmers

It was necessary to develop suitable categories to determine the food security status of farmers in selected aspects. For the purpose, the farmers were classified into

categories on the basis of obtained score of food security status by them. Categories were also developed for describing each of the selected characteristics of the rural people. Nature of the data and mode of the categorization prevailing on the social system guided the researcher in developing categories in respect of selected characteristics.

3.10 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 food security status of the farmers are analyzed using a regression model. The overall quality of fit of the model has been tested by ANOVA specifically F and R^2 test. The data were analyzed in accordance with the objectives of the proposed research work. The factors that contribute to the climate change vulnerability and farmers' food security are analyzed using a regression model, multiple regression analysis (β) 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 (β) 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 (β) 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:

$$Yi = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + b_9x_9 + b_{10}x_{10} + b_{11}x_{11} + b_{12}x_{12} + e; (i=1, 2, 3)$$

Where,

Yi=1 is the food availability

Yi=2 is the food stock ability

Yi=3 is the nutritional security

Of the independent variables, x_1 is the farmers' age, x_2 is level of education, x_3 is family size, x_4 is farm size, x_5 is farming experience, x_6 is annual income, x_7 is agricultural training exposure, x_8 is agricultural extension media contact, x_9 is farmers' perception of climate change, x_{10} is climate change vulnerability, x_{11} is knowledge on climate change and x_{12} is knowledge on food security. b_1, b_2, b_3, b_4, b_5, b_6, b_7, b_8, b_9, b_{10}, b_{11} and b_{12} 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 interpretation of the results have been presented according to the objectives of the study. This chapter has been divided into four sections. The first section deals with the selected individual characteristics of the farmers while the second section deals with the extent of climate change vulnerability on farmers' food security. The third section deals with contribution of the farmers' selected characteristics on their food security; while the fourth section deals with the problem faced associated with achieving food security has been discussed.

Table 4.1 Salient features of the characteristics of farmers (N = 93)

Categories	Measuring unit	Range		Mean (x)	SD
		Possible	Observed		
Age	Years	-	22-74	49.34	11.24
Level of education	Year of schooling	-	0.00-16	4.80	4.57
Family size	Member	-	3-9	5.82	1.404
Farm size	Hectare	-	0.06-4.80	1.08	0.77
Farming experience	Years	-	2-60	31.98	11.45
Annual family income	'000' taka	-	5-112	28.15	22.74
Agricultural training	Days	-	0-9	2.03	1.93
Agricultural extension contact	Score	0-28	10-25	17.87	2.98
Farmers' perception of climate change	Score	0-56	12-37	31.21	3.67
Climate change vulnerability	Score	0-28	7-24	15.65	4.006
Knowledge on climate change	Score	0-20	4-18	11.59	2.66

Knowledge on food security	Score	0-20	4-14	9.93	2.59

4.1 Selected Characteristics of the Farmers (Independent Variables)

In this section the findings of the farmers' selected characteristics have been discussed. The selected characteristics are age, level of education, family size, farm size, farming experience, annual family income, agricultural training exposure, agricultural extension media contact, farmers' perception of climate change, climate change vulnerability, knowledge on climate change, and knowledge on food security. The salient features of the characteristics of the farmers were shown in Table4.1

4.1.1 Age

Age of the respondent farmers was found to range from 22 to 74 years. The average age was 49.34 years with the standard deviation of 11.24. Based on their age, the farmers were classified into three categories namely "young", "middle" and "old" aged as shown in Table 4.2

Table 4.2 Distribution of the farmers according to their age

Categories (years)	Respondents		Mean (x)	SD
	Number	Percent		
Young aged (up to 35)	12	12.9	49.34	11.24
Middle aged (36 to 50)	43	46.2		
Old aged (> 50)	38	40.9		
Total	93	100		

Data furnished in Table 4.2 indicates that the highest proportion (46.2 percent) of the respondents fell in the middle age category, while 40.9 percent and 12.9 percent belonged to old and young age categoriesrespectively. However, data also revealed that 87.1 percent of the respondents in the study area were middle to old aged.

4.1.2 Education

The education score of the respondents ranged from 0 to 16 with the average of 4.80 and the standard deviation was 4.57. Based on their educational score, the farmers were classified into four categories namely "illiterate", "primary level", "secondary level" and "above secondary level" as shown in Table 4.3.

Table 4.3 Distribution of the farmers according to their education level

Categories	Respondents		Mean (x)	SD
	Number	Percent		
Illiterate (0)	37	39.8	4.80	4.57
Primary level (1 to 5)	17	18.3		
Secondary level (6 to 10)	30	32.2		
Higher secondary level (11-12)	9	9.7		
Total	93	100		

The data indicate that the majority (39.8 percent) of the farmers were illiterate, while 32.2 percent farmers had secondary level education, 18.3 percent primary level education and 9.7 percent higher secondary level education. At present the literacy rate of the country is 62.3 percent (Bangladesh Economic Review- 2015). Thus the findings revealed that the literacy rate in the study area seems to be slight lower than the nationalaverage.

4.1.3 Familysize

The family size ranged from 3 to 9 person with the average of 5.82 and the standard deviation was 1.40. Based on the family size score the respondents were classified into three categories namely ‘small family’, ‘medium family’, and ‘large family’ as shown in Table 4.4.

Table 4.4 Distribution of the farmers according to their family size

Categories (members)	Basis of categorization (Mean±SD)	Observed range (score)	Respondents		Mean (x)	SD
			Number	Percent		
Small family	≤ 4(x -1SD)	3-9	18	19.4	5.82	1.40
Mediumfamily	5-7(x ±1SD)		62	66.6		
Large family	> 7(x +1SD)		13	14		
Total			93	100		

Study area was higher than the national average of 4.85 persons (BBS, 2015). This may be due to the prevalence of joint family system in the study area. The study showed thatthe study area was in a remote village where family bonding was very

common and they wanted to live together so thattheir family size was bigger.

Farmsize

The farm size of the farmers in the study area varied from 0.06 to 4.80 hectares (ha.). The average farm size was 1.09 ha and the standard deviation was 0.77. This farm size average was higher than the national average of 0.91 hectare (BBS, 2013). Based on the farm size, the respondents were classified into four categories (according to DAE, 1999) namely 'marginal farm size', 'small farm size', 'medium farm size' and 'large farm size' as shown in Table 4.6.

Table 4.5 Distribution of the farmers according to their farm size

Categories (ha)	Respondents		Mean (x)	SD
	Number	Percent		
Marginal farm size (0.06-0.20 ha)	5	5.4	1.09	0.77
Small farm size (0.21 to 1.0 ha)	46	48.4		
Medium farm size (1.01 to 3.0 ha)	40	44		
Large farm size (> 3.0 ha)	2	2.2		
Total	93	100		

The Table 4.5 shows that the highest proportion (48.4 percent) of the respondents belonged to small farm size category, while 44 percent belonged to medium farm size, 2.2 percent belonged to large farm size and 5.4 percent belonged to marginal farm size. Thus most (92.4 percent) of the farmers were in the categories of small to medium farm size.

4.1.4 Farming experience

The experience score of the respondents ranged from 2 to 60. The mean score was 31.97 with the standard deviation 11.45. On the basis of experience, the respondents were classified into three categories namely, 'low experience', 'medium experience' and 'high experience' as shown in Table 4.6.

Table 4.6 Distribution of the farmers according to their experience

Categories	Basis of	Observed	Respondents	Mean	SD

	categorization (year)	range (year)	Number	Percent	(x)	
Low experience	≤ 20(x -1SD)	2-60	18	19.4	31.97	11.45
Medium experience	21-33(x ±1SD)		41	36.5		
High experience	>33(x +1SD)		26	44.1		
Total			93	100		

Data contained in the Table 4.6 revealed that the majority (44.1%) of the farmers had high experience as compared to (19.4%) and (36.5%) having low and medium experience respectively. The majority (80.6%) of the respondents had medium to high experience in farming.

