Impact of Climate Change On Crop Agriculture Southern Region of Bangladesh: A Case Study of Banaripara Upazila ,Barisal.

A dissertation By

Md. Shahidul Islam

Master of Arts in Governance and Development:

MAGD-8 BU

ID – 17172006

Approved as to Style and Contents

By

Professor Niaz Ahmad Khan, Ph. D.

Supervisor

Chairman of the Department of Development Studies

University of Dhaka

BRAC Institute of Governance and Development

BRAC UNIVERSITY

Dhaka, Bangladesh

DECLARATION

I, Md. Shahidul Islam, declare that this dissertation, submitted in partial fulfillment of the requirements for the award of Master of Arts in Governance and Development(MAGD), in the BRAC Institute of Governance and Development (BIGD), BRAC University, is wholly mine unless otherwise referenced or acknowledged. The document has not been submitted for qualifications or other purposes at any other institution.

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MD. SHAHIDUL ISLAM

BU ID 17172006
Batch number: MAGD-8
BRAC Institute of Governance and Development (BIGD)
BRAC University

DISSERTATION CERTIFICATE

It is my pleasure to certify that the dissertation entitled “Impact of Climate Change On Crop Agriculture Southern Region of Bangladesh”: A Case Study of Banaripara Upazila ,Barisal by Md. Shahidul Islam has been completed under my direct supervision and guidance. So far my knowledge goes, the dissertation is an individual achievement of the candidate, and it does not reflect a collaborative work. I also certify that I have gone through the draft and the final version of the dissertation and found it generally satisfactory for submission to the BRAC Institute of Governance and Development, BRAC University in partial fulfillment of the requirements for the degree of Master of Arts in Governance and Development of the BRAC University.

NIAZ AHMED KHAN, PhD(Wales)

Professor and former Chair, Department of Development Studies, University of Dhaka, Bangladesh; Former Country Representative-Bangladesh, International Union for Conservation of Nature (IUCN); Former Senior Program Coordinator-CHT, UNDP-Bangladesh; and Executive Director, Centre for Resources and Development Research.

ACKNOWLEDGEMENT

I would like to express my heartiest thanks and gratitude to my supervisor, Dr. Niaz Ahmad Khan, for his great guidance and invaluable suggestions to conduct my research. His direction and affection have always inspired me in doing the work with care.

I am grateful to Mr. Sultan Hafiz Rahman, Director of BRAC Institute of Governance and Development, BRAC University. I am expressing thanks to**Shanawez Hossain, Ph.D.** Research Fellow & HeadUrban, Climate Change and Environment (UCCE) Cluster, academic coordinator, BIGD, BRAC University for his kind.

I must mention here that my wife, my one son and one daughter always helped me in various ways to complete the dissertation.

I cannot but convey my special thanks to my respondents for giving me their all out support.

And it is me who is responsible for any mistake in this study.

MD. SHAHIDUL ISLAM

BU ID 17172006
Batch number: MAGD-8
BRAC Institute of Governance and Development (BIGD)
BRAC University

Abstract

The study was conducted on disaster prone area of Banaripara upazila Barisal, Bangladesh. The objective of the study was to find out the existing agricultural production system and how climate change is affecting agricultural cropping pattern. Primary data were collected using multiple approaches, e.g. key informant interviews, 40 interviews of each village of two. According to the resource map, there have very small amount of forest cover and forest reserve areas in the study areas. The stratification of the surveyed villages indicated that there were three wealth groups in both villages. On the context of the status of the three wealthy groups, it implies that vulnerabilities and adaptive capacities among groups vary accordingly in the two villages studied. From the field survey, it was clear that that the local responses on climate changes were more significant on their perceptions. It has been reported that the area becomes extremely hot during the day but during the night it remains very cold. This study also showed variation on rainfall patterns in different seasons. The average minimum temperature is decreasing but the average maximum temperature is increasing. The Rabi crops are less vulnerable to change rainfall rate in winter as the production rate of potato, vegetables and banana are increasing trends or constant. In Kharif season, paddy, mustard and wheat production varied with the rise and fall of rainfall intensity. In Kharif-II season, transplanted aman production showed the constant trends of production but the vegetables production fluctuated with the fluctuation of rainfall and temperature.

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List of acronyms

ADB – Asian Development Bank
AEO – Agriculture Extension Office
AR4 – Fourth Assessment Report
BARI – Bangladesh Agricultural Research
BBS – Bangladesh Bureau of Statistics
BIDS – Bangladesh Institute of Development Studies BMD – Bangladesh Meteorology Department.
BRRI—Bangladesh Rice Research Institute.
CC—Climate Change
CO—Carbon Mono-oxide.
DAE – Department of Agriculture Extension DMG – Disaster Management Goal
ds / m – desicymole / meter
FAO – Food and Agriculture Organization FGD – Focus Group Discussion
GDP – Gross Domestic Product GM – Genetically Modified
GOB -Government of Bangladesh
HYV—High Yielding Variety
IPCC – Intergovernmental Panel on Climate Change
KII – Key Informant Interview MPO – Master Plan Organization MSL – Mean Sea Level
NGO- Non Government Office.
SLR – Sea Level Rise
TAR – Third Assessment Report UNO – Upazila Nirbahi Officer
WARPO - Water Resources Planning Organization.

CHAPTER 1
INTRODUCTION

This chapter sets out the background and methodology of the study. It has got 11 (eleven) sections. The first section describes the research problem, while the second section is Rationale of the study, and the other sections are as follows Objective of the study , Methodology ,Area selection Data collection Tools and Techniques ,Primary data collection,Key information interviews,Focus Group Discussion , Secondary data collection,Data Analysis and the section is Limitation of the study. This chapter ends with a conclusion.

1.1 Background of the study and statement of the problem:

Due to natural processes such as modulations of solar cycle, volcanic eruptions etc. or external forces i.e. persistent anthropogenic changes in composition of atmosphere or land use.UNFCC (Article 1) defines climate change as "a change of climate attributed directly or indirectly to human activity that alters the composition of global atmosphere & which is in addition to natural climatic variability observed over comparable time period"UNFCC makes a distinction between climate change attributable to human activities altering the global composition & climate variability attributable to natural causes.

Earth is subjected to many human induced and natural pressures, collectively referred to as global

- Increased emissions of Greenhouse Gases viz.; CO_2, N_2O, CH_4, Per fluro carbon compounds (PFCs), HFCs, SF_6 (breakdown).
- Selective exploitation of species.
- Water & Air pollution.
- Increased demand for resources.
- Depletion of the ozone layer and increased UV-B radiation on the earth's surface.
- Urbanization, industrialization.
- Land use and land cover change.

The atmosphere and ocean have warmed.Primary reasons for increase in GHGs is burning of fossil fuels, deforestation, land use & land cover changes.Atmospheric concentration of CO_2 has increased from 280 ppm (pre-industrial) to 379 ppm (2005), 393.1 ppm (2012) & 400 ppm (2013).Assessment Report 5 (2013) showsunequivocal evidence of warming of climate systems :Science shows with 95% certainty that human activity is the dominant cause of observed warming since mid 20^{th} century.Climate change from human activities puts additional stress on the earth's ecosystems and Biodiversity.IPCC's Fifth Assessment Report (AR 5)-Direct observations of changes in temperature, sea level and snow cover in northern hemisphere during 1850 to the presentAmount of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased Findings of IPCC.

Evidences of Global Climate Change:

- Each of the last 3 decades have been successively warmer at Earths surface than preceding decade since 1850.
- GHG emission increased by 70% between 1970-2004.
- Atmospheric concentration of CO_2, Methane (CH_4) & Nitrous Oxide (N_2O) have increased by 141%, 260% & 120% respectively of pre-industrial levels (1750) (WMO GHG Bulletin, Nov 2013).
- Increase in Global mean temp by 0.74**^oC** during 1906-2005.
- Global sea level rise by @1.8mm/year during 1961-2003 and @3.1mm/year during 1993-2003.
- Last 11 years (1995-2006) among 12 warmest years since 1850.
- Across all scenarios average warming is predicted as 0.2 **^oC** per decade.
- Multiple model averages show that temperature increase may range from 1.1**^oC** to 6.4**^oC**(2090-2099) and sea level rise could be between 0.18 mtrs to 0.59 mtrs.

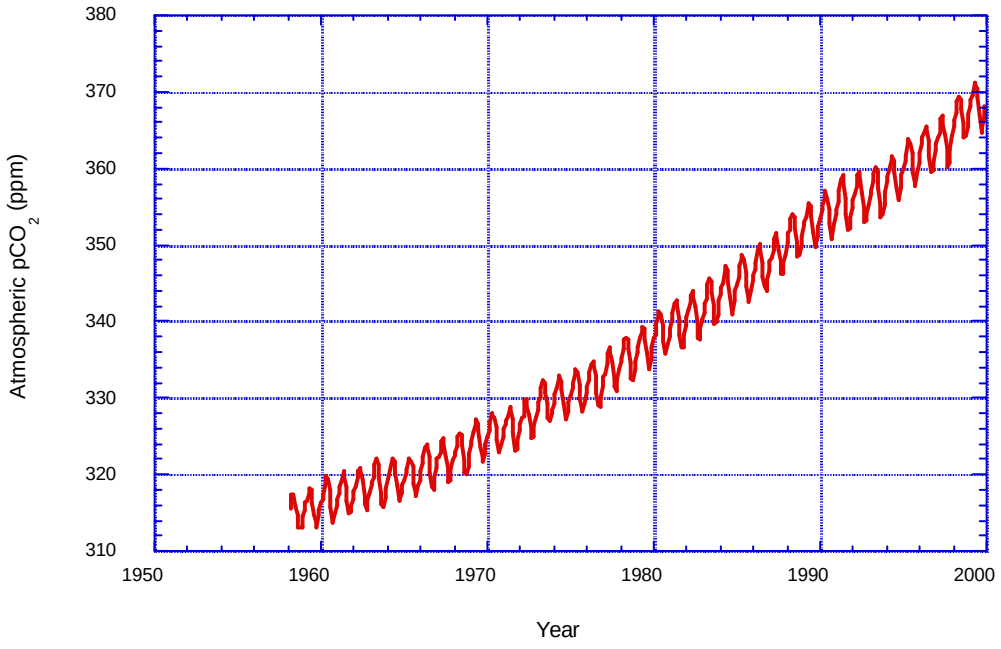


Fig-1.2: Global average temperature (^oC) over the past millennium

Source: Power point presentation of Chiranjiv Choudhary IFS,Commissioner Horticulture and Sericulture, Department of Agriculture,Govt.ofAndhra Pradesh, Hyderabad.

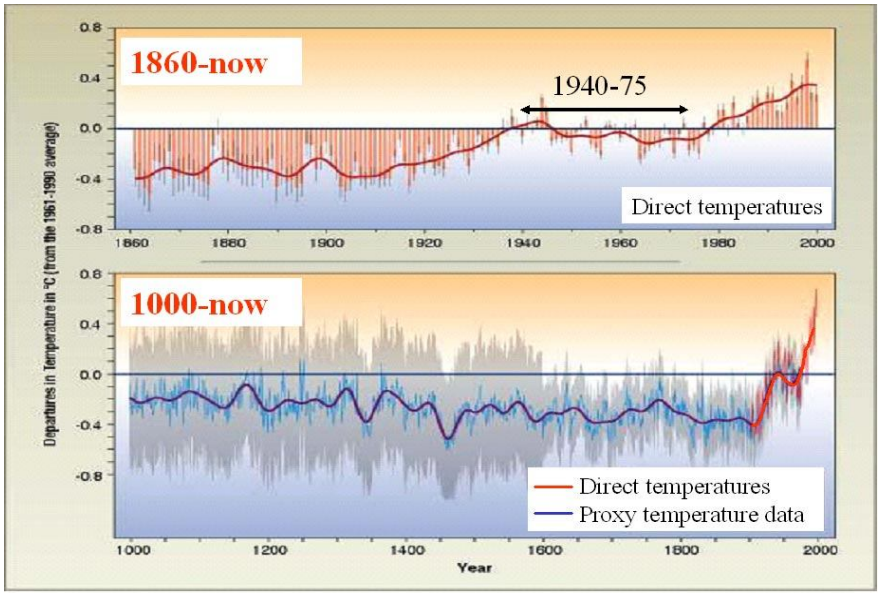


Fig-1.3:Observed global average surface temperature rise (°C) from 1860 to 2000
Increase of almost 1°C in last 50 years.

Source:Power point presentation of Chiranjiv Choudhary IFS,Commissioner Horticulture and Sericulture, Department of Agriculture,Govt.ofAndhra Pradesh, Hyderabad

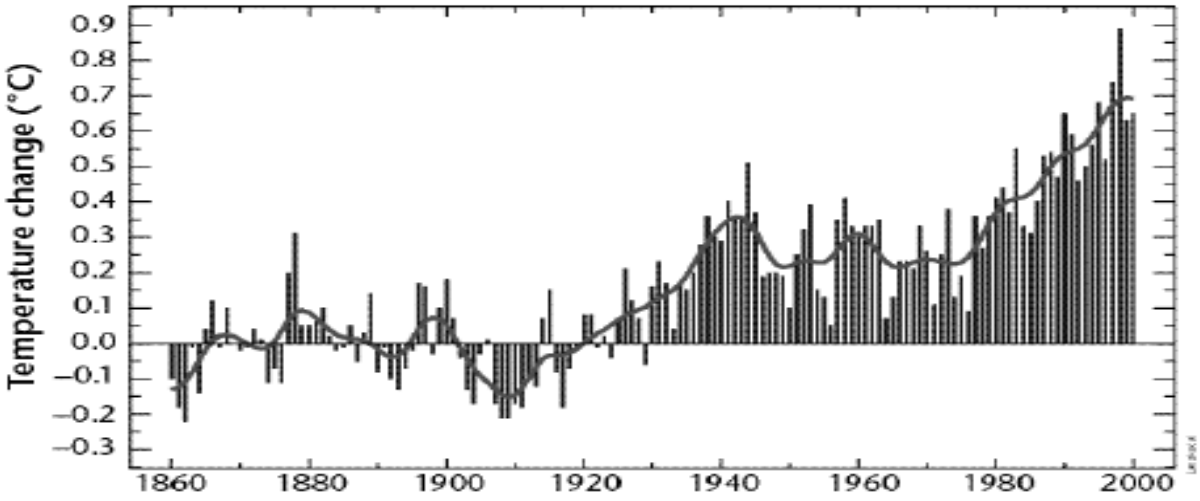


Fig-1.4: Observed global average surface temperature rise (°C) from 1860 to 2000
Increase of almost 1°C in last 50 years

Source: Power point presentation of Chiranjiv Choudhary IFS,Commissioner Horticulture and Sericulture, Department of Agriculture,Govt.ofAndhra Pradesh, Hyderabad

In 21st century:

- Temperature may rise from :1.5-4.5° C.
- Atmospheric CO_2 likely to be doubled.
- Rainfall may increase by 3-5 % globally.
- Sea level may rise by about 45 cm.

Atmospheric CO2, CH4, SO2, N2O, etc. are mainly responsible for temperature increase resulting in the rise of sea level. Temperature rise by 1.0^0 C would inundate 18% area of Bangladesh as indicated by different studies. At the same time, the country is affected frequently by flood, drought, cyclone, and salinity due to climate change. As a result, soil fertility, crop productivity, and food security would be seriously threatened. Climate change has also accelerated hunger, poverty, malnutrition and incidence of diseases, especially in developing countries (IPCC, 2007).

It is basically the poor that would be worst victims of climate change. Profit driven mode of production by corporate agencies and their over extraction and consumption of fossil fuels (coal, oil) has also hastened global warming.