4.1.5 Annual familyincome

Annual family income score of the respondents ranged from Tk. 5 to Tk. 112 thousands with the average of Tk. 28.16 and the standard deviation was Tk. 22.75. On the basis of observed range, the respondents were classified into three categories namely “low income”, “medium income”, and “high income” as shown on Table4.7.

Table 4.7 Distribution of the farmers according to their annual family income

Categories (‘000’ tk)	Respondents		Mean (x)	SD
	Number	Percent		
Low income (up to 40)	72	77.4	28.16	22.75
Medium income (41-80)	19	20.4		
High income (> 80)	2	2.2		
Total	93	100		

Data presented in Table 4.7 indicate that the highest proportion (77.4 percent) of the respondents had low annual income, while 20.4 percent had medium income and 2.2 percent had high income. As a result, the most (97.2 percent) of the respondents in the study area were medium to low income earners.

4.1.6 Agricultural trainingexposure

Training exposure scores of the respondents were found to be varying from 0 to 9 days with the average of 2.03 and the standard deviation was 1.93. The farmers on the basis of their training received score were classified into three categories namely 'no training', 'low training', 'medium training' and 'high training' as shown in Table 4.8.

Table 4.8 Distribution of the farmers according to their received training

Categories (days)	Respondents		Mean (x)	SD
	Number	Percent		
No training (0)	14	15.1	2.03	1.93
Low training (1 to 3)	66	70.9		
Medium training (4 to 6)	8	8.6		
High training (> 6)	5	5.4		
Total	93	100		

The Table 4.8 shows that the highest proportion (70.9 percent) of the respondents belonged to low training exposure, while 15.1 percent belonged to no training exposure, 8.6 percent belonged to medium training exposure and 5.4 percent belonged to high training exposure category.

4.1.8 Agricultural extension media contact

An extension contact score was computed for each respondent on his extent of contact with 7 selected media. Each respondent was asked to mention the frequency of his contact with each of the 7 selected media. Extension media contact scores of the farmers ranged from 10 to 25 with an average of 17.87 and standard deviation of 2.99. It was measured as one's extent of exposure with different information sources. On the basis of their extension media contact, the respondents classified into three categories (Mean ± Standard Deviation) namely, low contact, medium contact and high contact. The scale used for computing the extension contact score of a respondent is displayed table 4.9.

Table 4.9 Distribution of the farmers according to their extension media contact

Categories (scores)	Basis of categorization (Mean±SD)	Observedrange (score)	Respondents		Mean (x)	SD
			Number	Percent		
Low contact	≤ 15 (x -1SD)	10-25	17	18.3	17.87	2.99
Mediumcontact	16-20(x ± 1SD)		58	62.6		
High contact	>20(x +1SD)		18	19.4		
Total			93	100		

Data contained in the Table 4.9, indicated that the highest proportion (62.6%) of the respondents had medium extension media contact as compared to (18.3%) and (19.4%) having low and high extension media contact respectively.

4.1.9 Farmers perception of climate change

The observed perception of climate change score of the respondents ranged from 12 to 37. The mean score was 31.22 with the standard deviation 3.68. Based on the perception scores, the respondents were classified into two categories (Mean ± Standard Deviation) namely 'low perception' and 'medium perception' and 'high perception' asshown in Table 4.10.

Table 4.10 Distribution of the farmers according to their perception of climate change

Categories (scores)	Basis of categorization (Mean ± SD)	Observedrange (score)	Respondents		Mean (x)	SD
			Number	Percent		
Low perception	≤ 28 (x - 1SD)	12-37	19	20.4	31.22	3.68
Medium perception	29-34 (x ± 1SD)		62	66.7		
High perception	> 34 (x +1SD)		12	12.9		
Total			93	100		

Data shown in Table 4.10 reveal that the highest proportion (66.7 percent) of the respondents had medium perception, 20.4 percent of the respondents had low perception and 12.9 percent of the farmers had high perception.

4.1.10 Climate change vulnerability

Scores of climate change vulnerability of the respondents could range from 0 to 30whiletheobservedscoresrangedfrom 7to24.Themeanscorewas 15.66 with the standard deviation 4.01 as shown in Table 4.9. Based on their climate change vulnerability, the respondents were classified into three categories (Mean ± Standard Deviation) namely "low vulnerability", "medium vulnerability" and "high vulnerability" as shown in Table 4.11.

Table 4.11 Categories of farmers based on the climate change vulnerability

Categories (scores)	Basis of categorization (Mean ± SD)	Observedrange (score)	Respondents		Mean (x)	SD
			Number	Percent		
Low vulnerability	≤ 11 (x - 1SD)	7-24	15	16.1	15.66	4.01
Medium vulnerability	12-19 (x ± 1SD)		60	64.5		
High vulnerability	> 19 (x +1SD)		18	19.4		
Total			93	100		

Data presented in the table 4.11 indicate that the highest proportion (64.5 percent) of the farmers had medium climate change vulnerability, while 19.4 percent had high climate change vulnerability and 16.1 percent had low climate change vulnerability. Findings also show that majority (83.9 percent) of the farmers possessed medium to high level of climate change vulnerability.

4.1.11 Knowledge on climate change

The score of the knowledge on climate change ranged from 4-18 with a mean and standard deviation of 11.59 and 2.66 respectively. On the basis of knowledge on climate change farmers were classified into three categories (Mean ± Standard Deviation) such as, 'low knowledge', 'medium knowledge' and 'high knowledge' on climate change. The distribution of the farmers according to their knowledge on climate change scores is shown in the table 4.12.

Table 4.12 Distribution of the farmers according to their knowledge on climate change

Categories (scores)	Basis of categorization (Mean±SD)	Observedrange (score)	Respondents		Mean (x)	SD
			Number	Percent		
Low knowledge	≤ 9 (x - 1SD)	4-18	13	14	11.59	2.66
Medium knowledge	10-13 (x ± 1SD)		53	57		
High knowledge	> 13 (x +1SD)		27	29		
Total			93	100		

Data presented in the Table 4.12 shown that the majority (57%) of the respondents had medium knowledge on climate change while (29%) had high knowledge and (14%) of the farmers had low knowledge on climate change. The majority of the farmers (86%) have medium to high knowledge on climate change.

4.1.12 Knowledge on food security

The observed knowledge on food security scores of the respondents ranged from 4 to 14. The mean scores were 9.96 with the standard deviation of 2.59. Based on their knowledge, the respondents were classified into three categories (Mean ± Standard Deviation) namely, ‘knowledge, ‘medium knowledge’ and ‘high knowledge. The distribution of the farmers according to their perception shown in the Table 4.13

Table 4.13 Distribution of the farmers according to their knowledge on food security

Categories (scores)	Basis of categorization (Mean±SD)	Observedrange (score)	Respondents		Mean (x)	SD
			Number	Percent		
Low knowledge	≤ 7(x - 1SD)	4-14	12	12.9	9.96	2.59
Medium knowledge	8-11(x ± 1SD)		45	48.4		
High knowledge	> 11(x +1SD)		36	38.7		
Total			93	100		

Findings shown in the Table 4.11 revealed that the majority (48.4%) of the

respondents had medium knowledge on food security while (38.7%) and (12.9%) having high to low knowledge on food security categories.

4.2 Climate change vulnerability on farmers' food security

As stated earlier, the dependent variable of this study was climate change vulnerability on farmers' food security. Climate change vulnerability on farmers' food security had three selected dimensions namely a) food availability, b) food stock ability and c) nutritional security. Direct survey measures level of food security through a series of questions designed to identify food availability, food stock ability and nutritional security. The results of different dimensions are presented in bellow:

4.2.1 Food availability

Food availability scores of the farmers ranged from 820 to 3015 kcal. The average score and standard deviation were 1746.45 and 371.76,respectively. Based on the scores, the farmers were classified into three categories namely low, medium and high food availability (Table 4.14).

Table 4.14 Distribution of the farmers according to their food access availability

Categories (kcal)	Respondents		Mean (x)	SD
	Number	Percent		
Low (up to 1005)	3	3.2	1746.45	371.76
Medium (2006 to 2010)	74	79.6		
High (above 2010)	16	17.2		
Total	93	100		

Results presented in the Table 4.14 reveals that the food availability of the farmers were highest in medium level, it was 66.9 percent and medium food availability was closer to the low food availability as 21.5 percent. The high food availability category constituted by 11.6 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.

4.2.2 Food stock ability

Food stock ability scores of the farmers ranged from 12 to 1080 per meals and the

average score and standard deviation were 333.60 and 338.07, respectively. Based on the scores, the farmers were classified into three categories (Observed range) namely low, medium and high food stock ability (Table 4.15).

Table 4.15 Distribution of the farmers according to their food stock ability

Categories (kcal)	Respondents		Mean (x)	SD
	Number	Percent		
Low (up to 360)	12	73.1	333.60	338.07
Medium (361 to 720)	9	9.7		
High (above 720)	16	17.2		
Total	93	100		

Results presented in the Table 4.15 reveals that the food stock ability of the farmers were highest in low level; it was 73.1 percent and medium food stock ability was 9.7 percent. The high food stock ability category constituted by 17.2 percent farmers.

4.2.3 Nutritional security

Food stock ability scores of the farmers ranged from 520 to 2800 and the average score and standard deviation were 1648.20 and 474.57, respectively. Based on the nutritional security scores, the farmers were classified into three categories (Mean ± Standard Deviation) namely low, medium and high nutritional security (Table 4.16).

Table 4.16 Distribution of the farmers according to their nutritional security

Categories (kcal)	Respondents		Mean (x)	SD
	Number	Percent		

Low (up to 1174)	16	17.2	1648.20	474.57
Medium (1175 to 2122)	61	71		
High (above 2122)	16	17.8		
Total	93	100		

Results presented in the Table 4.16 reveals that the nutritional security of the farmers were highest in medium level, it was 71 percent and low nutritional security was closer to the high nutritional security as 17.2 percent. The low nutritional security ability category constituted by 17.2 percent farmers.

4.3 Factors related to the food security status of the farmers

In order to estimate the farmers' food security status through three selected dimensions namely a) food availability, b) food stock ability and c) nutritional security, multiple regression analysis was used which is shown in Table 4.17.

Table 4.17 multiple regression coefficients of contributing factors related to the farmers' food availability

Dependent variable	Independent Variable	β	P	R^2	Adj. R^2	F
Farmers' food availability	Age	0.259	0.172	0.477	0.399	6.089
	Level of education	0.323	0.000**			
	Family size	-0.191	0.035*			
	Farm size	0.146	0.111			
	Farming experience	0.022	0.913			
	Annual family income	-0.051	0.567			
	Agricultural training	-0.087	0.319			
	Agricultural extension contact	0.136	0.136			
	Farmers' perception of climate change	0.212	0.047*			
	Climate change vulnerability	0.080	0.427			
	Knowledge on climate change	0.077	0.402			
	Knowledge on food security	0.070	0.485			

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

Table 4.17 shows that there is a significant contribution of respondents' level of

education, family size and farmers' perception of climate change. Of these, level of education was the most important contributing factors (significant at the 1% level of significance). Family size and farmers' perception of climate change were also the important contributing factors (significant at the 5% level of significance), while coefficients of other selected variables don't have any contribution on farmers' access to food.

47.7% (R2 = 0.477) of the variation in the respondents changed farmers' access to food can be attributed to their level of education, family size and farmers' perception of climate change on food security, making this an excellent model (see Table 4.17). The F value indicates that the model is significant ($p<0.000$).

However, each predictor may explain some of the variance in farmers' access to food conditions simply by chance. The adjusted R-square value penalizes the addition of extraneous predictors in the model, but values of 0.399 still show that the variance in farmers' access to food can be attributed to the predictor variables rather than by chance, and that both are suitable models (Table 4.17). In summary, the models suggest that the respective authority should consider their recipients' level of education, family size and farmers' perception on climate change.

Table 4.18 Multiple regression coefficients of contributing factors related to the farmers' food stock ability

Dependent variable	Independent Variable	β	P	R^2	Adj. R^2	F
Farmers' food stock ability	Age	0.056	0.678	0.516	0.443	7.098
	Level of education	0.276	0.019*			
	Family size	0.008	0.932			
	Farm size	-0.077	0.377			
	Farming experience	0.056	0.631			
	Annual family income	-0.065	0.439			
	Agricultural training	-0.110	0.215			
	Agricultural extension contact	0.036	0.676			
	Farmers' perception of climate change	0.232	0.047*			
	Climate change vulnerability	0.056	0.562			

	Knowledge on climate change	0.301	0.009**			
	Knowledge on food security	0.016	0.896			

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

Table 4.18 shows that there is a significant contribution of respondents' level of education, farmers' perception of climate change and knowledge on climate change their food stock ability status. Of these, Knowledge on climate change was the most important contributing factors (significant at the 1% level of significance). Level of education and farmers' perception of climate change were the important contributing factors (significant at 5% while coefficients of other selected variables don't have any contribution on food stock ability. 51.6% (R2 = 0.516) of the variation in the respondents changed food stock ability can be attributed to their level of education, farmers' perception of climate change and knowledge on climate change, making this an excellent model (see Table 4.18). The F value indicates that the model is significant ($p<0.000$).

However, each predictor may explain some of the variance in respondents' food stock ability conditions simply by chance. The adjusted R-square value penalizes the addition of extraneous predictors in the model, but values of 0.443 still show that the variance in respondents' food stock ability can be attributed to the predictor variables rather than by chance, and that both are suitable models (Table 4.18). In summary, the models suggest that the respective authority should consider their recipients' level of education, farmers' perception of climate change and knowledge on climate change.

Table 4.19 Multiple regression coefficients of contributing factors of nutritional security

Dependent variable	**Independent Variable**	**β**	**P**	**R^2**	**Adj. R^2**	**F**
Farmers' nutritional security	Age	0.474	0.006**	0.359	0.263	3.733
	Level of education	0.036	0.719			
	Family size	-0.245	0.014*			
	Farm size	0.063	0.532			
	Farming experience	-0.153	0.348			
	Annual family income	-0.061	0.528			
	Agricultural training	-0.091	0.342			
	Agricultural extension contact	0.285	0.005**			
	Farmers' perception of climate change	-0.070	0.508			

	Climate change vulnerability	0.021	0.849			
	Knowledge on climate change	0.014	0.904			
	Knowledge on food security	0.236	0.038*			

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

Table 4.19 shows that there is a significant contribution of respondents' age, family size, agricultural extension contact and knowledge on food security to change their nutritional security status. Of these, age and agricultural extension contact were the most important contributing factors (significant at the 1% level of significance). Family size and knowledge on food security were also the important contributing factors (significant at the 5% while coefficients of other selected variables don't have any contribution on nutritional security.

35.9% ($_R2 = 0.359$) of the variation in the respondents changed nutritional security can be attributed to their age, family size, agricultural extension contact and knowledge on food security, making this an excellent model (see Table 4.19). The F value indicates that the model is significant ($p<0.000$).

However, each predictor may explain some of the variance in respondents' nutritional security conditions simply by chance. The adjusted R-square value penalizes the addition of extraneous predictors in the model, but values of 0.263 still show that the variance in respondents' nutritional security can be attributed to the predictor variables rather than by chance, and that both are suitable models (Table 4.19). In summary, the models suggest that the respective authority should consider their recipients' age, family size, agricultural extension contact and knowledge on food security.