In Bangladesh, about 1 million ha of the coastal region is saline. But very few varieties are available for combating salinity. Drought affects annually 2.5 million ha in *kharif* and 1.2 million ha in dry season. Kharif drought affects T. *aman* rice severely. Besides, about 2.6 m ha are affected by flood in a normal year (Z. Karim, 1997). The devastating flood of 2004 inundated 40 districts and caused considerable loss of crops and human life. But very limited technologies are available that are tolerant to flood and drought.

According to Intergovernmental Panel on Climate Change (IPCC, 2001), coastal area of Bangladesh may go under saline water by 2050. Due to the rise in temperature, crop production will be reduced by about 30%. Climate change, especially temperature rise would decrease the yield of *boro* rice by 55-62% and wheat by 61% by 2050 in Bangladesh (New Age, 2008). Frequent felling of green trees by the influential's, especially in coastal belts for building shipyards has also become a threat to climate change.

The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (1PCC-AR4) summarises the scientific evidence on impacts up until 2006. The evidences demonstrate that composition of global atmosphere is changing, e.g. increasing atmospheric concentrations of greenhouse gases (GHG), such as carbon-di-oxide (379 ppm recorded in 2005), methane (1774 ppb recorded in 2005) and nitrous oxide (319 ppb)years).

Salinity Intrusion (Almost the whole Coastal Belt along the Bay of Bengal is experiencing Salinity problem).**Extreme Temperature and Drought** (North and North-Western regions of the country are suffering because of the Extreme Temperature problem).

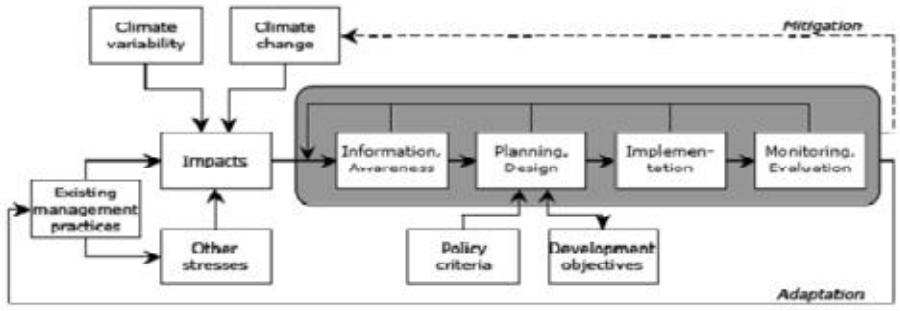


Fig-1.6: Extreme temperature and drought

The Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) has reported that the average global surface temperature has increased by 0.74˚C during last 100 years. It is also reported that the sea level rose at an average rate of 1.8 per year over 1961 to 2003, mountain glaciers, and snow cover have declined on average in both hemispheres. Project global warming in this century is likely to trigger serious consequences for mankind and other life forms, including global temperatures rise between 1.8˚ C and 4.0˚ C by 2100 depending on emissions of greenhouse gases and that global sea levels are likely to rise from anywhere between 180 mm and 590 (IPCC, 2007).

The impact of global climate change on agriculture has been studied extensively for various crops at different scales in many countries of the world. Available reports show those tropical and subtropical countries would be more vulnerable to the potential impacts of global warming. It is believed that climate change would increase the disparities in cereal production between developed and developing countries. The production in the developed world would benefit from climate change, while that in developing nation would decline (Walker and Steffen, 1997).

Climate change is a significant and long-term change in the statistical distribution of weather patterns over periods of time that range from decades to millions of years. It may be a change in the average weather conditions or a change in the distribution of weather events with respect to an average, for example, greater or fewer extreme weather events. Climate change may be limited to a specific region, or may occur across the whole Earth (IPCC).

The overall effects of climate change are:

According to my concepts the overall climate change effects are as follows:

- Climate change is increasing of greenhouse gas concentrations in the atmosphere day by day.
- It is changing the intensity and geographic location of rainfall and snowfall.
- It is increasing the frequency and intensity of storms.
- Increasing the frequency of dry spells and droughts.
- It is increasing the frequency and intensity of floods.
- It is changing the timing of rainfall and duration of rainfall.
- It is changing in precipitation.
- It is changing seasonal weather and growing season of crops.
- It is increasing temperature (mean, maximum and minimum temperatures).

Bangladesh lies between 20˚ 34′ to 26˚38 North latitude and 88˚ 01′ to 94˚45′ east longitude.For this reason its unique geographic location, dominance of floodplains and low-lying topography, high population density, high levels of poverty, and overwhelming dependence on natural resources and services, many of which is climate sensitive. So at present clearly we can say Bangladesh is one of the most vulnerable countries facing the adverse impacts of climate change.

At present it is clear that Bangladesh is vulnerable to many climate change related Bangladesh is already vulnerable to many climate change related extreme events. It is expected that climate change will bring changes in characteristics of extreme events and gradual changes phenomenon of the physical and natural systems. Overall impacts of climate change on Bangladesh would be significant due to higher level of dependency on natural resource base.

The total land area is 147,570 sq. km. consists mostly of Floodplains (almost 80%) leaving major part of the country (with the exception of the north-western highlands) prone to flooding during the rainy season. Moreover, the adverse affects of Climate Change –especially High Temperature, Sea-level Rise, Cyclones and Storm Surges, Salinity Intrusion, Heavy Monsoon Downpours etc. has aggravated the overall Economic Development scenario of the country to a great extent. Bangladesh has got a population of around 150 million (2011) with a life expectancy at birth of around 63 years, and an adult literacy rate of 47.5%.

The recent Human Development Report ranks Bangladesh number 140 of 177 nations. Bangladesh has an average annual population growth rate of around 2% (4.6% in urban areas), almost 75% of the population lives in rural areas and a population density of 954.4 (people per sq. km.). Bangladesh is predominantly Agricultural with two thirds of the population engaged in farming or Agro-based industrial activity mainly.

By the middle to the end of the current century (21^{st}), wintertemperature is predicted torise by 1.5 – 2.5˚C. Such elevation of temperature is likely to pose a great threat to the winter or Rabi crops (WARPO, 2006).

The climate of Bangladesh can be characterized by High temperatures, Heavy rainfall, High humidity, and fairly marked three seasonal variations like Hot Summer, Shrinking Winter and Medium to Heavy Rains during the Rainy season.

Small areas (2%) with river floodplains and peat basins are found in the northern part of the coastal area. Tidal floodplains occur in Satkhira, Khulna, Bagerhat, Pirozpur, Jhalokhati, Barisal, Patuakhali, Chittagong and Cox's Bazar district. They cover a total of 18, 65,000 ha or about 65% of the coastal area. Estuarine floodplains occur in Noakhali, Bhola and Patuakhali districts and in the north-western part of Chittagong district. They cover about 9, 37,000 ha or about 33% of the coastal (Karim *et al.*, 1982).

The total area of Bangladesh is 147, 570 km2. The coastal region covers about 20% of the country and over 30% in the total cultivable area of Bangladesh. It extends inside up to150kmfrom the coast (Petersen & Shireen, 2001).

The recent estimates using different models with changed assumptions predicts for 2050 reduction in production by 1.5 – 25.8% for Aus rice, and 0.4 – 5.3% for Aman due to the effect of high temperature. For Boro rice production could be increased by f1.2 – 9.5%, assuming the temperature would not exceed the 35˚C threshold limit for rice production (Hussain, 2008).

The recent estimates using different models with changed assumptions predicts for 2050 reduction in production by 1.5-25.8% for Aus rice, and 0.4-5.3% for Aman due to effect of high temperature. Similarly, wheat production is also sensitive to temperature. It requires low temperature at certain stage to get desirable yield of wheat. On the other hand, disease infestation

in potato is accelerated due to foggy weather. Late blight disease of potato, responsible for long foggy weather, reduces potato yield drastically every year (Anonymous, 2008).
The southern zone consists of 19 districts and 147 upazillas with a total area of 47,201 km2, which is about 31% of the total area of Bangladesh, 147,570 km2. We know that climate change has become a challenge issue for crops due to temperature. Agricultural crops of Bangladesh are specially sensitive to the different variables of climate such as temperature rainfalls humidity day-length etc. as well as different natural disasters like floods, drought, salinity and storm surges etc. Therefore, adaptation measures have to be looked atfor the sustainability of agriculture.
According to information of there are some main crops they are as follows. i. Rice, ii. Wheat, iii. Dal, iv. Banana and v. Potato. Rice (Oryza sativa), wheat (Triticun aestivum) and potato (Solanum tuberosum) are major food crops in **Banaripara** growing at different cropping seasons with various temperature and rainfall requirements. Climate change already has brought some changes on crop production in reference to growing periods and cropping pattern. Changing rainfall patterns with increasing temperatures, flooding, droughts and salinity causes decline in rice production in Bangladesh by 8% and wheat by 32%, against 1990 as the base year (CCC, 2009).

The negative effects of climate change on Bangladesh agriculture are as follows:
(Mondal, 2008).

- Increasing temperature will lead to increase evapo-transpiration and droughts, causing water scarcity for irrigation and domestic uses in north –west Bangladesh>
- Extended flooding of arable land narrowing scope fir crop production, especially in the vast low land areas;
- Increased inundation and salinity intrusion, limiting crop cultivation with the existing varieties, especially in the coastal regions;
- Increased intensity of flush floods in Meghna basin and north eastern haor region, damaging standing Boro rice crop;
- Increasing loss of land to river erosion, reducing land-based livelihood opportunities, and increased drainage congestion and water logging due to sedimentation of rivers, limiting production options for the char dwellers.

There are many problems and environmental issues that are effecting development of Banaripara. Water scarcity is a present problem due to climate change and sea level rise that are effecting food grain production. Water scarcity intrusion due to reduction of freshwater flow from upstream, stalinization of groundwater and fluctuation of salinity's are major concern of **Banaripara**. Cyclone, storm and flood are the very common phenomenon in Bangladesh. Every year it destroyes to the lives and properties. Cyclone SIDR attacked on November 15, 2007 and AILA attack on May 25, 2009 to the South and Southwestern part of Bangladesh. It has damaged to the socio-economic and physical sectors. Damage of agriculture sector was havoc in SIDR and AILA, especially to the hardest hit **Banaripara** area. Farmers have been facing a lot of problems to bring all of their arable land under crops cultivation, especially, during winter Boro crops season a lion portion of their land remain untillaged only due to water level and financial, timely or interest low problem. There are some other problems such as non-availability of quality seeds, agricultural equipments interest free loan.

According to my view the climate change impacts in **Banaripara** are as follows:

- Increase of soil PH value Increase water salinity,
- Increase water scarcity
- Inland salinity intrusion,
- Increase Water-logging condition
- Increase loss of crops and their yields,
- Increase disease in crops, fishes and animals.

The different types of crops are practiced in **Banaripara** Upazila. The major cropping season of my study area. There are three types of seasons namely Kharif-1(mid-March to mid July), Kharif-2 (mid July to mid October) and Rabi (mid-October to mid-March). During the **Kharif–1** season farmers cultivate aus rice, oil seeds and different types of vegetables. During the **Kharif-2** season T. Aman is the dominant crop. Different types of T. Aman rice such as BR 11, BRRI 40,4147,53,54,55,74 BRRIdhan 36 ,55 BRRI dhan 51,52 BRRI dhan 28 ,45BRRI dhan 43,56 ,57 BINA-8, BINA -10 and local varieties are practiced during this season. In the **Rabi season wheat BARI-GOM 25,26,27,28 and BARI SARISA-14** are practiced. Other crops that are practiced are mustard, pulses and different types of vegetables. The farmers of **Banaripara** are changing their cropping patterns due to climate change especially after SIDR and Aila.

Due to Increasing water level and increase in soil ph will have serious negative impacts on agriculture. The presently practiced rice varieties may not be able to withstand increased soil ph value. Many farmers of Banaripara upazila who are involved in food production does not seem to have a better future in the event of a climate change. Many farmers of my study area follow cropping patterns that involve mixed-cropping, and relay sequential cropping. We know that generally there are three cropping season in Bangladesh. Like that in Banaripara upazila there are three cropping seasons, individual cropping pattern and cropping calendar. The main three season are Kharif-1, Kharif-2 and Rabi.

1.2 Rationale of the study:

The studyis important for several reasons: There is no specific study on climate change .We find that there are some impact of climate change in Bangladesh.Climate Change is one of the Challenge for human being survival .The information's that we get from research it will be helpful for the agricultural policy level. It will be helpful for the national agricultural policy or food security. The daily and weekly it is coded that due to climate change the damage water scarcity and soil ph value to the land are common characteristics at the southern region of Bangladesh. As a result, the ultimate impact will increase the vulnerability of the river side southern region people especially in **Banaripara** beside the Sandha River.

In my study region farmers were involved in assessing their damage and their future cultivation of crop plan. My study was undertaken to raise their knowledge regarding demand, to make them aware about high yielding varieties.

By using present study in **Banaripara** upazila it was tried to assess the actual amount of land, not brought under cultivation and the causes behind it. According to farmers' opinion on crops variety, seeds, services pesticides and difficulties they faced to bring back all their arable land under cultivation was look for. To recover the enormous loss of Climate Change, especially the loss of agricultural sector and minimizing the gaps between farmers and development workers which were not found through my study.

Many studies in the past have been conducted on climate change issues by different organizations. The future effect scenarios have also been developed by different organization. There are many different adaptation technologies, measures and strategies have already beendeveloped by different organizations. It also adapt by communities with climate change. The agriculture is the main sector of economy in our country, it is essential to identify suitable adaptation technologies or varieties of agricultural crops through field-testing. On the other hand community awareness for sustainability is important. Suitable adaptation measures and varieties of crops have been identified by this study. The results of this study will give hope and confidence to farmers in adapting their crops for climate change.On the other hand the results that we get from this study it will be helpful for the national policy level.

1.3 Objectives of the study:

The main objectives of the research are as follows:

To find out the impact ofclimate change on selected cropping patterns with special reference to the study area (**Banaripara).**

To identify the local and indigenous practices of adaptation to the above effects.

Torecommend possible policy and functional measures and options to address the challenges of cc on crop agriculture.

1.4 Methodology:

Tools, Study area ,(Selection of the Study area , Profile of the study area, Data analysis and limitations.

1.4.1 Area Selection

The southern region district Barisal consists of 10 upazilas. **Banaripara** is seriously affected upazilas among 10 upazilas, where serious damage is occurring in agriculture sector due to climate change. Water level rise, change of soil ph value, storm surge, cyclone, sea level rise, flood is the most important factor in my study topic is effect of climate change on cropping pattern in southern area of Bangladesh. In my view I think that **Banaripara** is the right place for my research work.

1.4.2 Data Collection tools and techniques:

The various professionals (Banaripara) firstly I chose and then I selected who are directly involved in agriculture. I have interviewed randomly with six farmers, NGO workers, Govt. officers (UAO, AEO), Agricultural product related businessman, whole seller, traders, dealers and labors.

My study area of Banaripara Upazila has 8 union Parishad. I collected data from all unions of Banaripara. A total of 56 farmers' were selected from 8 villages (8 villages from 8 unions). From each of a village 7-10 farmers' were sampled and data were collected for the study. I selected Union wise mostly affected village list from Agriculture Extension Office (AEO),

Banaripara. Among the selected farmers, they were in mixed groups of poor farmers, marginal and day laborers. It seemed to me Occupational changes and displacement was a major point to know from them through focus group discussions. In my view this regard key informants' were interviewed. (UP-Chairman & members) and officials (AEO) were also interviewed by myself. I finalized questionnaires by using field test . In my study Observation techniques were adopted. By using practical view of farmers to understand the cropping activities and on the basis due to climate change.

I used Focus group discussions with the farmers to know about cropping patterns, occupationchanges and their future plan for crop cultivation. I tried to know their thinking about the problems they face in cultivation and the way they are planning for solution of their problems were also addressed in my study.

I have collected data from rice and non-rice crops growing by farmers of the villages using questionnaire. Before interview, the selected farmers were contacted when they were available. During the interview of the farmers, all data I have recorded properly in my notebook. If any data seems to me confused, data was corrected through revisit by myself. I took help from the previous researchers to collect information. The collected data was manually coded according to the objective of the study. The data were summarized and scrutinized carefully. In my study primary data and secondary data that I have collected where the information of the agriculture cropping pattern issue.

1.4.3 Primary data collection:

My first-hand information primary data. I have collected data by using various methods such as interviewing, observation, focus group discussion transect walk, key informant interview,etc. from the communities. Farmers and local people and village communities were involved.

1.4.3.1 Key Informant Interviews (KII):
(How many, when and where)

I conducted Interviews with different professionals for experiencing the real gradual effect of climate change in this selected area. Because of the local people are direct observers of the climate changes. But they do not have immense idea about the hidden causes of theclimate changes. So I feel need the experience of the experts of that particular area. I have made sense with my own knowledge, It has been tried to analyze the fact with checking and rechecking their ideas.

The key informants that I have selected based upon their experienced basis on the relevant subject matters required for analyzing the issue rigorously. Five Key Informants Interviews were taken for the present study from Government (Upazilla Agriculture Extension Officer), Non Governments Organaizations workers in local offices (BRAC, Uddipon, USAID-Funded,Samarthok,CARE and Ahasania mission) and Dealers (seeds & fertilizers) respectively.

Md Kamal Hossain and Md Tofazzel Hossain in Banaripara bazaar they have twelve years experience in their occupation. The persons Nittanondon Das, secretary of ICM club in Murarbari village Bisherkandi Union helping for marketing of agricultural product. The businessman of agricultural product Sk. Shahid Hossain, Shubod Kundo Banaripara bazaar. Among 8 union Parishad Chairman I have talk with 5 persons and 13 members of those Union Parishad. Specially floating cultivation area in Bisharkandi Union I have talk with Nitai Das, Khirod Bepari village Kolavita:Md Mokhles Loskor, Ratan Barai village Morisbunia: Md Mostofa Hossain village Kodombari I have talked. I have selected 8 villages-Masrong in Banaripara Union, Betal in Soliabakpur, Murarbari in Bisherkandi, Uttorkul in Baisari, Moluhar in Eluhar Union, Lobonsara in Udaikati Union, Chirapara in Chakhar Union and Masjidbari in Soiodkati.

The seeds & fertilizers Key informants for interviewed face to face and over telephone using semi-structured questionnaire. Beyond this questionnaire, Icolleted their comments that were also taken into consideration.

1.4.3.2 Focus Group Discussion (FGD):

I organized Focus Group Discussion(FGD) 29 December 2017. My Research Work was started on time, the program was started with greeting and thanks giving. The FGD was conducted with farmers. I asked different types of questions related with climate change specially they were asked question regarding the climate related Various Problems and difficulties of , livelihood, agricultural production, income generation, and adaptation technique applied in the selected area. It helps to gather a wide range of information in a relatively short time. The data collected from FGD was cross checked by a interviewing from the farmers. Eight FGD that I have arranged there 39 participants were actively participated.

The following broad questions that were focused interviewing system:

- What kind of change do you find in the seasonal pattern in your locality? What is your idea about the reason of this changing?
- How seasonal pattern is changing that affecting your agricultural practice?
- What type of problem do you face currently in irrigation? What do you do to overcome the situation?
- What type of problems that you feel for sub-merge soil?
- How seasonal cropping pattern is changing that is affecting your agricultural practice?

1.4.4 Secondary data collection:

The information about the agriculture related issues that I compiled by cross matching among different sources. The information had been taken from different relevant books, articles, Rep journals orts, maps, research paper, daily newspapers, library, website, **Banaripara** Upazila office, Reports from local NGO offices, Field study report under BRAC University etc.

1.4.5 Data analysis:

I have taken decision to adopt qualitative method. Qualitative analysis configures observation and narrative explanation rather than numbers.Therefore, conceptualization is required to bring order of understanding in a systematic manner. Three steps were followed to analyze and interpret narrative data as developed they are as follows: 1. Get to know the data, 2. Focus the analysis, 3. Categorize information etc.The questionnaire/forms has been organized in one place, and checked whether they are completed. I screened out the irrelevant and in appropriate questionnaires or forms.

1**1.5 Limitation of the study:**

The farmers of my study area grow various types of crops whose yield is potential is different ways. The respondents were asked the common questions. Both farmers and laborers were asked the same questions to estimate the yield loss and decline in crop size, regarding affect of water level in agriculture but the farmers, who are directly involved in crop growing, the answer was more reliable than other professionals. In my paper, we have used the average of the response. Moreover, samples were taken only from three villages which have been used to construct a general scenario for the interior area, more specifically Barisal district. Such small number of sample does not reflect the whole scenario of the interior area or even the district, but the study could open a new window in climate change research for southern part of Bangladesh which demands more comprehensive study involving multidisciplinary approach. The whole study was conducted within six months. Due to budget constraints, the sample size was not so smart. I tried to recheck and compared the data with established literature to maintain the rigor the study.

CHAPTER 2
LITERATURE REVIEW

Introduction:

For academic research, literature Review is a crucial element.. Without this chapter, no academic pursuit can be considered complete .We know that without literature review we cannot determine the trends in, and progress of previous information and research activities on the subject. This chapter has three sections. The first section reviews the main concepts used in this study; i.e. cc and impact of climate change on crop agriculture especially cropping pattern. The second section then identifies the gaps in the literature and proposes as to how this study may contribute to this relative inadequacy in the existing literature.This chapter ends with a conclusion.

For a research work the Literature Review is an important subject. Without this chapter it is not completed thesis work .We know that without literature review we cannot determine the previous activities of a recherché. When the study this chapter we find the information about the selected topics. After all we can say this chapter is a vital factor a research work.

Agriculture is the backbone of the country and is synonymous to the food security of the country. Attaining food self sufficiency by 2013 along with ensuring food to all is adopted in the 'Vision 2021' of the Government of Bangladesh. 1. Climate change accelerated the intensity and frequency of occurrences of salinity, storms, drought, irregular rainfall, high temperature, flash floods, etc. that resulted from global warming .Global warming is harmful for crops of the tropical countries. 2. Pressure for increased crop production is triggered by the rapid population growth and it is the most important challenge. Apart from food security, the sector alone contributes about12% of the GDP and employ 44% workforce of the country. For these reasons, the government has put top most priority to the agriculture sector. Agriculture sector is directly related to the rural poverty as the sector benefits livelihood of the rural poor people who account for majority of the population. Agriculture sector is the contributor of income and employment generation in Bangladesh.3. Most of the farmers are marginally occupying subsistence farming Crop production raises rural income and creates jobs for poor people.4. Bangladesh is one of the most climate vulnerable countries in the world. Located between the Himalayas and the Bay of Bengal, the country is very pronetonaturaldisasters.

2.1 The Key Concepts

- 2.1.1 Climate Change
- 2.1.2 Climate Change impact on crop agriculture especially cropping pattern

2.2 The Gap in the Literature

Conclusion

2.2 Key Concepts:

Climate is usually described in terms of long-term (typically 30-year) averages of a range of parameters. It varies continuously, at all scales of time and space. Weather is the variation at daily and local scales. Both climate and weather are ways of describing variety of states of the Earth's atmosphere, which is a non-linear (chaotic) system. Climate Change refers to change in the state of climate that can be identified (by using statistical tests) by changes in the mean and /or the variability of its properties that persists for an extended period.

Impact of climate Change:

- Water Resources (reduced ground water & raw water quality, surface water resources).
- Agriculture & Food Production (i.e. global reports predicts 10-40% loss in crop production, greater loss is expected in Ravi crops i.e. wheat & maize in India).
- Forests & Wild Life (shift in forest types, extinction of species, habitat fragmentation, net bio-diversity loss etc).
- Major shift in provision of ecological services.
- Increase in frequency and severity/magnitude of extreme events (heat waves, drought, flood, cyclone, wild fires etc).
- Health (i.e. increase in vector borne & water borne diseases etc).
- Livelihood Security.

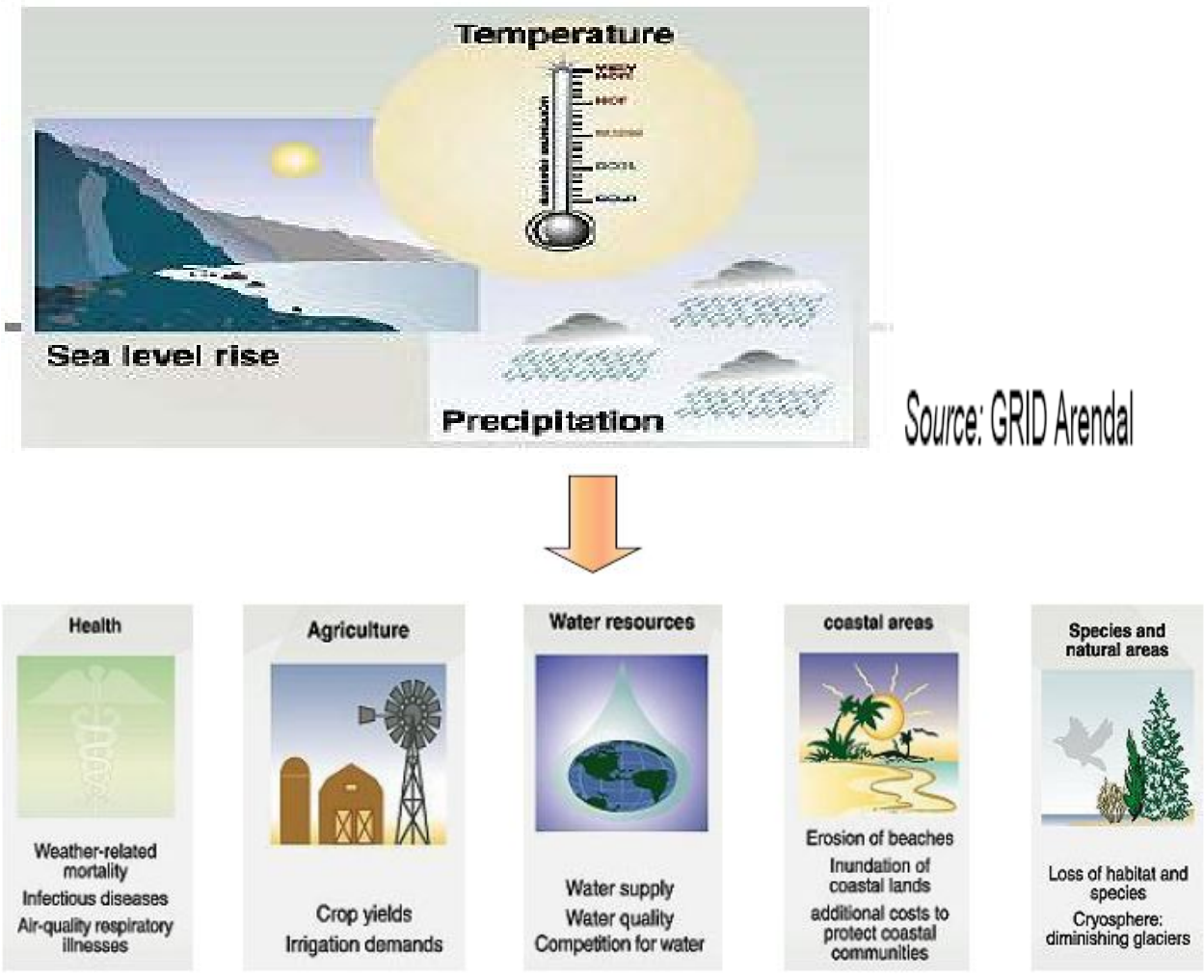


Fig-2.1: Impact of climate chanange.

Source: Power point presentation of Chiranjiv Choudhary IFS,Commissioner Horticulture and Sericulture, Department of Agriculture,Govt.ofAndhra Pradesh, Hyderabad

Climate Change & BiodiversityProjected changes in climate due to human activities include:Increase in temperature / warmingChanges in precipitationSea-level rise, acidification of ocean

Increased frequency and intensity of some extreme climatic events such as heat waves, droughts, floods, tropical cyclones leading to increased climatic variability.There is unequivocal evidence that climate change is occurring and having impacts on biodiversity (IPCC, 2007).

Agriculture is the most vulnerable sector as its productivity totally depends on climatic factors like temperature, rainfall, light intensity, radiation and sunshine duration, which are predicted to be erratic. Incidences of floods, droughts, high temperature, flashfloods and floods, etc., are predicted to be more frequent and intense. Salinity intuition could be more acute problem in future due to sea level rise.Physical changes associated with Climate change:Potential Ecological Consequences associated with these changes that are shown in below:

Observed or Projected Physical Change	**Potential impacts on Biodiversity**
Increased ambient temperature	Species and population range shifts and/or changes in phonology leading to alteration or loss of biotic interactions
Changes in annual & seasonal precipitation	Changes in community composition
Increased frequency of extreme events	Mortality resulting from flooding, after storms or drought events; damage or mortality resulting from deep freezes or heat waves
Changes to hydrologic regimes	Reduced stream flow affecting population persistence and community composition
Changes to fire regimes	Changes in community composition
Ocean acidification	Change in water chemistry affecting calcification rates of marine organisms
Sea level rise	Habitat loss and fragmentation affecting population persistence
Increases in ocean stratification	Reduced productivity of pelagic ecosystems
Changes in coastal upwelling	Changes in productivity of coastal ecosystems and fisheries

Source: Power point presentation of Chiranjiv Choudhary IFS,Commissioner Horticulture and Sericulture, Department of Agriculture,Govt.ofAndhra Pradesh, Hyderabad

Climate Change: Impact on Biodiversity

Vegetation:

- Warming is expected to result in significant shifts in vegetation types.
- Migration of vegetation towards higher altitudes / latitude.
- Non native Invasive species may replace the local species as they are more tolerant.
- Changes in phonological behaviour i.e. early flowering & maturation with shortened grain fill period & consequent less yield.
- Increased incidences of forest fires.

Source: Power point presentation of Chiranjiv Choudhary IFS, Commissioner Horticulture and Sericulture, Department of Agriculture, Govt. of Andhra Pradesh, Hyderabad

Increased pests attack:

Species composition of forest is likely to change:

- Because of changes in soil characteristics, soil moisture in particular, disturbed regimes (i.e. fires, pests and diseases).
- These changes would favor some species over others and thus change the species composition of ecosystems.
- In some areas entire forest types may disappear, while new assemblages of species and hence new ecosystems may originate.
- Climate change is causing many species to shift their geographical ranges, distributions, and phonologies at faster rates than were previously thought; however, these rates are not uniform across species.
- Many terrestrial, freshwater, and marine species have shifted their geographic ranges, seasonal activities, migration patterns, abundances, and species interactions in response to ongoing climate change.