4.4 Problems faced by the farmers in achieving food security for climate change vulnerability

Scores of problems faced by the farmers in achieving food security for climate change vulnerability of the respondents could range from 0 to 40 while the observed scores ranged from 13 to 34. The mean score was 28.04 with the standard deviation 4.58 as

shown in Table 4.10. Based on problems faced by the farmers in achieving food security for climate change vulnerability, the respondents were classified into three categories namely ‘low’, ‘medium’ and ‘high’ as shown in Table 4.20.

Table 4.20 Categories based on the problems faced by the farmers in achieving food security for climate change vulnerability

Categories (years)	Farmers		Mean (x)	SD
	Number	Percent		
Low (up to 24)	17	18.3	28.04	4.58
Medium (25 to 32)	62	66.6		
High (above 32)	14	15.1		
Total	93	100		

Data arranged in the table 4.20 indicate that the highest proportion (66.6 percent) of the farmers faced medium problems, while 18.3 percent faced low problems and 15.1 percent faced high problems in achieving food security for climate change vulnerability. Findings show that most (84.9 percent) of the farmers were in the categories of low to medium problems in achieving food security for climate change vulnerability.

4.4.1 Problem facing index (PFI) along with rank order

The extent of problems faced by the farmers in achieving household food security in terms of Problem Facing Index (PFI) along with their rank order based on the PFI values have been presented in table 4.21. Data furnished in the table indicate that the problem which ranked first was “climate change influences high price of food items” followed by second ranked “weak marketing facilities negatively influence farmers’ food security” and third ranked “poor storage facilities negatively influence farmers’ food security”, “climate change hampered livestock production” was the least important problem among those faced by the farmers in achieving household food security.

Table 4.21 Ranking of problems according to descending order

Sl. No.	Problems	PFI	Rank Order

1	Climate change influences high price of food items	303	1st
2	Weak marketing facilities negatively influence farmers' food security	295	2nd
3	Poor storage facilities negatively influence farmers' food security	289	3rd
4	Crops yield decrease due to climate change	278	4th
5	Quality of crops decrease because of climate change	271	5th
6	Climate change influence of declining soil fertility	259	6th
7	High cost of production due to climate change	249	7th
8	Irrigations facility hampered due to climate change	245	8th
9	Climate change hampered fish production	223	9th
10	Climate change hampered livestock production	196	10th

The problems faced by farmers in achieving food security according to descending order through the analysis of the received data from farmers are climate change influences high price of food items, weak marketing facilities negatively influence farmers' food security, poor storage facilities negatively influence farmers' food security, crops yield decrease due to climate change, quality of crops decrease because of climate change, climate change influence of declining soil fertility, duration of rainy season become shorter due to climate change, irrigations facility hampered due to climate change, climate change hampered fish production and climate change hampered livestock production respectively.

The result shows that the highest problem faced by farmers' in achieving food security is Climate change influences high price of food items. May be this is caused due to weakness of the supply chain. The lowest cause in achieving food security at the study area is climate change hampered livestock production. This happens because the flood had not flourished for the last several years in the study area.

CHAPTER V
SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

This chapter presents summary of major findings, conclusion and recommendation of the study. The study entitled "climate change vulnerability on farmers' food security." The main purpose of the study was to determine climate change vulnerability on farmers' food security of selected farmers and to ascertain the contribution of the selected characteristics of the farmers to their climate change vulnerability on farmers' food security. The location of the study was three unions of Chilmari Upazila under Kurigram district.

5.1 Summary of Findings

5.1.1 Selected characteristics of the farmers

The major findings of the study are summarized below:

Age: Age of the farmers ranged from 22 to 74 years with the average of 49.34 years and the standard deviation was 11.24. Highest proportion (46.2 percent) of the farmers was under middle aged category.

Level of education: Education score of the respondents ranged from 0 to 16 with the average of 4.80 and the standard deviation was 4.57. Highest proportion (39.8 percent) of the farmers was under illiterate.

Family size: Above the half (66.6%) of the respondent had medium family size compare to 19.4% and 14% had small and large family size respectively.

Farm size: The small farm size constituted the highest proportion (48.4%), whereas the only 2.2% 0f the farm holder was large farm size.

Farming experience: High experience constituted the highest proportion (44.1%) and low experience constituted the lowest proportion (19.4%).

Annual family income: The highest proportion (77.4 percent) of the respondents had low annual income, while 20.4 percent had medium income and 2.2 percent had high income.

Agricultural trainings exposure: The highest proportion (70.9 percent) of the respondents belonged to low training exposure, while 15.1 percent belonged to no training exposure, 8.6 percent belonged to medium training exposure and 5.4 percent belonged to high training exposure category.

Agricultural extension contact: The highest proportion ((62.6%) of the respondents had medium extension media contact as compared to (18.3%) and (19.4%) having low and high extension media contact respectively.

Farmers' perception of climate change: The highest proportion (66.7 percent) of the respondents had medium perception, 20.4 percent of the respondents had low perception and 12.9 percent of the farmers had high perception.

Climate change vulnerability: The highest proportion (64.5 percent) of the farmers had medium climate change vulnerability, while 19.4 percent had high climate change vulnerability and 16.1 percent had low climate change vulnerability.

Knowledge on climate change: The highest proportion ((57%) of the respondents

had medium knowledge on climate change while (29%) had high knowledge and (14%) of the farmers had low knowledge on climate change.

Knowledge on food security: The majority (48.4%) of the respondents had medium knowledge on food security while (38.7%) and (12.9%) having high to low knowledge on food security categories.

5.1.2 Climate change vulnerability on farmers' food security

- **Food access availability**

The respondents having medium food access availability (79.6 %) was higher than low food access availability (3.2 %) and high food access availability (17.2%).

- **Food stock ability**

The respondents having low food stock ability (73.1%) was higher than medium food stock ability (9.7%) and high food stock ability (17.2%).

- **Nutritional security**

The respondents having medium nutritional security (71%) were higher than high nutritional security (17.4%) and low nutritional security (17.2%).

5.1.3 Contribution of the selected characteristics of the respondents

- There was a significant contribution of the farmer level of education, family size and farmers' perception of climate change to change in food availability status through which 47.7% (R2 = 0.477) of the variation attributed.
- There was a significant contribution of the farmer level of education, farmers' perception of climate change and knowledge on climate change their food stock ability status through which 51.6% (R2 = 0.516) of the variation attributed.
- There was a significant contribution of the farmer age, family size, agricultural extension contact and knowledge on food security to change in nutritional security status through which 35.9% (R2 = 0.359) of the variation attributed.

5.1.4 Problem faced in achieving food security

Problem faced

Among the farmers, majority (66.6%) of them faced medium level, 18.3 percent of them faced low level and 15.1 percent faced severe level of problems in achieving household food security.

Problem Facing Index (PFI)

The problem which ranked first was “climate change influences high price of food items” and “climate change hampered livestock production” was the least important problem among those faced by the farmers in achieving household food security.

5.2 Conclusions

Findings of the study enabled the researcher to formulate the following:

- Findings reveal that respondents having medium food availability (79.6 %) was higher and low food availability (3.2%) category constituted the by lower number of farmers.
- Findings reveal that the respondents having low food stock ability (73.1%) was higher and 9.7% (lower) farmers were medium food stock ability.
- Findings reveal that the respondents having medium nutritional security (71 %) were higher and low nutritional security was constituted by 17.2% (lower) farmers.
- Findings reveal that the farmers level of education, family size and farmers’ perception of climate change to change in food availability of the farmers. It may be concluded that the food availability is likely to be influenced by the farmers‘ level of education, family size and farmers’ perception of climate change to achieve food security.
- Findings show that the farmers’ level of education, farmers’ perception of climate change and knowledge on climate change to change in nutritional security of the farmers. It may be concluded that the nutritional security is likely to be influenced by the farmers’ level of education, farmers’ perception of climate change and knowledge on climate change.
- Findings reveal that the respondents’ age, family size, agricultural extensions contact and knowledge on food security to change in food security status of

the farmers. It may be concluded that the food security is likely to be influenced by the respondents' age, family size, agricultural extension contact and knowledge on food security.