Source: Power point presentation of Chiranjiv Choudhary IFS, Commissioner Horticulture and Sericulture, Department of Agriculture, Govt. of Andhra Pradesh, Hyderabad

Increasing evidences of population decline and localized extinctions attributed to climate change:

- Global warming will have a winnowing effect on ecosystems, filtering out those that are not mobile and favoring less diverse, more 'weedy' vegetation or systems dominated by pioneer species.
- Reductions in species diversity through reductions in habitat patch size.
- Coastal systems & low lying areas will increasingly experience adverse impacts i.e. submergence, coastal flooding & erosion.
- Net loss in Global Biodiversity.

Source: Power point presentation of Chiranjiv Choudhary IFS, Commissioner Horticulture and Sericulture, Department of Agriculture, Govt. of Andhra Pradesh, Hyderabad

Animals:

- Changes in species composition & distribution.
- Extinction of certain endangered / threatened species due to loss of habitat, sea level changes, warming of ocean surface, longer drier spells, availability of food
- **Distorted sex ratio** i.e. more female sea turtles are produced due to high temperature as sex of sea turtle depends on temperature
- Changes in ocean temperature & acidification may cause loss of living corals

Ecosystem:

- ✓ Marine & Coastal Ecosystem
- ✓ Island Ecosystem
- ✓ Inland Water Ecosystem
- ✓ Forests
- ✓ Agriculture
- ✓ Dry land & Grassland Ecosystem
- ✓ Mountain
- ✓ Polar ice & Glaciers

Source: Power point presentation of Chiranjiv Choudhary IFS, Commissioner Horticulture and Sericulture, Department of Agriculture, Govt. of Andhra Pradesh, Hyderabad

- ➢ Climate change is expected to occur at a rapid speed, more than the speed at which ecosystems can adapt and re-establish themselves.
- ➢ Differences in how organisms respond to climate change determine which species or populations will benefit (winners), and which will decline and possibly go extinct (losers) in response to climate change.
- ➢ Loss of habitat during progressive shifts of climatic conditions.
- ➢ Species which have evolved in situ may fail to migrate, particularly endemic species.
- ➢ MILLENNIUM ECOSYSTEM ASSESSMENT (MEA) predicted Climate Change to be the principal threat to biological diversity.
- ➢ 2/3rd of ecosystems (approx.) have declined more rapidly & extensively in past 50 years than at any other comparable time in history.
- ➢ Overall, the impacts of climate change are projected to result in a net loss of global biodiversity and major shifts in the provision of ecosystem services.
- ➢ Living Planet Report (WWF): fall of 30% in health of species & doubling in human demand on biosphere during last 30 years.

Source: Power point presentation of Chiranjiv Choudhary IFS,Commissioner Horticulture and Sericulture, Department of Agriculture,Govt.ofAndhra Pradesh, Hyderabad

1. Impact of Temperature on Crop Production:

With the change in temperature (by 20Cand 40C), the prospect of growing wheat and potato would be severely impaired. Production loss may exceed 60% of the achievable yields.7 Higher temperature has negative effect on soil organic matter also. Every crop has a temperature range for their vegetative and reproductive growth. When temperature falls below the range or exceeded the upper limit then crop production faces constraints. A study6 found that 10Cincrease in maximum temperature at vegetative, reproductive and ripening stages there was a decrease in*Aman* rice production by 2.94, 53.06 and 17.28 ton respectively.

2. Impact of Rainfall on Crop Production of Bangladesh:

It was found8 that1mm increase in rainfall at vegetative, reproductive and ripening stages decreased *Aman* rice production by0.036, 0.230 and 0.292 ton respectively. Scarcity of water limits crop production while irrigation coverage is only56% as delivered by the Bangladesh Agriculture Development Corporation (BADC). Rainfall is one of the major climatic factors for crop production. All crops have critical stages when it needs water for their growth and development. Moreover excessive rainfall may occur flooding and water logging condition that also lead to crop loss.

3.Impact of Sea Level Rise on Crop Production:

Sea level rise affects agriculture in three ways, i.e., by salinity intrusion, by flooding and by increasing cyclone frequency and its depth of damage.
Salinity intrusion due to sea level rise will decrease agricultural production by unavailability of fresh water and soil degradation. Salinity also decreases the terminative energy and germination rate of some plants.9,10 The loss of rice production in a village of Satkhira district wasinvestigated11 and it was found that rice production in2003 was 1,151 metric tons less than the year 1985,corresponding to a loss of 69%. Out of the total decreased production, 77% was due to conversion of rice field into shrimp pond and 23% was because of yield loss. Sea level rise cause inundation of more area which is already reported by scientist. Therefore damage of agricultural crops will be more in future. About 1/3 of Bangladesh or 49,000 sq. km. area are influenced by tides in the Bay of Bengal. Through study it is clear that the inundation coastal inundation area will be increased in future with an adverse effect on crop production. In a study12 found that if sea level rise up to1 meter, normal flood waves can be expected to increase from presently 7.4 meters to 9.1 meters. In Bangladesh, about 15-17 million people will be displaced from the land inundation by sea level rise that will cost 12-16% of total land area.

4.Impact of Flood on Crop Production:

Prolonged floods would tend to delay *Aman* plantation, resulting in significant loss of potential *Aman* production, as observed during the floods of1998. Loss of *Boro* rice crop from flash floods has become a regular phenomenon in the *haor* areas over the recent years. Considering all the direct and induced adverse effects of climate change on agriculture, one may conclude that crop agriculture would be even.Flood has most deleterious effect on crop production of Bangladesh. The 1988 flood caused reduction of agricultural production by 45%.14 higher discharge and low drainage capacity, in combination with increased backwater effects, would increase the frequency of such devastating floods under climate change scenarios.

5. Impact of Cyclone on Crop Production:

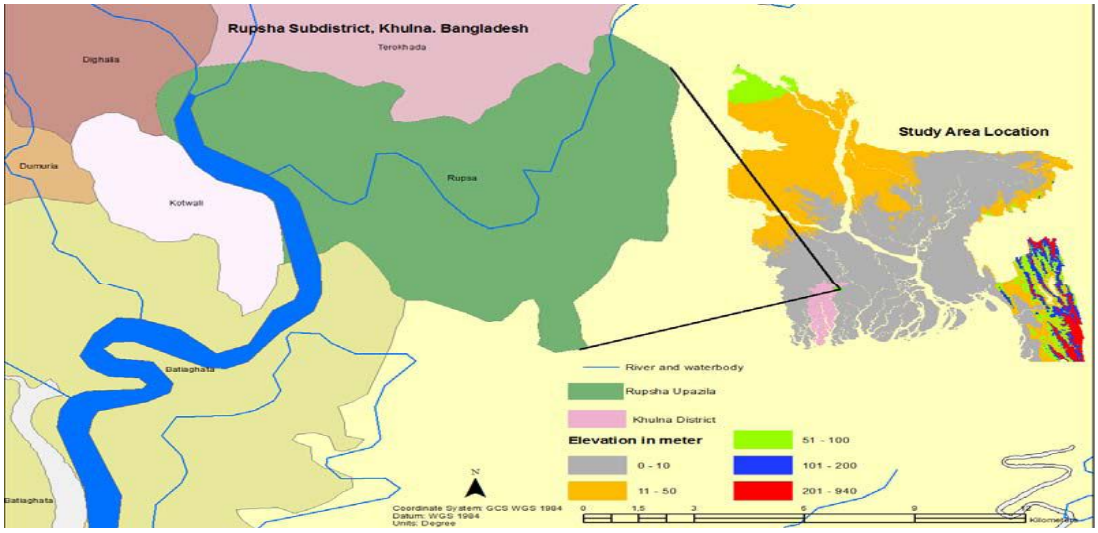
According to the estimate by Department of Agricultural Extension of Bangladesh, the loss in rice equivalent is at some 1.23 million tonnes, with 535,707tonnes in the four severely affected districts, 555,997tonnes in badly affected 9districts and 203,600 tonnesin moderately affected 17 districts in Bangladesh.Cyclone cause huge damage to production of crop.FAO/GIEWS Global Watch (2007)16 reported at the time of the passage of cyclone SIDR, the main 2007 "*aman*" rice crop, accounting for about 70% of the annual production in the most affected area, was nearing harvest.

6. Impact of Drought on Crop Production Due to Climate Change:

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

According to **IPCC** Report (2007), effect of sea water intrusion in the estuaries and into the groundwater would be enhanced by low river flow, sea level rise and subsidence. The adverse effects of sea water intrusion will be significant on southern agriculture and the availability of fresh water for public and industrial water supply will fall. Agriculture is a major sector of Bangladesh's economy and the southern area of Bangladesh is very fertile for growing rice. Increase in salinity intrusion and increase in soil salinity will have serious negative impacts on agriculture. The presently practiced rice varieties may not be able to withstand increased salinity. The food production does not seem to have a better future in the event of a climate change. In Bangladesh, rice production may fall by 10 % and wheat by 30 % by 2050 (Climate change in Asia 'too alarming to contemplate'-report, IPCC, 2007).

According to **Haque** (2007), the main obstacle to intensification of crop production in the coastal areas is seasonally high content of salts in the root zone of the soil. The salts enter inland through rivers and channels, especially during the later part of the dry (winter) season, when the downstream flow of fresh water becomes very low. During this period, the salinity of the river water increases. The salts enter the soil by flooding with saline river water or by seepage from the rivers, and the salts become concentrated in the surface layers through evaporation. The saline river water may also cause an increase in salinity of the ground water and make it unsuitable for irrigation. Coastal areas of Bangladesh manifest different climatic and non-climatic vulnerabilities such as tropical cyclones, salinity intrusion, and endemic poverty. As part of the coastal region, the communities also endure frequent climatic disasters such as the tropical cyclones of 2007 and 2009 and flooding. Figure 2 shows the location of the study area in context of Bangladesh.



Source:Marc A Rosen (25,March 2015, Accepted 19 June 2015, Published 30 June 2015)

Fig-2.2: Frequent climatic disaster context of Bangladesh.

Table-2.1. Major natural disaster events and impacts in the study location between 1987 and 2009.

Year	Disaster	National Impacts	Immediate Local Impacts
1987	Flood	40% area affected, 2055 killed, $727,500,000 economic loss	Loss of rice production.
1988	Flood, Cyclone	63% area affected, 2137 killed, $2,137,000,000 economic loss	Agricultural loss (mostly "Boro 1" and seasonal vegetables), Human casualties (5708 people in whole cyclonic region), Loss of shelter, Long term food shortage.
1991	Cyclone	138,000 killed, $1,780,000,000 economic loss	Complete damage of "Boro" production, Loss of shelter.
1994	Cyclone	400 people killed, economic damage data not available	Agricultural and shelter loss.
1995	Cyclone	650 people killed, economic damage data not available	Agricultural and shelter loss.
1997	Cyclone	126 killed, economic damage data not available	Agricultural loss.
2000	Flood	24% area affected	Loss of rice production, Loss of shrimp production, Aquaculture loss, Water logging, Intrusion of saline water.
2002	Flood, High tide, Heat wave	10% area affected	Agricultural loss, Loss of shrimp production, Loss of shelter.
2004	Flood	37% area affected	Loss of agriculture, shrimp and shelter, Salinity intrusion, Water logging
2005	Cyclone, Cold wave	Data not available	Shelter loss, Loss of standing crops.
2006	Cyclone, Tidal surge, Flood	Data not available	Agricultural damage, Salinity intrusion, Short term food shortage.
2007	Flood (2 times), Water logging, Cyclone	50% area affected by flood, 1230 killed, $114,000,000 economic damage 4275 killed by cyclone, $2,300,000,000 economic loss	Human casualty, Loss of infrastructure, Loss of shelter (80% of the houses), Loss of both "aman 2" and "boro" (nearly 100% of the crops), Loss of shrimp and aquaculture (nearly 100%), Long term food insecurity, Loss of livelihood security e.g., income and employment.
2008	Cyclone, Flood, Heat wave, Tidal surge	55 killed, economic damage unknown	Loss of standing crop, Salinity intrusion.
2009	Cyclone	197 killed, $270,000 economic loss	Loss of shelter (50% of the houses), Salinity intrusion, Loss of standing crop (nearly 80% of the total crop), Food shortage.

Source:Marc A Rosen (25,March 2015, Accepted 19 June 2015, Published 30 June 2015)

Table -2.2. Capacities of community to adapt impacts of natural disasters.

Community Asset Dimensions	**Components of Capacities**	**State after Cyclone Sidrin 2007**	**State after 1 year of Sidr 2008**	**Explanation**
1. Physical	Land use	Decreasing (−)	Decreasing (−)	Rice to shrimp farm conversion occurs steadily.
2. Social	Education	No changes	Increasing (+)	No apparent impacts
	Government supports	Increasing (+)	Increasing (+)	Government support increasessteadily through safety netprogrammes.
	Loan	Decreasing (− −)	Increasing (+ +)	Cash loan flow reduced after climaticevents because everybodyneeds money.
	Peer support	Increasing (++)	Increasing (+)	Peer support other than cash loan increases after a climatic shock.
3. Economic	Shrimp farming	Increasing (+)	Increasing (+)	Saline water intrusion encourages shrimp farming.
	Rice farming	Decreasing (−)	Increasing (+)	Saline water intrusion reduces ricefarming.
	Home stead gardening	Decreasing (−)	Increasing (++)	Soil and water salinity prevents homestead agriculture.
	Microcredit	Increasing (++)	Increasing (+)	Lack of cash loan from peer groupsincreases microcredit flow.
	Income	Decreasing (−)	Increasing (+)	Agriculture, fish pond, and rice fields destroyed.
4. Environmental	Natural vegetation	Decreasing (−)	Increasing (+)	Natural vegetation degraded after aclimatic event
	Rivers, canals and pond	Decreasing (−)	Decreasing (−)	Even one year after a climaticevent, rivers and ponds wereincreasingly silted and salinized.
	Soil	Decreasing (− −)	Decreasing (−)	Soil salinity increases.
5. Infrastructural	Roads	Decreasing (−)	Increasing (+)	Road conditions gradually improve.
	Market and market access	Decreasing (−)	Increasing (+)	Local market access improves

Source: Field Survey Data, 2009, 2011; (scale: +/− small increase/decrease, ++/−− significant increase/decrease).

A direct consequence of sea level rise would be intrusion of salinity with tide through the rivers and estuaries. It would be more acute in the dry season, especially when freshwater flows from rivers would diminish. According to an estimate of the Master Plan Organization, about 14,000 sq km of coastal and offshore areas have saline soils and are susceptible to tidal flooding. If some 16,000 sq km of coastal land is lost due to a 45 cm rise in sea level, the salinity front would be pushed further inland. The present interface between freshwater and saline water lies around 120 to 160 km inland in the southwest, and this could well be pushed northward as far as central Jessore region in the event of a sea level rise (BIDS/ADB 1994).

Agriculture is one of the most vulnerable systems to be affected by climate change in the south Asian region. The climate in Bangladesh is changing. It is becoming more unpredictable every year and its variability is being experienced more frequently than ever before. Hazards like floods, droughts, cyclones and others are likely to be aggravated by climate change. Salinity intrusion would be a more acute problem in the coastal region. This will have extra bearing on the agriculture and the potable water in that region. The salinity conditions in the coastal area of Bangladesh could further exacerbate due to reduced dry-season freshwater supply from upstream sources resulting from climate change (IPCC, 1998) and saline water intrusion due to sea level rise.

According to **Briefing Report-2008** (Climate Change and Agriculture in Bangladesh Information), Sea level rise affects agriculture in three ways, i.e., by salinity intrusion, by flooding and by increasing cyclone frequency and its depth of damage. Combined effects of these three factors decrease agriculture production in the coastal zone. Salinity intrusion due to sea level rise will decrease agricultural production by unavailability of fresh water and soil degradation. Salinity also decreases the terminative energy and germination rate of some plants. The loss of rice production in a village ofBarisal district was investigated and it was found that rice production in 2003 was 1,151 metric tons less than the year 1985, corresponding to a loss of 69%. Out of the total decreased production, 77% was due to conversion office field into shrimp pond and 23% was because of yield loss.

According to **Sikder** (Climate Change 2007: Synthesis report), the study reveals that the crop yield would be negatively impacted by rise in temperature, erratic rainfall, flooding, droughts, salinity, etc. and among which water logging and drainage congestion are the major problems. The ecological conditions are more vulnerable which is very likely to be alerted though slowly but surely due to climate change and sea level rise. Dependency on fertilizer and irrigation is increasing which leads to permanent fertility loss of the land, loss of biodiversity, extinction of local varities, ground water scarcity, loss the sustainability of production. However, adaptations to climate change like agronomic manipulations, sustainable climate-resilient agriculture, shifting the planting dates, using short duration crop cultivars can reduce vulnerabilities, delay the process and increase food security.

Cyclone cause huge damage to production of crop. Food and Agriculture Organization/ GIEWS Global Watch (2007)16 reported at the time of the passage of cyclone SIDR, the main 2007 "*Aman*" rice crop, accounting for about 70% of the annual production in the most affected area, was nearing harvest. According to the estimate by Department of Agricultural Extension of

Bangladesh, the loss in rice equivalent is at some 1.23 million tonnes, with 535,707 tonnes in the four severely affected districts, 555,997 tonnes in badly affected 9 districts and 203,600 tonnes in moderately affected 17 districts in Bangladesh.

According to **Walker and Steffen** (1997), it is believed that climate change would increase the disparities in cereal production between developed and developing countries. The production in the developed world would benefit from climate change, while those in developing nations would decline (Walker and Steffen, 1997). Farm level adaptation would be inadequate in reducing the disparities. Even an extensive farm-level adaptation in the agricultural sector would not entirely prevent such negative effects. In general, the tropical and subtropical countries would be more vulnerable to the potential impacts of global warming through effects on crops, soils, insects, weeds and diseases. On the other hand, elevated carbon-di-oxide (CO) concentrations will have beneficial effects on crop production. Impacts of climate change would cause enhanced vulnerability to the crop production systems in Bangladesh.

In Our Country Sea level rise cause inundation of more area, damage of agricultural crops will be more in future. About 1/3 of Bangladesh or 49,000 sq. km. area are influenced by tides in the Bay of Bengal. It is clear that the inundation coastal inundation area will be increased in future with an adverse effect on crop production. If sea level rise up to 1 meter, normal flood waves can be expected to increase from presently 7.4 meters to 9.1 meters. In Bangladesh, about 15-17 million people will be displaced from the land inundation by sea level rise that will cost 12-16% of total land area.

Since IPCC-AR4 scientific understanding of impacts of climate change has progressed significantly. These studies, amongst others, take advantage of developments in climate and scientific modeling to provide a more specific picture of current impacts and predicted changes over the next several decades. For example, Stanford researchers recently published analysis in *Nature* documenting that from 1980-2008, due to rising global temperatures, global maize and wheat production has already decreased by 3.8% and 5.5% respectively (Label] et al., 2011).

It's a factor of continuing emissions of greenhouse gases and other anthropogenic factors are likely to result in significant changes in mean climate and its intra-seasonal and inter-annual variability in the Asian region. Bangladesh, it is being in South Asia, is one of the most vulnerable countries regarding the impacts of climate change.

The variability of climate change has become a challenging issue for agriculture. Agricultural crops of Bangladesh are especially sensitive to the different variables of climate such as temperature, rainfall, humidity, day-length etc. as well as different natural disasters including floods, drought, salinity, storm surges etc.

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It is Challenging issue of the variability of climate change has become more and more for agriculture. Agricultural crops of Bangladesh are especially sensitive to the different variables of climate such as temperature, rainfall, humidity, day-length etc. as well as different natural disasters including floods, drought, salinity, storm surges etc.

Adaptive capacity is the potential or ability of a system, region, or community to adapt to the effects or impacts of climate change. Enhancement of adaptive capacity represents a practical means of coping with changes and uncertainties in climate, including variability and extremes. In this way, enhancement of adaptive capacity reduces vulnerabilities promotes sustainable development (Goklany, 1995; Burton, 1997; Cohen *et al*. 1998; Klein, 1998; Rayner and Malone. 1998; Munasinghe, 2000; Smit *et al.*, 2000).

It is scientifically based sustainable adaption practices are essential to cope up with the changing Climatic conditions. Otherwise, it will be very difficult to make communities more resilient towards adverse impacts of climate. The main objective of the article is to suggest suitable adaptation techniques that have the potential to help farmers to adapt climate change. These include, amongst others, identification of suitable cropping patterns, choice of seeds, management of irrigation, and intensification of crop. Therefore, the research analyses the changing pattern of climatic parameters, mainly temperature (monthly and yearly average of maximum and minimum temperatures) and rainfall for the selected regions. It also focuses on the impacts of climatic variability (changing temperature and rainfall pattern) on crop production.

3. Changes in Maximum and Minimum Temperature and Rainfall:

The rainfall variability and distribution, and changes in temperature may cause the most disruption to crop yields. Temperature, as noted earlier, **is** significant for physiological processes of a crop, particularly affecting phases such as pollination and grain filling, and basic photosynthesis. Accordingly, high temperatures, lasting over a series of days or an extreme spike of several hours, can have negative effect on these processes, with consequential implications on yields. The botanists state that extreme heat events of even short duration duringflowering or pollination can severely reduce harvest (Araus et al., 2008; Semenov and Halford,2009).

Yet the major models that have been developed to date to evaluate the impacts of climate changes on agriculture cannot **factor** in well the temperature dependency of these key variables and thus may lead to underestimation of the **potential impacts** of rising temperatures on agricultural production and yields (Stanford University, 2009). Moreover, some writers

also call into question an ˙over-optimistic reliance" on the potential for increased CO2 concentrations to counter **the** yield-reducing effects of increasing temperatures (for example, see Long et al., 2005 and Long et al., 2006.

3.3 Southern region

On an average, the total change of monthly average maximum and minimum temperature for the particular months except November has increased by nearly about 1°C during this period. The yearly average maximum and minimum temperature has increased at the rate of 0.02°C and 0.014°C respectively. The monthly average maximum temperature has increased at the rate of 0.015°C per year. Moreover, increasing trend is particularly significant for the months between of April and December except November. The changing pattern of rainfall in each year is found to increase by 5.47 mm and 2.90 mm in monsoon and post-monsoon season respectively. The rainfall during monsoon and post-monsoon seasons has increased whereas it decreased in winter and pre-monsoon seasons at southern region in Bangladesh.

3.4 Impacts of Changing Climatic Parameters on Crop Production:

Monthly average maximum and minimum temperatures have decreased at a significant rate in all selected regions in January during the years of 1976-2008. The rate of change is comparatively higher in central region which might have adverse impact on crop production in future particularly in this area. Furthermore, it has also been observed from the data of 33 years that the monthly average maximum and minimum temperature has fluctuated during the period of January to **April** which might play a negative role on *robi* season when maximum cereals are being grown. A considerable amount of production may be lost due to this climatic variability. A field-based study carried out in 1990 shows that very high grain sterility (40-90%) due to unusual fall of temperature in Marchresultsin crop failure in some regions of Bangladesh (Hug*et al.*,1999).

On an average, both monthly average maximum and minimum temperature have increased each year at a rate of 0.02t during May to October. The increased rate of temperature might have a significant negative impact on *kharif* crops and a part of *rob!* crops in future. Islam (1995) shows that the higher minimum temperature during the ripening phase affected the grain yield significantly. In his study, multiple regressions between grain yield and temperature and solar radiation reveals that higher mean temperature at vegetative stage affects grain yield too. According to Satake and Yoshida (1978), spikelet sterility from high temperature is induced largely on the day of flowering.

The present research demonstrates that yearly average maximum and minimum temperature have increased in all selected regions. The increased rate of temperature also has an effect on moisture availability for the growth of the crop growth, whether or not levels of rainfall have remained unchanged. Rowntree *et al.* (1989) conducted an experiment at mid-

latitudes and found that evaporation increased by about 5 percent for each degree centigrade of mean annual temperature. Moreover, most

agricultural diseases have greater potential to reach severe levels under warmer conditions. Fungal and bacterial pathogens are likely to increase in severity in areas where precipitation increases. Under warmer and more humid conditions, cereals are more prone to diseases such as Santeria (Beresford *et al.,* 1989).

Similarly to the temperature, rainfall patterns have also changed over the years. A considerable amount of rainfall has increased during monsoon and post-monsoon seasons, whereas, it has decreased during pre-monsoon and winter periods. The changing pattern might have a significant negative impact on crop production for the selected areas in the upcoming year. Studies relating to changing rainfall pattern and water requirement of crops show that variability of rainfall affects crops at different times. If variability is associated with an untimely cessation at the reproductive or ripening stage of the rice crop, yield reduction is severe (Moomaw and Vergara, 1965). The irrigation requirement during different months of the crop-growing period is a function of rainfall deficits in those months (Talukder *et al,*, 1994).

Therefore, rainfall deficit information **for** different areas and periods can greatly help determine water release from sources (ground orEffects of Climate Change on Crop Production and Climate Adaptive.

In view of the above literature I can conclude that Agriculture is the most vulnerable sector because the productivity totally depends on climatic factors. On the other hand we can say Crop production is adversely influenced by, sea level rise rainfall, temperature extremes and increased soil alkalinity, floods, river erosion, and storm surges, cyclone and drought. All those factors increase as a result of climate change. Increased extreme weather events and sea level risehas the potential to increase the demand on the agricultural sector whilst limiting the amount ofcultivatable land. Soil PH value causes unfavorable environment and hydrological situation thatrestrict the normal crop production all over the year. The effect of the tides is manifested in a regular alternation of rise and fall of the water level of the sea. The saline river water may also cause an increase in salinity of the ground water. Sometimes it may become unsuitable for irrigation. Scarcity of irrigation water can be a problem especially during the winter season. It may have negative implication of the yield of B*oro* rice. It affects crops depending on degree of soil acidity and alkalinity at the essential stages of growth. It affects yields and in some cases total yield may be lost.

Physical changes associated with Climate Change Potential Ecological Consequences associated with these changes:

Observed or Projected Physical Change	**Potential impacts on Biodiversity**
Increased ambient temperature	Species and population range shifts and/or changes in phenology leading to alteration or loss of biotic interactions
Changes in annual & seasonal precipitation	Changes in community composition
Increased frequency of extreme events	Mortality resulting from flooding, after storms or drought events; damage or mortality resulting from deep freezes or heat waves
Changes to hydrologic regimes	Reduced stream flow affecting population persistence and community composition
Changes to fire regimes	Changes in community composition
Ocean acidification	Change in water chemistry affecting calcification rates of marine organisms
Sea level rise	Habitat loss and fragmentation affecting population persistence
Increases in ocean stratification	Reduced productivity of pelagic ecosystems
Changes in coastal upwelling	Changes in productivity of coastal ecosystems and fisheries

Climate Change implications at global context:

- Annual mean surface air temp rise is projected from 3.5^{o}**C** -4.3^{o}**C** at the end of this century.
- India is included in the category of "extreme risk" countries in climate change vulnerability index (13th position).
- Stress on the land and water resources.
- Threat to ecosystems and biodiversity.
- Yields of major crops are expected to decline thereby affecting food security.
- Greater vulnerability to extreme climate events like typhoons, cyclones, droughts and floods, particularly in coastal areas.

- Potential for drier conditions in arid and semi-arid parts of India.

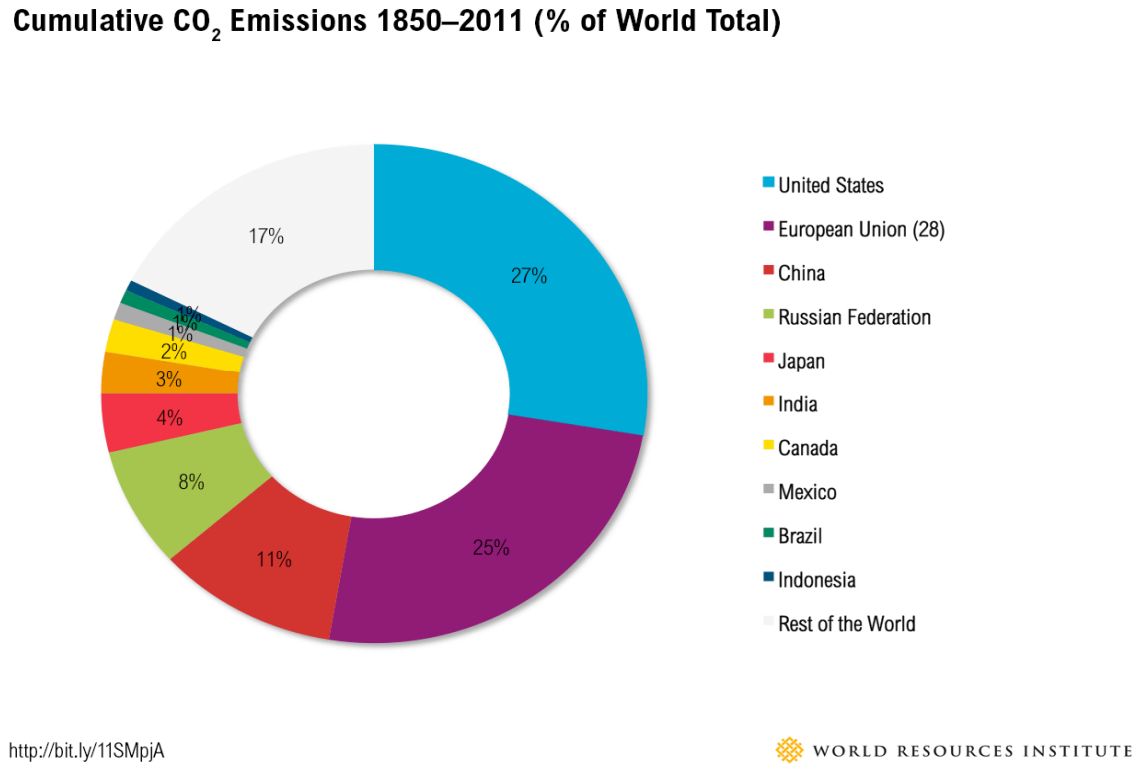
Source: Power point presentation of Chiranjiv Choudhary IFS, Commissioner Horticulture and Sericulture, Department of Agriculture, Govt. of Andhra Pradesh, Hyderabad

Table-2.3: Comparison of India's per capita GHGs emission with other countries

Country	Per capita CO_2 emissions	% of Global share
USA	20.6	19.0
UK	9.8	2
GERMANY	9.8	2.8
JAPAN	9.9	4.0
CANADA	20	2
CHINA	3.8	23
BRAZIL	1.8	1.1
SOUTHAFRICA	9.8	1.5
INDIA	1.2	6.0

Cumulative CO_2 Emissions (1850 – 2011) % of World Total

Source: Power point presentation of Chiranjiv Choudhary IFS,Commissioner Horticulture and Sericulture, Department of Agriculture,Govt.ofAndhra Pradesh, Hyderabad



Source: Power point presentation of Chiranjiv Choudhary IFS, Commissioner Horticulture and Sericulture, Department of Agriculture, Govt. of Andhra Pradesh, Hyderabad

Table-2.4: Comparison of Per Capita Emission of Developing countries with World & OECD

Country	**Per capita CO_2 emission in Tonnes**
World	04.5
Organization for Economic Cooperation & Development (OECD)	11.5
Developing Countries	02.4

Per Capita Emissions (2005)

Source: Power point presentation of Chiranjiv Choudhary IFS,Commissioner Horticulture and Sericulture, Department of Agriculture,Govt.ofAndhra Pradesh, Hyderabad

2.3 Global position on Climate Change:

- Per capita emission will never exceed that of the developed countries (total emission is estimated to be 4,000 – 5,000 million tonnes & per capita emission of 3-4 tonnes in 2030).
- India cannot & will not take on emission reduction targets.
- Poverty reduction/eradication, social & economic development are priorities.
- Each human being has equal right to global atmospheric resource (Principle of Equity).
- Common but differentiated responsibility.