5.3 Recommendations

5.3.1 Recommendations for policy implications

On the basis of the findings and conclusion of the research some recommendations have been formulated. These are following-

- The study indicated that most of the farmers enabled them to their food security as medium category in aspect of food security dimension. To uplift their food security condition, the government should take more initiatives through increasing awareness of the farmers about convenience of the food security so that they can lead their life safely from adverse future effect.
- The findings of the research indicate that the different indicators of food security including the dimensions of the food security were attributed to the farmers' level of education, farmers' perception of climate change and knowledge on climate change. It may be recommended that the government should consider the farmers' mentioned characteristics during providing any program or training to the farmers.
- The research findings indicate that the level of education, knowledge on food security had significant contribution to the food security status of the farmers. It may be recommended that the government along with NGOs should provide educational facilities to the farmers of villages so that they can gather more knowledge on food security to uplift their food security status.
- The research findings indicate that respondents' age, family size, agricultural extension contact and knowledge on food security had significant contribution to the food security status of the farmers. It may be recommended that the government should considered these characteristics during implementing any program so that they can get the opportunities to upgrade their food security status.

5.3.2 Recommendations for further study

On the basis of scope and limitations of the present study and observation made by

the researcher, the following recommendations are made for further study.

i. The present study was conducted in ChilmariUpazila under Kurigram district. It is recommended that similar studies should be conducted in other areas of Bangladesh.

ii. This study investigated the contribution of 12 characteristics of the farmers with their climate change vulnerability on farmers' food security status as dependent variable. Therefore, it is recommended that further study should be conducted with other characteristics of their climate change vulnerability on farmers' food security in crop production for sustaining soil productivity.

iii. The present study was concern only with the extent of climate change vulnerability on farmers' food security. It is therefore suggested that further studies should be included more reliable use of concerned variable is necessary for further study.

iv. The study was based on climate change vulnerability on farmers' food security. Further studies may be conducted in respect of climate change vulnerability on farmers' food security for the crop production.

v. In this study, contribution of the selected characteristics of the farmers has been examined with the climate change vulnerability on farmers' food security. Further research is necessary to examine the contribution with other agricultural activities of the farmers.

REFERENCES

Adger, W. N. (2010). Climate change, human well-being and insecurity.*New Political Economy*, **15**(2), 275-292. https://doi.org/10.1080/13563460903290912

Afique, A. A. (2006). Rural Women's Perception of Benefit from Agricultural Model Farm Project of SUS. M.S. (Ag. Ext. Ed.) Thesis, Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh.

Agrawala, S., Ota, T., Ahmed, A.U., Smith, J. and Aalst, M.V. (2003). Development and Climate Change in Bangladesh: Focus on Coastal Flooding and The Sundarbans. *Organization for Economic Cooperation and Development*. COM/ENV/EPOC/DCD/DAC (2003)3/FINAL

Ahmed, S. (2002). Problem Confrontation of the Contact Growers of BADC in Jute Seed Production. M.S. (Ag. Ext. Ed.) Thesis, Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh.

Ahsan, S., Ali, M. S., Hoque, M. R., Osman, M.S., Rahman, M., Babar, M. J., Begum,

S. A., Rahman, D. M. and Islam, K. R. (2011). 'Agricultural and Environmental Changes in Bangladesh in Response to Global Warming', in R. Lal, M. V. K. Sivakumar, S. M. A. Faiz, A. H. M. M. Rahman and K. R. Islam (eds), *Climate Change and Food Security in South Asia*, Springer, Netherlands, (pp. 119–34).

Al Mamun, A.; Al Pavel, M.A. (2014): Climate Change Adaptation Strategies through Indigenous Knowledge System: Aspect on Agro-Crop Production in the Flood Prone Areas of Bangladesh. *Asian Journal of Agriculture and Rural Development***4**(1): 42-58. http://ageconsearch.umn.edu/bitstream/198381/2/6-383- AJARD-4%281%292014-42-58.pdf.

Alam, A.S.M.J. (2007). Impact of Food Security Project on Crop Production. M.S. (Ag. Ext. Ed.) Thesis, Department of Agricultural Extension Education and Rural Development, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur.

Alam, M.S. (1997). Use of Improved Farm Practices in Rice Cultivation by the Farmers. M.S. (Ag. Ext. Ed.) Thesis, Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh.

Ali, M.A. (1978). Cattle Problems of the Farmers in Tarakanda Union of Fulpur Thana under Mymensingh District. M.S. (Ag. Ext. Ed.) Thesis, Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh.

BBS (2014). Statistical Year Book of Bangladesh. Bangladesh Bureau of Statistics. Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh.

BBS. (2015). Statistical Pocket Book of Bangladesh. Bangladesh Bur. Stat. Div. Min. Plan., Govt. Peoples Republic. Bangladesh. (pp. 3).

BER. (2010). Bangladesh Economic Review. Ministry of Finance, Government of the People's Republic of Bangladesh, Dhaka.

Biswas, S.C. (2003). Accessibility of Rural Women to Family Decision Making Process. M.S. (Ag. Ext. Ed.) Thesis, Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh.

Boeing, G. (2016). "How Our Neighbourhoods' Lost Food, and How They Can Get It Back". Progressive Planning. **206**: 35–37.

Bosello, F. and Zhang, J., Assessing Climate Change Impacts: Agriculture (July 1, 2005). FEEM Working Paper No. 94.05; *CMCC Research Paper*, **2**, http://dx.doi.org/10.2139/ssrn.771245.

Chowdhury, S. A., Karim Z. (2009). Implication of climate change on livestock production of Bangladesh. Submitted in Electronic Journal, Livestock Research for Rural Development.

DAE. (1999). Agriculture Extension Manual. Department of Agricultural Extension, Ministry of Agriculture, Government of the People's Republic of Bangladesh. Retrieved from: http://www.dae.gov.bd/

DOE, (Department of Environment). (2007). Climate Change and Bangladesh, Bangladesh Government & United Nations Development Programme, Dhaka.

Douglas, I., K. Alam, M. A. Maghenda, Y. Mcdonnell, L. McLean, and J. Campbell. (2008). unjust waters: climate change, flooding and the urban poor in Africa. Environment and Urbanization, **20**(1): 187-205.

Ezekiel, M. and Fox, K. A. (1959). Method of Correlation and Regression Analysis. (3rd Edn). John Willey and Sons Inc., New York, U.S.A.

FANTA. (2006). Food and Nutrition Technical Assistance. Food Security, Retrieved from http://www.fantaproject. org/focus/foodsecurity.html.

FANTA. (2006). Food and Nutrition Technical Assistance, Food Security, http://www.fantaproject. org/focus/foodsecurity.shtml (Last consulted: July 11, 2007).

FAO. (2009). Building adaptive capacity to climate change. Policies to sustain livelihoods and fisheries. New Directions in Fisheries – *A Series of Policy Briefs on Development Issues,* **8**(16).

FAO. (2013). Food Security: Concepts and Measurement. Food and Agriculture Organization. Retrieved from: http://www.fao.org/docrep/005/y4671e/ y4671e06.html.

FAO, Agricultural and Development Economics Division. (2006). "Food Security"

(PDF) (2). Retrieved June 8, 2012.

FAO. (1996). "Rome Declaration on Food Security and World Food Summit Plan of Action". Food and Agriculture Organization Retrieved 26 October 2013 from

FAO. (2003).Trade Reforms and Food Security: Conceptualizing the Linkages. United Nations Committee on Economic, Social, and Cultural Rights (1999). The right to adequate food. Geneva: United Nations. Food and Agriculture Organization (FAO), Rome, Italy.

FAO. (2008), Climate Change and Food Security: A Framework Document. Food and Agriculture Organization of the United Nations.

FAOSTAT. (2009). Food and agriculture data. Food and Agriculture Organization Statistics. Retrieved from: http://faostat.fao.org

FAOSTAT. (2010). Food Balance Sheet, FAOSTAT data, Rome, Italy. http://faostat.fao.org/site/502/DesktopDefault.aspx?PageID=502 (Last consulted: June, 2010)

Ficke, A. D., Myrick, C. A, Hansen, L. J. (2007) Potential impacts of global climate change on freshwater fisheries. Rev Fish Biol Fish 17(4):581–613

GOB. (2000). Report of the Task Force on Comprehensive Food Security Policy for Bangladesh, Government of the People's Republic of Bangladesh, Bangladesh. Sukhatme, P.V. 1978. Assessment of Adequacy of Diets at Different Income Levels, Economic and Political Weekly, 12: 31-32. Gopalan, C. 1968. Leucine and Pellagra, Nutr. Rev., 26: 323-326.

Goode, W. J. and Hatt, P. K. (1952). Methods in social research. McGraw-Hill Book Company. New York, USA.

Greer, J. and Thorbecke, E. (1986). A Methodology for Measuring Food Poverty Applied to Kenya, Journal of Dev. Eco., 24: 59-74.

Gregory, P.J., Ingram, J. S. I. (2000), Global change and food and forest production: future scientific challenges. *Agricultural Ecosystem*. **82** :(3–14). doi:10.1016/S0167- 8809(00) 00212-7

Gujarati, D.N. (1995). Basic Econometrics, McGraw-Hill International.

Haque, M. S. (1995). Problem Confrontation of the Members of

MohilaBittaheenSamabayaSamitte Working under the Bangladesh Rural Development Board. M.S. (Ag. Ext. Ed.) Thesis, Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh.

Haque, S. (2007). Summary of Discussion and lessons Learnt. 2nd International Workshop on Community Based Adaptation to Climate Change. Organised by: Bangladesh Centre for Advanced Studies, IIED & The Ring. Radission Water Garden Hotel, Dhaka, 24th – 28th February, 2007.

Harasawa, H. (2006). Key vulnerabilities and critical levels of impacts on east and Southeast Asia, in Avoiding Dangerous Climate Change. In: Schellnhuber, H.J. *et al.*, Cambridge, Cambridge University Press. 133 p.

Hasan, A. N. M. (2005). Problem Confrontation of the Farmers in Crop Production Activities in Two Selected Villages of Atria Upazila in Naogaon District. M.S. (Ag. Ext. Ed.) Thesis, Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh.

Hasan, M. K. (2006). Participation in Farming Activities by Conventional and Organic Farmers. M.S. (Ag. Ext. Ed.) Thesis, Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh.

Hazell, P.B.R. (1984), 'Sources of Increased Instability in Indian and U.S. Cereal Production, *American Journal of Agricultural Economics*, *66*,(302–311).

HIES. (2010). Household income and expenditure survey. Bangladesh Bureau of Statistics, Government of the People's Republic of Bangladesh, Dhaka.

Hoffmann, I. (2008). Livestock genetic diversity and climate change adaptation. *Proceedings of the Conference on Livestock and Global Change*, May *17-20*, 2008, Hammamet, Tunisia, (pp. 1-34).

Hossain, M. and Deb, U. (2011). 'Crop agriculture and agrarian reforms in Bangladesh: present status and future options', in MK Mujeri& S Alam (eds), Sixth Five Year Plan of Bangladesh 2011–2015: Background Papers, Bangladesh Institute of Development Studies & Ministry of Planning, Dhaka, vol. 2, (pp. 1–24).

Hossain, M. M. (1999). Farmers' Perception of the Effects of Agro Chemicals on Environment. M.S. (Ag. Ext. Ed.) Thesis, Department of Agricultural

Extension Education, Bangladesh Agricultural University, Mymensingh.

Hossain, M. S. (2002). Resource Poor Farmers' Problem Confrontation in Using Manures towards Integrated Plat Nutrition System. M.S. (Ag. Ext. Ed.) Thesis, Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh.

Hossain, M., Naher, F. and Shahabuddin, Q. (2005). Food Securityand Nutrition in Bangladesh: Progress and Determinants, *Journal of Agricultural and Development Economics, 2(2)*: 103-132.

IPCC (2007). Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Contribution of Working Group I. IPCC Secretariat: Geneva, Switzerland. Retrieve from, https://www.ipcc.ch/report/ar4/wg1/

IPCC. (2007). Summary for Policymakers. In: Climate Change 2007: *The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor and H. L. Miller (eds.)]. *Cambridge University Press*, Cambridge, United Kingdom and New York, NY, USA.

Islam, MB., Ali, MY., Amin, M. and Zaman, SM., (2011).Climate Variations: Farming Systems and Livelihoods in the High Barind Tract and Coastal Areas of Bangladesh, in Lal, R., Sivakumar, M.V.K., Rahman.

Islam, M. N. (1987). Artificial Insemination Problem Confrontation of the Farmers in the Two Selected Unions of MadhupurUpazila under Tangail District. M.S. (Ag. Ext. Ed.) Thesis, Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh.

Islam, S.M.R., Huq, S. and Ali, A. (1999). Beach Erosion in the Eastern Coastline of Bangladesh. *Vulnerability and Adaptation to Climate Change for Bangladesh*. (pp. 71 – 92). In: S. Eds. Huq, Karim, Z., Asaduzzaman, M., &Mahtab. London: UK, Kluwer Academic Publishers.

Karim, M. L. (1996). Relationships of Selected Characteristics of Kakrol (Momordicadioica) Growers with their Problem Confrontation. M.S. (Ag. Ext.

Ed.) Thesis, Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh.

Karim, M.R., Ishikawa, M., Ikeda, M. and Islam, M.T. (2012). Climate change model predicts 33 % rice yield decrease in 2100 in Bangladesh. Agron. Sust. Dev. **32 (4)***:* 821- 830.https://hal.archives-ouvertes.fr/hal-00930570/

Karmalkar, A.; McSweeney, C.; New, M.; Lizcano, G. (2012). UNDP Climate Change Country Profiles: Bangladesh. Available via http://www.geog.ox. ac.uk/research/climate/projects/undp-cp/UNDP_reports/Bangladesh/ Bangladesh.hires.report.pdf

Kerlinger, F. N. (1973). Foundations of Behavioral Research, Educational and Psychological Inquiry. Rinehart and Winston Inc., Halt, New York, U.S.A.

Krishnamurthy, P.K., Lewis, K. and Choularton, R.J. (2014). A methodological framework for rapidly assessing the impacts of climate risk on national-level food security through a vulnerability index. *Global Environmental Change*,**25**:121–132.

Lancet, (2011). Editorial: A commission on Climate Change. Vol: 373: 1659.

Leary, N., Adejuwon, J., Barros, V., Burton, I., Kulkarni, J. and Lasco, R. (2008). Climate change and adaptation. Earthscan/James & James, London, UK; Sterling, VA, USA, (pp. 376).

Mallick, B., Rahman, K.R. and Vogt, J. (2011). Coastal livelihood and physical infrastructure in Bangladeshafter cyclone Aila. Mitigation Adaption Strategies Global Change 16:629–648.

Midgley, G.F. and Thuiller, W. (2011). Potential responses of terrestrial biodiversity in Southern Africa to anthropogenic climate change. Regional Environmental Change, 11, 127-135.

Miles, J. and Shevlin, M. (2001). Applying Regression and Correlation: A Guide for Students and Researchers. London: Saga Publications.