- Respective capabilities.
- India will continue to be a low carbon economy (World Bank Study).
- Developed countries should take lead in addressing Climate Change in accordance with historical responsibility (Polluter Pays principle).
- India will work with other developing countries & push for further emission reduction & equity by developed nations.
- Developed countries must implement their commitments under convention towards developing countries.
- Finance (Green Climate Fund).
- Technology development & transfer.
- Capacity building support for mitigation & adaptation.
- Primary focus on adaptation with specific niches for mitigation.
- Only those Nationally Appropriate Mitigation Actions (NAMAs) can be subject to international monitoring, reporting & verification that are enabled & supported by international finance & technology transfer.
- India advocates Collaborative Research in future low carbon technology & access to IPRs as global public goods.
- Comprehensive approach to Reduction of Emissions from Deforestation & Forest Degradation by including conservation & sustainable management of forests (REDD+)

Source: Power point presentation of Chiranjiv Choudhary IFS,Commissioner Horticulture and Sericulture, Department of Agriculture,Govt.ofAndhra Pradesh, Hyderabad

3.4 INTERNATIONAL INITIATIVES:

- Prime Minister's National Council, National Action Plan on Climate Change, National Steering Committee on Climate Change, Expert Group on Low Carbon Strategies for Inclusive Growth.
- State Action Plan on Climate Change
- PM's Council is a high level advisory group with the following objectives;
- Coordinate National Action Plan for assessment, adaptation & mitigation of Climate Change
- Advise government on pro-active measures to deal with challenges of CC
- Facilitate inter-ministerial coordination & guide policy in relevant sector.

Mission	Objectives /Actions
National Solar Mission	20,000 MW by 2020
Mission for Enhanced Energy Efficiency	10.000 MW of Energy Efficiency by 2020, Energy Auditing of large industrial consumers, promotion of Biofuels
Mission for Sustainable Habitat	Energy Efficiency in Residential & Commercial buildings by implementing **Energy Conservation Building Code** (2007) &

	Incentives for retooling exDrought proofing, Risk Mgt, Focussed Agriculture Research isting Buildings, Compliance to ECBC is incorporated in EIA requirements for large Buildings, Public Transport, Solid Waste Management, Technology for Power generation from wastes,
Green India Mission	Drought proofing, Risk Mgt, Focussed Agriculture Research
Mission for Sustainable Agriculture	Vulnerability Assessment, Research & Develop Water Conservation & River Basin Mgt. Increasing Water use efficiency by 20% across all sectors, Setting up of National Bureau of Water Use Efficiency, Water Resources Information System, Water Harvesting & artificial recharge, Conservation of Wetlands
Mission for Sustaining Himalayan Ecosystem	Conservation & Adaptation practices, Mission has established Centre for Glaciological Studies, Study commissioned by Ministry in collaboration with ISRO for monitoring of Himalayan Glaciers
National Water Mission	Water Conservation & River Basin Mgt. Increasing Water use efficiency by 20% across all sectors, Setting up of National Bureau of Water Use Efficiency, Water Resources Information System, Water Harvesting & artificial recharge, Conservation of Wetland.

Source: Power point presentation of Chiranjiv Choudhary IFS, Commissioner Horticulture and Sericulture, Department of Agriculture, Govt. of Andhra Pradesh, Hyderabad

- Establishment of a Network of Research Institutions for National Communications (NATCOM) on climate change (131 institutions).
- 24 other critical initiatives for which detailed plans & institutional framework have been put in place.
- Energy Efficiency in Power Generation (super critical technologies, Gas based power plants, Nuclear power program, efficient transmission & distribution etc).
- Other Renewable Energy Technology (Biomass based generation technologies, small hydro-power, wind energy etc).
- Protection of Coastal Area (enhanced plantation & regeneration of Mangroves & coastal forests, salinity tolerant).
- Crop cultivars, measures for coastal protection, early warning system & timely forecast of cyclone & flood, community awareness on coastal disasters, high resolution storm surge models.
- Health Sector.
- Creating appropriate capacity at different levels of the Government.
- Disaster Management Response to extreme climate events.
- Reducing risk to Infrastructure-better design, strengthening of communication network & Disaster Response Management, community capacity building.
- Voluntary mitigation actions to pursue low carbon pathways.

- Domestic mitigation goal of reducing emission intensity of GDP by 20-25% by 2020 at 2005 level.
- Mainstreaming climate change concerns in Planning & Policy formulation.
- Proactive participation in multilateral negotiations.
- Engaging with emerging economies i.e. BASIC.
- Engaging with like minded developing countries.

  Source: Power point presentation of Chiranjiv Choudhary IFS,Commissioner Horticulture and Sericulture, Department of Agriculture,Govt.ofAndhra Pradesh, Hyderabad

3.5 Implications for Bangladesh:

We know that Bangladesh is very much Vulnerable to climate Change. So the implications are given below.

- One of the largest delta in the world with highest population density.
- Highly vulnerable to various types of natural disasters.
- Climate Change & Environmental Risk Atlas (2015) places Bangladesh as the most vulnerable country in the world besides rating 32 other countries under 'extreme risk' category in climate change vulnerability index.
- Insignificant or virtually zero contributor to GHG emission that affect global climate change (487.50 mt ,0.3% of global total).
- Adverse impact due to.
- High temperature resulting in increased intensity & frequency of cyclones, tidal surges causing coastal flood & erosion, water logging, increased salinity.
- Sea level rise.
- Acidification of ocean.
- Cyclone & storm surges.
- Salinity intrusion.
- Heavy monsoon down pour / Flood / Cyclone.
- Decrease in arable land – reduced crop production – Food security?
- Adverse impact on Fisheries sector – Food & livelihood security?
- Impact on Water resources & Hydrology.
- With rise in sea level up to 1 mtr – Bangladesh could lose 15% of its land area affecting 30 million people in coastal region.
- Impact on flora & fauna of Sunderbans (475 species) & coastal areas (Biodiversity of Mangrove is at riseForced Displacement of population causing social tension.
- Damage to infrastructure.
- Threat to environmental security.
- Food security & livelihoods.
- Health concerns.
- Economic Growth.
- Due to submergence of low areas & increase in salinity).

  Source: Power point presentation of Chiranjiv Choudhary IFS,Commissioner Horticulture and Sericulture, Department of Agriculture,Govt.ofAndhra Pradesh, Hyderabad

3.6 Global Practices:

- Public Transport: Use of Biofuels, **Mass Rapid Transit System (BRTS, Metro),** Hybrid & electric vehicles.
- Increasing share of clean energy (wind power has trebled & solar energy has increased by ten times in last 10 years in USA).
- Reducing carbon pollution from power plants by putting in place Carbon Pollution Standards.
- Halt deforestation of natural forests.
- Restoration of degraded forests & agricultural land.
- Make connected & compact cities as preferred form of urban development (Climate Smart Cities/ Climate Smart Urbanization).
- Phasing out of subsidies for fossil fuels, agriculture inputs & incentives for urban sprawl.
- Strengthen enforcement of forest & environment governance.
- Disaster resistant & Sustainable city planning (Tulsa, Oklahoma) by banning development in flood plains, re-locating structures to safer zone with public-private partnership.
- Carbon Neutral: Samso island (Danish) achieved carbon neutrality & now generates more electricity from renewable resources than their requirement.
- The C40 cities Climate Leadership Group - a network of world mega cities addressing climate change by sharing technical expertise on best practices.
- Low carbon Building design: Addis Ababa (Ethiopia) using this technology in construction programme to shift large population from unplanned area to formal living.
- Congestion Charging Scheme: being practiced in Central Business district of London since 2003 which had led to reduction of over 70,000 vehicles per day cutting Carbon emission by 15%.
- Solid Waste Management (Zero Waste): San Francisco plans to move to zero waste by 2020, already it recycles or composts 77% of its waste.
- Urban green Planning: Sydney has planned a scheme to have every resident with in 250 m walk of continuous green links that would connect to major city parks.
- Climate Smart Agriculture.
- System of Rice Intensification (SRI).
- Application of organic fertilizer.
- Integrated Pest Management (IPM).
- Weather based crop insurance.
- Agro-forestry.
- Water conservation i.e. Drip, sprinkler, water harvesting structures.
- Clean Energy Ministerial: increase share of clean energy, energy efficiency, diversity of renewable energy resources.

Source: Power point presentation of Chiranjiv Choudhary IFS,Commissioner Horticulture and Sericulture, Department of Agriculture,Govt.ofAndhra Pradesh, Hyderabad.

3.7Conclusion:

In this chapter Literature Review here the impact of climate on agriculture and impact of temperature, impact of rainfall on crop production of Bangladesh that was reported by the

government. organization BADC. On the other hand impact of sea level rise on crop production, impact of flood on crop production, impact of cyclone on crop production. Here the IPCC Report (2007), the repot of Haque (2007). There is an important report that is included in the forms of table 1987 and 2009.Here I inserted capacities of community to adopt impacts of natural disaster. Here I included the briefing report- 2008. Sikder (Climate Change -2007), the Walker and Steffen(19997).It is believed that climate Change would increase the disparities in cereal production.

CHAPTER-3

Impact of climate change on cropping and seasonality in THE STUDY AREA:

3.1 Introduction:

This chapter sets out the Geography and demography of the study. It has got 13 (Thirteen) sections. The first section describes the geography, while the second section demography, and the other sections are as follows Physical infrastructure of the study area,Communication facilities of my study area ,Seasons versus climate change ,Land use in agriculture, the socio economic condition of the study area, Cropping season and cropping pattern, Kharif-1season (Aus), The Kharif-2 (Aman), The Rabi, The cultivation of Vegetables .This chapter ends to conclusion.

Chapter-3 is called the study area. My study area is selected is on the basis of vulnerability of disaster like natural disaster .Here I tried to the best of my ability to establish my opinion by researching the real phenomenon .In the southern region of Bangladesh Barisal is an important district.In Barisal district the Banaripara upazila is important. In this chapter geography, demography,the physical infrastructure of the study area.The concepts of climate , the socio-economic condition of my study area the cropping season ,the general information of Banaripara Upazila that I included . I expressed the research activities by systematicways in this chapter.

3.2 Geography:

Banaripara is located in the western part of Barisal District. The upazila is located between 22 °45′ and 22 ° 52′ North latitudes and between 90 °02′ and 90 °13′ East longitudes. The river Sandha has run though the middle of the Upazila making fertile land on both side of the river. The distance from the district town is 26 kilometer.The total area of the upazila is130 square km of which 9 km is river.

3.3 Demography:

The total no. of population is1,48,188 (UNO office).The population density is 2858 /sq- Mile. The literacy rate is 67%.Population growth rate in the upazila is -0.31%.

3.4 Physical infrastructures of the study area:

The total area of Banaripara is 134.30 sq-km, including 9 sq-km wide river. It consists of 8 Union Parishads and one pourasoova. 77 mouzas and 77 villages (UNO). The River Sandha crossed across the middle of the upazila making both side of the river enriched with fertile clay soil.

3.5 Communication facilities are: The upazila is connected with District and other neighbour upazila with Pucca road. The communication system within the upazila includes 23 kilometer pucca,6 km semi pucca road and 266 km mud road.The main transports within the upazila are bus,trucks,auto rickshaw,country boat and launch.

3.6 Season Versus Climate:

Climate Change refers to change in the state of climate that can be identified (by using statistical tests) by changes in the mean and /or the variability of its properties that persists for an extended period.

Mainly three seasons is observed. Rainy season starts from may and lasts till October. More than 90% rainfall occurs during this period. Winter starts in November and ends in February. Winter starts 15 days later and ends 15 days earlier than Northern part of the country. Summer exists between March and April. Weather is very extreme during this period. Sometimes winds blows with high speed from South-western corner of the country which is localled ‘Kal Baisakhi’ storm. Hail storm is common during this time. The lowest temperature is observed during December and January month which is 20^0C on an average. The extreme hot temperature is recorded 41.1^0C in April and the extreme cold is recorded up to 5.6^0C in February. The Earlier rainfall record shows that the average monthly rainfall in winter (November-February) is very low accounting only 21 mm whereas the average rainfall is 389 mm during June to September. The annual rainfall is 2180 mm. Continuous rainfall for 7-10 days is a recent phenomenon in the locality. In July month in 2015, 180 mm rain is recorded in a single day in Banaripara (UAO, Banaripara).The temperature below 15 ^{0}C prevails for 50-70 days from 4 December to 4 February. The annual rainfall is 2180mm.

Map-3.1: Map of Banaripara Upazila

3.7 Land use in Agriculture:

Land use	Area (hectare)
Total cultivable land	10,450
Net cropped land	1075
Permanent fallow land	199
current fallow land	560
single cropped land	3185
Double cropped land	5491
Tripple cropped land	1416
Total cropped land	10,450

Farm family of Banaripara:

Type of farm family	Number of farm family
Large farm family	308
Medium farm family	1658
Small farm family	8110
Marginal farm family	9526

Land less farm family	2906
Total farm family	22,873

3.8The Socio-economic condition of my Study Area:

The status of primary occupation of the household heads largely varies. Percentage of people is involved in agriculture is 35% and agricultural wage laborer 20%. Moreover, people are involved in fishing. Fishing is the second dominant livelihood strategy like the agriculture labor. Fishing is predominant livelihood strategy at. The rest of the people are involved in fish business, rickshaw pulling, country boat driver, running small shop. Livestock is an important property and its ownership patterns cross culture have some significance as far as rights and social status is concerned. In Banaripara about 40% HHs have livestock and 30% households do not rear any livestock. Households having poultry and cows are more evident in this area. More and more people are being involved in livestock farming as farmers finds it less risky the field crops. Further livestock and poultry gives farming gives farmer more profit than agriculture from the same areas of land.(ULO, Banaripara) About 98% of the households in Banaripara have to use pond water for the purpose of drinking, cooking and washing..But still a majority portion of people use pond or canals water for washing clothes or utensils which makes them vulnerable to water born disease. (Upazila public health office).

3.9- Cropping Seasons:

We know that Food supply varies according to the season, with domestic food supplies being and high rice prices. scarce during the lean seasons in March–April and October–November, prior to harvesting. The lean seasons are characterized by a lack of agricultural employment opportunities, low agricultural wages. The Farmers themselves are changing their cropping pattern within their land plots. Farmers in study area sow pulses, oilseeds, potatoes and vegetables on the plots previously in rice-wheat. Commonly used 2-crop combinations are Aman-Boro rice, Aman-Aus rice and Aman-Boro rice.

3.9.1- Cropping: Seasons and Patterns

Rice	Sowing Period	Harvesting Period
Aus	Mid March to mid April	Mid July to early August
Aman-Broadcast	Mid March to Mid April	Mid November to Mid December
Aman-Transplanted	End June to early September	December to early January
Local	Mid November to mid	April to May
Boro	January	
Boro-HYV	Dec to mid Feb	Mid April to June

Table 3.1: Sowing and harvesting period of different varieties of rice (Source: FGD & KII)

There are mainly three cropping season,Rabi,kharip-1,and kharip-2.