Minar, M.H., Hossain, M.B. and Shamsuddin, M.D. (2013). Climate Change and Coastal Zone of Bangladesh: Vulnerability, Resilience and Adaptability. Middle-East J. Sci. Res. 13 (1): 114-120.

MoEF. (2009): Bangladesh Climate Change Strategy and Action Plan. Ministry of Environment and Forests.

MoEF,(2005). National Adaptation Program of Action (NAPA), Ministry of Environment and Forest, Dhaka.

MoF.(2016). The Statistics for food Import and Export. Ministry of Food, Government of the People's Republic of Bangladesh. Retrieved from: http://www.mofood.gov.bd/

Ministry of Planning (MoP). (2011). Sixth Five Year Plan of Bangladesh, General Economics Division, Planning Commission, Dhaka.

Moniruzzaman, M. (2012). Impact of climate change in Bangladesh: water logging at south-west coast. In: Filho WL (ed) Climate change and the sustainable use of water resources, *climate change management*. Springer, Berlin, (pp 317–336).

MoYS. (2012). the Population Category in Bangladesh. Ministry of Youth and Sports, Government of the People's Republic of Bangladesh. Retrieved from: http://www.moysports.gov.bd/

NAPA. (2005). National Adaptation Programme of Action (NAPA) Final Report. Dhaka: Ministry of Environment and Forest, Government of the People`s Republic of Bangladesh.

Nath, N. C. (2015). The Paper for presentation at 19th Biennial Conference of the BEA on the Theme “Rethinking Political economy of Development” Food Security of Bangladesh: Status, Challenges and Strategic Policy Options.

National Adaptation Programme of Action (NAPA). (2005). Final report. Ministry of Environment and Forest, Government of the People’s Republic of Bangladesh, Dhaka.

Nicholls, R. J., Wong, P. P., Burkett, V.R., Codignotto, J. O., Hay, J. E., McLean, R. F., Ragoonaden, S., Woodroffe, C. D. (2007) Coastal systems and low- lying areas. In: Parry ML, Canziani OF, Palutik of JP, vander Linden PJ, Hanson CE (eds) Climate change. (2007): impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Inter-governmental Panel on Climate Change, Cambridge University Press, Cambridge, (pp 315–356).

Ostfeld, R.S. (2009). Climate change and the distribution and intensity of infectious diseases. Ecology, 90(4), 903- 905.

Paavola, J. (2008). Livelihoods, vulnerability and adaptation to climate change in Morogoro, Tanzania. Environmental Science & Policy, 11(7), 642- 654.

Parry, M.L., Canziani, O.F., Palutikof, J.P., VanDerLinden, P.J. and Hanson, C.E. (2007). Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Patel, R. (2016). "Raj Patel: 'Food sovereignty' is next big idea"Financial Times. Retrieved from: https://www.ft.com/content/584ed992-421611e3-9d3c-00144feabdc0

Pouliotte, J., Smit, B. and Westerhoff, L. (2009). 'Adaptation and development: Livelihoods and climate change in Subarnabad, Bangladesh', Climate and Development, 1(1): 31-41.

Rahman, A. and Mallick, D. (2011). Climate Change Impacts on Agriculture and Food Security – *Adaptation and Mitigation Options in National Policies and Strategies*, Workshop Presentation, BCAS, Dhaka.

Rahman, F. M. M. (2007). Food Security through Homestead Vegetable Production in the Smallholder Agricultural Improvement Project Area. M.S. (Ag. Ext. Ed.) Thesis, Department of Agricultural Extension Education and Rural Development, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur.

Rashid, S. M. M. (2014). Empowering Farmers through e-Agriculture. M.S. (Ag. Ext. & Info. Sys.) Thesis, Department of Agricultural Extension and Information System, Sher-e-Bangla Agricultural University, Dhaka.

Reid, P. and Vogel, C. (2006). Living and responding to multiple stressors in South Africa--Glimpses from KwaZulu- Natal. *Global Environmental Change*, 16(2): 195-206.

Rosegrant, M. W. & Cline, S. A. (2003). Global food security: challenges and policies. *Science 302*, (1917–1919). doi:10. 1126/science.1092958.

Roudier, P., Sultan, B., Quirion, P. and Berg, A. (2011). The impact of future climate change on West African crop yields: What does the recent literature say?' *Global Environmental Change*, **21(3)**: 1073–83.

Ruane, A.C., Major, D.C., Winston, H.Y., Alam, M., Hussain, S.G., Khan, A.S., Hassan, A., Tamim, B.M.A.H., Goldberg, R., Horton, R.M. and Rosenzweig, C. (2013). Multi-factor impact analysis of agricultural production in Bangladesh with climate change. *Global Environmental. Change*. **23** (338–350).

Shahid, S. and Behrawan, H. (2008). 'Drought risk assessment in the western part of Bangladesh', *Natural Hazards*, ***46*(3)**, 391–413.

Sharmin, Z.; Islam, M.S. (2013). Consequences of Climate Change and Gender Vulnerability: Bangladesh Perspective. http://www.bangladeshstudies.org/files/WPS_no16.pdf.

Smith, M.D., Roheim, C.A., Crowder, L.B., Halpern, B.S., Turnipseed, M., Anderson, J.L., Asche, F., Bourillón, L., Guttormsen, A.G., Khan, A., Liguori, L.A., McNevin, A., O'Connor, M.I., Squires, D., Tyedmers, P., Brownstein, C., Carden, K., Klinger, D.H., Sagarin, R. and Selkoe, K.A. (2010). Economics. Sustainability and global seafood. Science, 327(5967):784-6. doi: 10.1126/science.1185345.

Thomas, D.S.G., Twyman, C., Osbahr, H. and Hewitson, B. (2007). Adaptation to climate change and variability: farmer responses to intra-seasonal precipitation trends in South Africa. Climatic Change, 83(3), 301-322.

Thomas, T.S., Mainuddin, K., Rahman, C.C.A., Haque, A., Islam, N., Quasem, S. and Sun, Y. (2013) Agriculture and adaptation in Bangladesh: current and projected impacts of climate change. IFPRI-Discussion-Papers. Washington, USA: International Food Policy Research Institute. 2013. (1281).

Tirado, M., Clarke, R., Jaykus, L., McQuatters, G.A. and Frank J., (2010). 'Climate change and food safety: A review', *Food Research International*, **43(7)**, 1745-65.

Townsend, J. C. (1953). Introduction to Experimental Method. International Student Education. McGraw Hill Book Company Inc, U.S.A.

Uddin, M.S., Khan, M.S.I., Talukdar, M.M.R., Hossain, M.I. and Ullah, M.H. (2011). Climate Change and salinity in Bangladesh: Constraints and Management Strategy for crop production,*Rajshahi University Journal Environmental. Science*. **1:**(13-20)

UNCESCR. (2016). UN Committee on Economic, Social and Cultural Rights. General Comment No. 12: The Right to Adequate Food (Art. 11 of the Covenant, 12 May 1999), UN Committee on Economic, Social Council. Retrieve from: http://www.refworld.org/docid/4538838c11.html

UNDP. (2007) Human Development Report 2007/8. Fighting climate change: Human solidarity in a divided world. United Nations Development Programme (UNDP), New York, NY, USA, pp. 1-399.

UNDP. (2010). Human development index. United Nations Development Programme. New York. Retrieved from: http://hdr.undp.org/en/media/ PR3-HDR10-HD1-E-rev4.pdf (20 March 2012).

UNISDR. (2009). UNISDR Terminology on Disaster Risk Reduction. [Online] Available at: https://www.unisdr.org/we/inform/terminology [Accessed 7 September 2016].

USAID. (1996). Annual Food Assistance Report (PN-ABZ-119). United State Agency for International Development, Washington, DC.

USDA. (2016). Food Security. Retrieved from: http://hdr.undp.org/en/media/ PR3-HDR10-HD1-E-rev4.pdf (20 March 2012). USAID. (1996). Annual Food Assistance Report (PN-ABZ-119). United State Agency for International Development, Washington, DC.

WHO. (2002). The World Health Report 2002: Reducing Risks, Promoting Healthy Life, World Health Organization, Geneva.

WHO. (2008). BMI Classification. Global Database on Body Mass Index. World Health Organization. Geneva, Switzerland.

World Bank (2010a): Economics of Adaptation to Climate Change: Bangladesh. https://openknowledge. world bank org./bit stream/ handle/10986/12837/702660 v10 ESW0P0IC000 EACC0 Bangladesh. pdf? sequence.

World Bank. (2005). World Development Indicator (WDI), Washington, DC.

World Bank, (2011). World Development Report 2008: Agriculture for Development. World Bank, Washington, DC, USA.

Xenarios, S.; Sarker, G.W.; Biswas, J.C.; Maniruzzaman, M.;Nemes, A.; Nagothu, U.S. (2014): Agricultural interventions and investment options for climate change in drought and saline-flood prone regions of Bangladesh.

Yamane, T. (1967). Elementary Sampling Theory, Prentice-Hall: Englewood Cliffs, NJ

Yongyut, T., Rob, A., and Eric, A. (2009) Projecting forest tree distributions and adaptation to climate change in northern Thailand. **1**(3): 055-063.

Young, K., Ulloa, C., Luteyn, J. and Knall, S. (2002). Plant Evolution and Endemism in Andean South American: An Introduction. Rev. 68: 4- 21.

Yusuf, H.K.M. (1997). Nutrition situation in Bangladesh, In: Sustained Food Security Mission Report, FAO, Rome.

APPENDIX-I

Department of Agricultural Extension and Information System

Sher-e-Bangla Agricultural University, Dhaka-1207

An Interview Schedule for the Study Entitled

"CLIMATE CHANGE VULNERABILITY ON FARMERS' FOOD SECURITY IN THE NORTHERN PART OF BANGLADESH"

Name of the respondent: ……Serial No.
Village: ……..…… Contact No. ……...
Union: …….Upazila:…….

(Please provide the following information. Your information will be kept confidential and will be used for research purpose only)

1. Age
How old are you? _____ Years.

2. Level of education
Please mention your level of education.

a) I can't read and write ☐

b) I can sign only ☐

c) I have passed ……. class.

d) I took NFE that equivalent to ……. formal class.

3. Family size
Please mention the number of your family member
a) Male……...
b) Female……. Total…….

4. Farm Size
Please mention the area of your land possession

Sl. No.	Use of land	Land possession	
		Local unit	Hectare
1.	Homestead area (A)		
2.	Own land own cultivation (B)		
3.	Land taken from others on *Borga* system(C)		
4.	Land given to others on *Borga* system (D)		
5.	Land taken from others on lease (E)		
Total=A+B+1\2(C+D)+E			

5. Farming experience
How long have you been practicing farming activities? ..... Year

6. Annual familyincome
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)	Labourer	
	iv)	Others	
Total Income			

7. Agricultural training exposure

Please mention about your training exposure on agriculture

Sl. No.	Name of the training course	Organization	Days
1.			
2.			
3.			
4.			
5.			

8. Agricultural extension media contact

Please indicate the extent of contact in following sources

SL. NO.	Name of information sources	Extent of contact				
		Regularly (4)	Frequently (3)	Occasionally (2)	Rarely (1)	Not at all (0)
1.	Contact/model farmers					
2.	Agricultural input (seed / fertilizer / pesticide / equipment) dealers					
3.	SAAO					
4.	NGO Worker					
5.	Upazila level agricultural organization					
6.	Agricultural program through electronic media (radio/TV)					
7.	Agricultural features in printing media (Daily Newspaper, leaflet, booklet, magazine etc.)					
	Total					

9. Farmers perception of climate change

	Name of the Statement	Extent of perception

No			Extreme (4)	Increased (3)	Reduced (2)	No change (1)	Don't know (0)
1.	Precipitation	Annual					
		In Rainy season					
		In Dry season					
		Length of Rainy Season					
		Length of summer Season					
2.	Temperature	Annual					
		Winter season temperature					
		Summer season temperature					
		Length of Cold period					
		Length of Hot period					
3.	Extreme events	Intensity of storms					
		Intensity of hotness					
		Intensity of Rainfall events					
		Saline water intrusion					

10. Climate change vulnerability

What types of vulnerability you have faced during last few years?

Sl. No.	Name of the hazardous	Extent of damage				
		Extreme (4)	High (3)	Medium (2)	Low (1)	Not ever (0)
1.	Drought					
2.	Flood					
3.	River erosion					
4.	Hail storm					
5.	Cyclone					
6.	Cold					
7.	Spread of pest					

11. Knowledge on climate change

Please answer the following questions

SL. No.	Questions	Full Marks (2)	Marks obtained
1.	What is your idea about climate change?	2	
2.	What are the elements of climate change?	2	
3.	Which month does the temperature highest and lowest?	2	
4.	What are the effects of temperature?	2	
5.	Which month do we call the rainy season?	2	
6.	When does the rain fall highest?	2	
7.	What is river erosion?	2	
8.	What are the effects of flood?	2	
9.	When do we call drought?	2	
10.	What are the effects of drought?	2	
Total			

12. Knowledge on food security

Sl. No.	Questions	Assigned Mark (2)	Marks obtained
1	What does breakfast usually look like? Lunch? Dinner?	2	
2.	What proportion of your weekly diet would you consider to be pretty healthy?	2	
3.	What are some examples of nutritious foods you eat most often?	2	
4.	How easy or difficult is it for you to eat nutritious foods regularly?	2	
5.	What helps you determine if the foods you are eating are healthy or nutritious?	2	
6.	When purchasing food, how often do you look at its nutrition label?	2	
7.	How does the cost of food affect your decisions about purchasing foods that are more healthy or nutritious?	2	
8.	What types of healthy or nutritious foods tend to be more expensive?	2	
9.	How often does the cost of food change your food buying decisions?	2	
10.	What would be different about your food buying choices if cost was not a factor?	2	

13. Food securitystatus
(A). Access to food per day

Sl. No.	Food items	Access of food	
		Amount of meal (gm.)	Nutritional value (kcal)
1.	Cereal grain		
2.	Vegetables		
3.	Meat		
4.	Fish		
5.	Fruits		

(B). Food stock ability
How many meals do you have in your stock?

Sl. No.	Food stock	No. of meals
1.	Up to one day (up to 3 meals)	
2.	Up to one week (4 to 21 meals)	
3.	Up to one month (22 to 90 meals)	
4.	More than one month (>90 meals)	

(C). Nutritionalsecurity

Sl. No.	Name of Meal	Amount (gm.)	Nutrition Value (kcal)
1.	Breakfast		
2.	Lunch		
3.	Supper/dinner		
4.	Others (if any)		

14. Problems faced by the farmers in achieving foodsecurity for climate change vulnerability

(Please mention the extent of problems that you have faced to achieving food security)

Sl. No.	Constraints	Extent of constraints				
		Severe (4)	Medium (3)	Low (2)	Very Low (1)	Not at all (0)

1.	Crops yield decrease due to climate change					
2.	Climate change hampered fish production					
3.	Climate change hampered livestock production					
4.	Irrigations facility hampered due to climate change					
5.	Quality of crops decrease because of climate change					
6.	Climate change influence of declining soil fertility					
7.	Duration of rainy season become shorter due to climate change					
8.	Climate change influences high price of food items					
9.	Poor storage facilities negatively influence farmers' food security					
10.	Weak marketing facilities negatively influence farmers' food security					

Thank you for your kind co-operations

Signature of the interviewer