Season	Start time	End time	Main feature
Rabi	Mid October	Mid-March	Dry season with low temperature
kharip-1	Mid March	Mid-June	Extreme hot weather
kharip-2	Mid June	Mid-October	Rainy season

3.9.2-Kharif-1 Season (Aus)

Kharip-1 season is locally called Aus Season. This season is characterized by unreliable rainfall and varies in timing,frequency and intensity from year to year, and provides only an intermittent supply of moisture for such crops as broadcast Aus, amaranths, teasel gourd, etc. The relative lengths and frequency of such periods depend on the timing and intensity of pre-monsoon rainfall during this season in individual years. During this transition period, soils intermittently become moist and dry. Aus is the main crop of Kharip -1 season .Due to climate change cultivation of aus rice is becoming a challenge for the farmers of Banaripara. Aus is cultivated with limited rainfall water ..In some cases farmers depend on surface canal water for irrigation .Due to heavy siltation and upstream low flow of water ,these canals are often found lack in sufficient irrigation water. In addition due to high temperature and limited supply of water farmers find it's difficult to prepare difficult to prepare seedbed. Further, transplanted aus seedlings are often damaged by continuous rainfall .For these reason aus cultivation is losing popularity day by day. However, newly developed short duration early aus varieties are getting popularity among farmers. For example BRRI dhan 27 and ,BRRI dhan 48,BRRI dhan 55 are getting much more popularity among farmer. These varieties are short duration and high yielding .Due to short duration these varieties can easily escape sudden flood. In some cases they can easily survive in adverse climatic condition.

Table-3.1: Some Modern aus varieties cultivated in the study areas:

Name of varieties	Life cycle(days)	Yield(ton/ha)	Special feature
BRRI Dhan 55	105	5	Salinity and drought tolerant.
BRRI Dhan 48	110	5.5	High yielding and short duration.
BRRI Dhan 27	115	4	Suitable for low land.
BRRI Dhan 26	115	4	High yielding and short duration

Table-3.2:Cultivation of HYV and local aus varieties in the study areas:

	HYV Aus		Local Aus	
Year	Cultivate areas(\Ha)	Total production(MT)	Cultivated areas(Ha)	Total production MT
2014-15	80	192	300	390
2015-16	90	216	285	370
2016-17	95	247	270	351
2017-18	110	286	250	325

***The above graph/table reflects that although the cultivation of High Yielding adaptive varieties are increasing in the areas, the cultivation of local aus varieties are decreasing in the areas. Hence, the total cultivation areas including HYV and Local are decreasing and

consequently the total yield of Aus rice are decreasing. These decreasing trend might be due to adverse climatic condition like early flood, high summer temperature. On the other hand cultivation of modern varieties are increasing due to their adaptive capacity to adverse environment.

Table-3.3: Different Vegetable cultivated in Banaripara in Kharip-1 season:

Name o crops	2013-14		2016-17	
	Total cultivation(Ha)	Total production	Total cultivation	Total production (MT)
Amaranth	21	315	25	375
Kangkong	20	120	25	275
Sweet gourd	21	630	25	750
Bittergourd	35	700	40	800
French bean	10	100	15	180
Aroids	8	150	10	200
Okra	35	350	40	400
Ridge gourd	38	450	40	480
Snake gourd	36	370	40	520
Spinach	21	400	25	625

The above table tells that the average production of different vegetable increased from 2013-14 to 2015-16.The reason behind this trend might be development of newer varieties which are adaptive to the changing climatic condition. Some vegetables like kangkong, sweet gourd, French bean, acaroids and amaranth are naturally adaptive to slightly saline condition. Due to development of hybrid vegetable, farmers are getting more production which brings them good profit. Due to adverse climate cultivation of rice fails to bring sufficient benefit for farmer. On the contrary farmers are getting more benefit by cultivating vegetable as compared to cultivating field crops. This may be another fuel which encourages farmer to cultivate more vegetable.

3.9.3:The Kharif-2 (Aman)

In my study area Aman (Mid -July to Mid October) starts from May when the moisture supply and from rainfall. Other factor is soil storage is enough to support rained or un-irrigated Kharif crops.Actually we can calculate the season begins on the date from which precipitation continuously exceeds 0.5 . When the combination of precipitation plus an assumed 100 mm of soil moisture storage after the rainy season falls below 0.5 PET. It is logical Potential Evapo-transpiration(PET) and ends on the date. During the greater part of this season, precipitation exceeds full PET and water can be held on the surface of impermeable soils by bunds. So when the period of excess precipitation is called the humid period.

In the aman season the crops most extensively cultivated during the Kharif-2 season that are called the broadcast Aman, Transplant Aman, sesame, different kinds of summer vegetables,

ginger, turmeric, pepper, green chilli, different kinds of aroids, cotton, mungbean, black gram, etc. Most Kharif-2 crops.Here it is subject to flood in areas without the controlling water.

Aman is the main field crop in the locality. Due to recent change in the atmosphere, farmers of Banaripara are losing interest in cultivating amon. Majority of cultivable land of Banaripara is medium low land which remains under water for 3-6 months. As a result it becomes difficult to find suitable land for cultivation of high yielding varieties (HYV) rice as it requires high land to cultivate HYV rice which are short in height as compared to local varieties. Further due to continuous precipitation during the season farmers find it difficult to cultivate local varieties as well. Sometimes seedbeds and transplanted seedlings are damaged due to continuous heavy rainfall. The hopeful thing is that scientists have developed some tolerant varieties of rice which are getting popular day by day among farmers of the locality. Although the climatic factors are in against amon cultivation in the areas, farmers consider cultivating amon rice cost effective as it requires less fertilizer. Further farmer can easily grow amon rice without any artificial irrigation. Limited application of fertilizer couple with free rain water have made aman cultivation popular in the locality.

Table-3.4: List of some tolerant modern varieties cultivated in Banaripara upazila:

Name of Varieties	Cultivated areas(ha)	Salient feature	Comments
BRRI dhan-22	25	Photo sensitive	Suitable to cultivate after flood
BRRI dhan-23	20	Photo sensitive	Cultivable after flood
BRRI dhan--33	1	Early variety,short duration	Can escape flood
BRRI dhan--51	1	Can survive under water for 15 to 30 days	Suitable for flood prone areas
BRRI dhan-52	350	Can survive under water for 15 to 30 days	Suitable for flood prone areas
BRRI dhan-40	5	Can tolerate 8-10 DS/Meter salinity	Stable for salinity prone areas
BRRI dhan-41	85	Can tolerate 8-10 DS/Meter salinity	Stable for salinity prone areas
BRRI dhan-44	94	Cultivate in tidal land	suitable for non saline tidal land
BRRI dhan-62	20	Zn rich,early variety	Can escape flood
BRRI dhan-76	2	Tall Varieties	Suitable for low land

BRRI dhan-77	1	Tall Varieties	suitable for low land

Soure: DAE, Banaripara

Due to unfavorable situation in the aman season, the above rice varieties are getting popularity aman farmers in the study areas.

Table-3.5: A comparative table showing cultivation of local and HYV rice during amon season:

Year	HYV Varieties		Local Varieties	
	Cultivated areas(ha)	Production(Mt)	Cultivated areas(ha)	Production(MT)
2014-15	450	1800	5350	15,900
2015-16	525	2100	5255	15,700
2016-17	550	2300	5200	15600
2017-18	625	2670	5050	15,250

******The table shows that although the overall production of aman rice is increasing in the locality, the production of local varieties amon rice is decreasing. However, cultivation areas and production of HYV is increasing in the areas. As the cultivable land is decreasing each year, it is rational to be decreased the cultivation areas in the study areas. On the contrary, the areas under cultivation of HYV rice in Banaripara showincreasing trend. Due to invention of tolerant varieties, the areas under HYV cultivation is increasing. Due to frequent natural calamities, the tolerant rice varieties are getting popular day by days in the areas. Khesari is a popular pulse crops, which is cultivated as Relay Crops in aman fields. Some improved tolerant khesari like BARI Khesari-1 is getting farmer consideration in Banaripara Upazila.
On the other hand sessame was a vital crops in Banaripara upazila in the past. But currently farmers are losing interest in cultivation sessame due to continous loss in cultivation sessame. This loss is mainly for continuous damage of sessame by heavy rainfall in early summer season.

3.9.4: The Rabi:

Rabi (16- October to 15- March) season starts at the end of the humid period and laststo the pre-kharif-1 season. We can calculate The mean length of the Rabi growing period range from 100-120 days. But in the extreme west, to 140-150 days . In the case of northeast of the country.me Rabi season ranges from 1-10 October in the extreme west in the mean date , 1-10 November in the Northeast.In this it is calculated central and eastern coastal areas. Last date that range from 1-10 February in the following year in extreme west to 20-31 March in the Northeast. Finally Rabi or winter common crops are, sweet potato, sugarcane, lentil, chickpea wheat, maize, Boro rice, mustard, groundnut, sesame, potato, grass pea etc. On lowlands, very lowlands and bottomlands where flooding continues even after the end of rainy season. According to the cropping calendar Rabi season starts from the date when the ends of flooding .

Table-3.6: Some important field crops grown in Banaripara in Rabi season are given in the table:

Name of crops	Areas under cultivation(Ha)

	2016-17	2015-16	2014-15
Boro	5735	5600	5550
Wheat	20	160	200
Maize	25	35	24
Potato	182	180	170
Sweet potato	45	50	65
Mustard	60	55	40
Vegetable	975	800	776
Lentil	60	55	54
Black gram	52	50	55
Mungbean	210	210	200
Chilli	175	170	155
Onion	5	10	16
Sessame	20	35	40

Source: DAE,Banaripara,

As can be seen from the above table Boro rice is the main field crops in Banaripara.Due to favorable weather condition cultivation of Boro rice is increasing in the area.
The following table shows the cultivation of HYV,Hybrid and local varieties of boro rice in the Banaripara Upazila.

Table-3.7: HYV and local cultivated areas.

Year	Cultivated Areas(Ha)		
	HYV	Local	Hybrid
2014-15	3800	350	1200
2015-16	3950	260	1350
2016-17	4075	210	1450

The above table shows that the cultivation of HYV and hybrid boro rice is increasing in the study areas. Due to invention of high yielding tolerant varieties of boro varieties, the cultivation of modern boro rice is increasing. On the contrary the cultivation of local boro rice varieties are decreasing noticibly. The reason might be lower yield of local varieties. The cultivated boro rice varieties with their salient features are given in the table:

Name of arieties	Characteristics	Comment
BRRI dhan-28	High yielding, require low irrigation	Suitable to cultivate in sudden

		flood prone areas
BRRI dhan-29	High yielding	
BRRI dhan-47	Salinity tolerant, cold tolerant, Drought tolerant	Suitable to cultivate in the salinity affected areas
BRRI dhan-58	High yielding	
BRRI dhan-55	Salinity,drought,cold tolerant	
BRRI dhan-74	High yielding	Could be cultivated as alternate to BRRI dhan-47

There are number of hybrid rice varieties developed by research organization which have drawn farmers interest to be cultivated in the season throughout Banaripara upazila. The main problem facing by the farmer is lack of irritation water. Farmers mainly rely on surface sweet water from canals for irrigation. But these canals remain almost dry in the winter season which hamper Boro cultivation.

As Aman rice are cultivated late in the areas, it becomes difficult for the farmers to cultivate Boro rice in time which hamper yield of rice. In addition due to late cultivation of Boro rice, early flood and irregular rainfall damage the boro rice during Rabi season. Despite Boro cultivation is increasing in the upazila as currently farmers are getting actual price for rice Government on the other hand encouraging farmer to produce more boro rice in the areas as Boro could be cultivated in the areas with surface sweet water without disturbing the underground water. But the main problem farmers suffering in the area is lack of sufficient machineries for irrigation.

Wheat is another major crops cultivated in my study areas . But currently the cultivation of wheat is decreasing due to high temperature. A couple of years ago wheat was cultivated into 200 hectare of land, whereas currently wheat is cultivated into only 20 hectare of land. The reason behind these dramatic change is **rude climatic environment**. Due to global warming, winter is becoming shorter for the last couple of years which hampered the yield of wheat tremendously. Consequently farmers lose their interest in cultivating wheat in the areas. Cultivation of onion has also lesson recently due to short duration of winter.

Farmers lost their interest in cultivating sessame due to damage caused to sessame by early flood in late march.On the other hand cultivation of some other Rabi crops like mustard, maize Chilli, pulse crops have increased in the recent years. Presently developed new mustard varieties like BARI Mustard-15, And BARI Mustard-17 are short varieties which could be cultivated early in late October. Cultivation of early varieties of mustard can easily escape flood or high temperature in March.

3.10: Cultivation of Vegetable:

Mainly vegetable is cultivated in winter in my study area. Although the land and climate of Banaripara are in disfavor of vegetable cultivation, the vegetable production has increased dramatically in recent decades. Due to low lying wet land farmers find its challenge to grow early winter vegetable. As land remains occupied with amon rice till mid January, it becomes harder for farmer to grow early winter vegetable as field crops. In recent years farmers are facing unusual climatic environment like sudden rain in November-December which drastically hamper early winter vegetable cultivation a lot. Despite farmers cultivate winter vegetable in raised bed system which locally called 'Sarjan' method. As farmers do not get sufficient benefit by cultivating rice, vegetable cultivation is becoming popular in the locality. Farmers get better profit by cultivating vegetable rather than cultivating other field crops. In addition due to availability of hybrid /high yielding seeds of different vegetable, farmers can make more profit than before by cultivating those. As management of vegetable is easier than field crops, farmers find it less risky to cultivate in adverse climatic condition. Vegetable is cultivated in 1200 hectares of land in Banaripara. More than 90% vegetable is cultivated in winter in the area. A limited summer vegetable is grown in the locality either on gher land or on 'sarjan'

Table-3.8: The major winter crops grown in the locality are depicted in the table:

Name of Vegetable	Cultivate areas(Hectare)		
	2014-15	2015-16	2016-17
Brinjal	12	15	18
Tomato	23	25	26
Cauliflower	45	50	52
Cabbage	41	40	43
Radish	42	45	46
Lau (Bottle gourd)	55	60	65
Sweet gourd	70	75	72
French bean	15	15	18
Cucumber	25	25	27
Ridge courd	22	20	27

The above table tells us that the average production of vegetable in the areas is increasing. The reason behind this trend might be greater profit as well finding vegetable cultivation less risky as compared to field crops in changing climate.

Crop calendar in Banaripara:

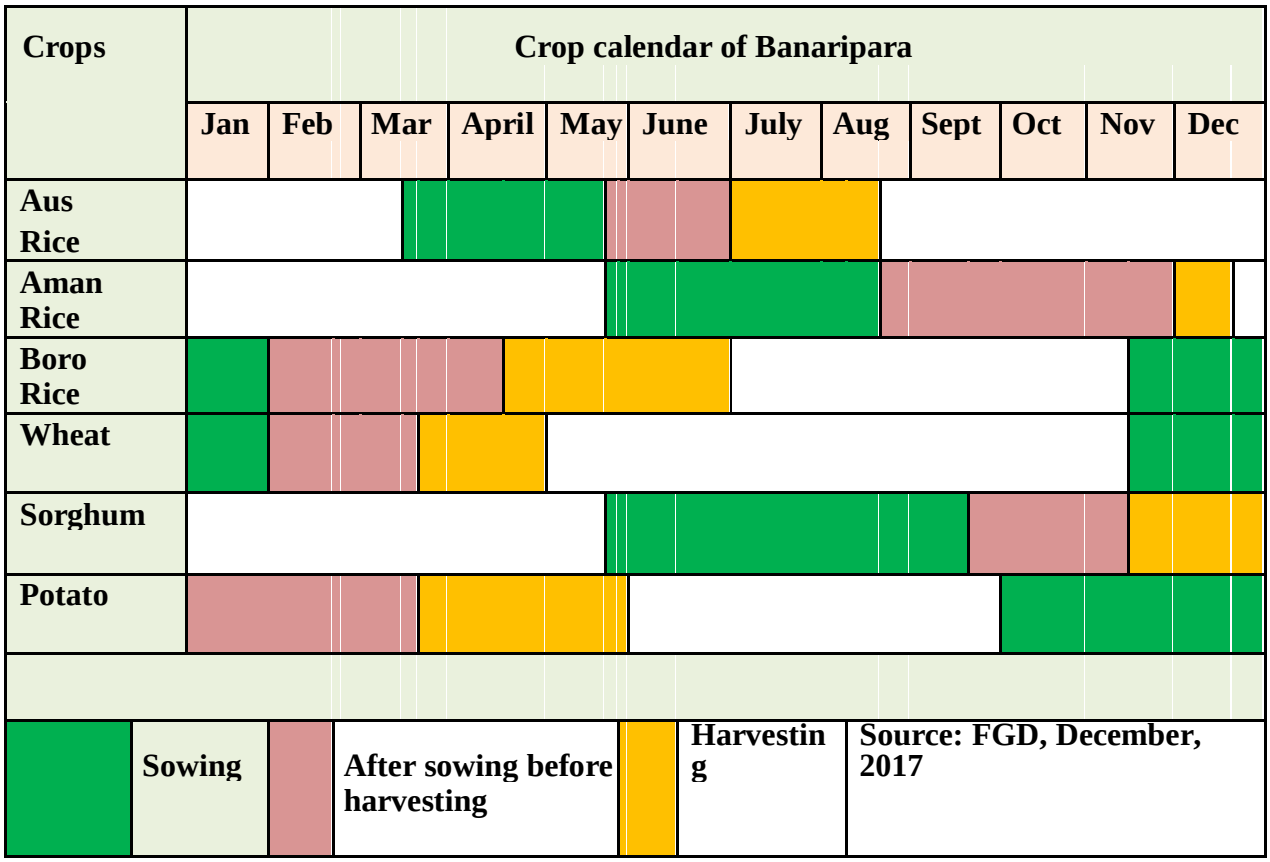


Figure 3.1: Crop calendar of Banarippara (**Source: FGD, December, 2017)**

3.12: Conclusion:

Considering the demands and needs of natural resource management, a comprehensive study on present situation on the effect of climate change on natural environmental livelihood of the people and different other problems constraining climate change was carried out to find out possible ways for mitigating the problems the ensuring sustainable climate change management in the upazila. After my study the following major issues were identified which are responsible for the degradation of land resources and sufferings in human live and livelihoods: a) The most alarming situation found in the Banaripara Upazila was valuable agriculture land had markets , industries ,roads and other development infrastructures. b)Soils in the low lying areas remainswet for the most of the time in dry season limiting intensive crop cultivation especially in the rabi reason. c) Scarcity of surface water for irrigation and higher cost different agricultural machinery and equipments in the local markets are the major problems for intensive irrigation in the area and d) During field survey it was found that most of the old canals of the Banaripara Upazila had been closed due to unplanned human interventions like construction of houses markets and other infrastructures which were creating barriers to naturals flow of water and thus ultimately had created drainage congestion in the study area.

CHAPTER 4
IMPACTS OF CLIMATE CHANGE:

4.1: Introduction:

This chapter sets out the Effect of sea level rise of the study. It has got 8 (Eight) sections. The first section the effect of sea level rise, while the second section is drainage congestion. The sections are as follows The soil ph value ,discontinuous rainfall, frequent storm and cyclone , the Range of temperature and policy &institutional arrangements. This chapter ends with the conclusion.

Here this chapter identifies some national steps that can help to reduce the effect of climate change. The national and International level the following steps can play important role for mitigate the effect of climate change. These are as follows:

- Developed countries should take lead in addressing Climate Change in accordance with historical responsibility (Polluter Pays principle).
- Technology development & transfer.
- Only those Nationally Appropriate Mitigation Actions (NAMAs) can be subject to international monitoring, reporting & verification that are enabled & supported by international finance & technology transfer
- Developed countries must implement their commitments under convention towards developing countries.
- The world advocates Collaborative Research in future low carbon technology & access to IPRs as global public goods.
- Poverty reduction/eradication, social & economic development are priorities.
- The world will work with other developing countries & push for further emission reduction & equity by developed nations.
- Comprehensive approach to Reduction of Emissions from Deforestation & Forest Degradation by including conservation & sustainable management of forests (REDD+).
- The world will continue to be a low carbon economy (World Bank Study).
- Per capita emission will never exceed that of the developed countries (total emission is estimated to be 4,000 – 5,000 million tonnes & per capita emission of 3-4 tonnes in 2030).
- Each human being has equal right to global atmospheric resource (Principle of Equity).
- Common but differentiated responsibility.
- Respective capabilities.
- Finance (Green Climate Fund).
- Capacity building support for mitigation & adaptation.
- Primary focus on adaptation with specific niches for mitigation.
- Advise government on pro-active measures to deal with challenges of CC.
- Facilitate inter-ministerial coordination & guide policy in relevant sector.

- Coordinate National Action Plan for assessment, adaptation & mitigation of Climate Change.
- Prime Minister's National Council, National Action Plan on Climate Change, National Steering Committee on Climate Change, Expert Group on Low Carbon Strategies for Inclusive Growth.
- PM's Council is a high level advisory group with the following objectives.
- State Action Plan on Climate Change.

We know that the physiology is controlled by climatic factor. The climatic factors are rainfall, temperature extremes, increased salinity, drought, floods, river erosion, and tropical storms etc. From the focus group discussion, literature review, Key informant interview, personal experience and observation, data collection from government Agriculture Extension office I have found

some positive and negative trends in the cropping pattern in Banaripara.
The negative trends are as follows:The findings of this paper have greater implications for devising climate change impacts adaptation policies as well as managing and mitigating the impacts and reducing vulnerabilities of local communities. It is important to focus on the key factors of vulnerability such as exposure to hazards or stressors, susceptibility (or fragility), societal response capacities, and lack of resilience. In order to make adaptation to climate change impacts effective, it is also important to consider the complexities of the impacts and the different orders of vulnerability. Therefore, the formulation of future adaptation policies should consider the non-linear, cumulative, and multi-order nature of climate change and the vulnerability of communities. In conclusion, the authors recommend the following adaptation measures for the consideration of policy-makers and climate change adaptation actors:

- Excavate and re-excavate canals, rivers, and ponds to protect agricultural lands that are being
- Improving access to and diversifying livelihood sources/assets.
- Providing local communities with good physical infrastructure such as roads and access to markets.
- Develop and empower community-based organizations to provide effective social network
- Provision of financial support to smallholder farmers during the cropping season and long-term support after natural disasters. The financial support should be carefully designed so that the farmers will not be heavily indebted.
- Services during and after natural disaster disasters. In cooperation with local institutions such as
- Provision of access to health services, especially for the poor.
- Invaded by saline water during high tide.
- Union Councils, local communities should work as brokers of social networking through the
- Build protective walls to prevent saline water from entering ponds when cyclones strike.
- provision of knowledge, information, and advisory services.(Sustainability 2015,7)

4.2: The Impact of Sea Level Rise:

Due to sea level rise the sea water enters into river water and then it mixed with sweet water. For this reason the sweet water of river become tasty water. High content of salts there is a serious problem to crop production. The water level of Banaripara upazila is higher than the previous year.
According to the speech of FGD and the according to the UAO every year the water level is changing. The stagnant water is a seaman problem for source crops for the problem. The Boro rice cultivation is seriously affected (FGD, common).

The main effects of sea level rise on water resources are fresh water availability reduction by salinity intrusion. The main obstacle to intensification of crop production in the southern areas is seasonally high content of salts in the root zone of the soil. The salts enter inland through rivers and channels, especially during the later part of the dry (winter) season, when the downstream flow of fresh water becomes very low. During this period, the salinity of the river water increases (FGD, common). The salts enter the soil by flooding with saline river water or by seepage from the rivers, and the salts become concentrated in the surface layers through evaporation. The saline river water may also cause an increase in salinity of the ground water and make it unsuitable for irrigation.

The increase in water level of these areas has created suitable habitat for floating cultivation. Along with other factors, floating cultivation played a major role to increase water level, particularly (FGD & KII – Bisherkandi). A direct consequence of sea level rise would be intrusion of salinity with tide through the rivers and estuaries. It would be more acute in the dry season in Banaripara, especially when freshwater flows from rivers would diminish (KII-UEO).
Sea level rise will increase flood frequency and flooding duration, affecting Aman production. Due to sea level rise, salinity of water and soil will increase, and this will damage Aman cultivable land. Agricultural lands in the southern area will be affected by salinity; soil quality will be degraded and flooding event will loss the agricultural production. Sea water and water logging, are possible reduction of Aman and Boro paddy area due to longer duration of flooding and restriction in irrigation. Due to Sea Level Rise the High Yielding Verities of Aman paddy would start losing increasing amount of suitable land for cropping in Banaripara. So the farmers of Banaripara are losing their crops every year due to climate change.

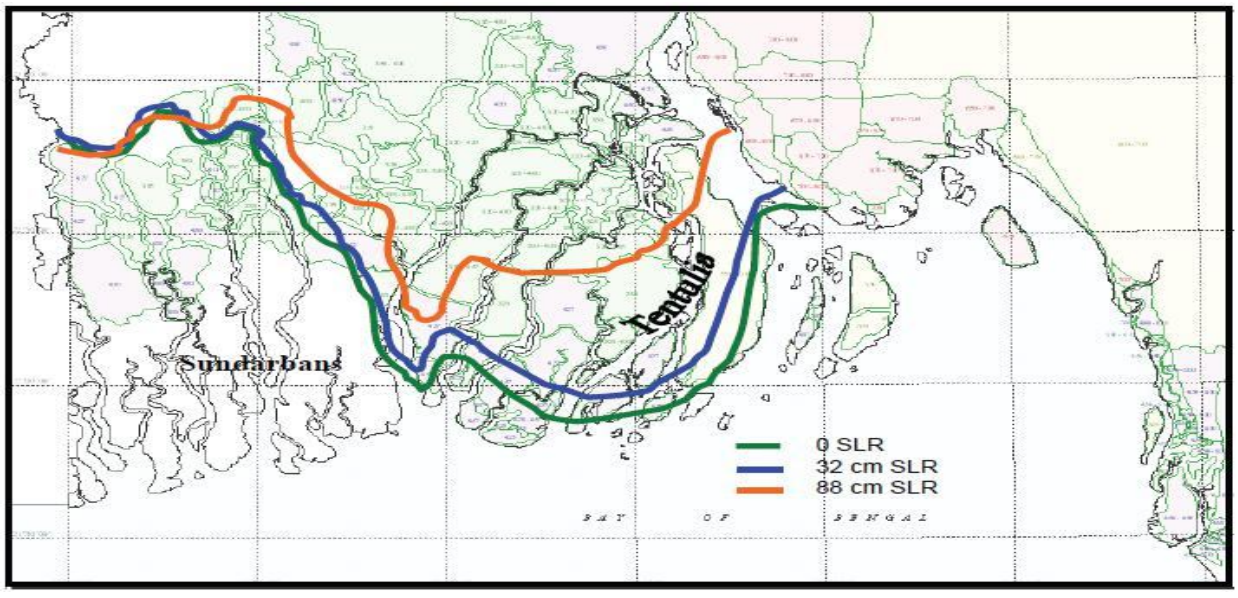


Fig-4.1: Sea level rise scenarios (Source: IWM, 2005).

Lack of fresh water for cultivation they are interested to shrimp cultivation (FGD, common). When the rice fields are converted into floating ponds, total rice production decreases because of decreased rice field areas. Farmers couldn't produce two rice crops during the year, as one vegetation cycle was used for floating cultivation instead of crop production. Thus sea level rise will have an impact on agricultural production.
Both water and soil salinity in Banaripara will be increased with the rise in sea level, destroying normalcharacteristics of southern environment.
On the other hand salinity levels have already increased in domestic ponds, groundwater supplies and agricultural land, through the various estuaries and water inlets intertwined with Major River.

The sea water weather decreases the longevity of the houses. People are going to other places for work and earn money. Sea water weather makes the life difficult. The cultivable lands lose its fertility day by day. Its fertility as a result of crop diminishing at quick rate people migrate different places in search of livelihood. Those who are remaining there are facing the problem of cultivation and other purposes. Salinity bounds people to migrate (FGD, common).

4.3: Drainage congestion:

The drainage congestion is a great problem. Become the threat climate change is drainage congestion. When the heavy rainfall occurs then the water stagnant may be lengthy. For this reason this water will strong some days. The drainage problem when serious the pulse crops go under waters. According to the speech of (FGD) the water will not go lacking well drainage system. It is a problem of climate change.

Drainage congestion may become a serious threat due to climate change. It is being a grave problem due to the combined effect of siltation, subsidence, and poor maintenance of the drainage channel networks in many parts of the southern zone. It is aggravated by reducing natural drainage capacity (*World Bank, 2000*).

The tidal floodplain has a distinctive, almost level landscape crossed by innumerable interconnecting tidal rivers and creeks. The estuarine islands are constantly changing shape and position as a result of river erosion and new alluvial deposition. Peat basins are located in some of the low lying areas between the Ganges river floodplains and tidal floodplains occurring in the western part of Khulna (Karim *et al.*, 1982).

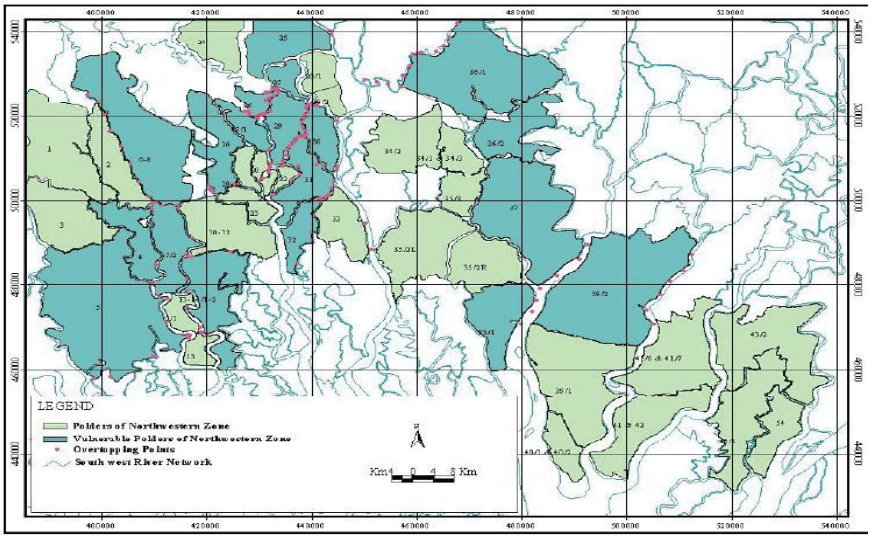


Fig-4.2: Drainage congestion effects due to SLR (Source: IWM, 2005)

Perennial water-logging due to inadequate drainage and faulty operation of sluice gate facilities restricts potential land use of the low lands within the embankment areas.

4.4: Soil PH Value:

When the Aman crops in the field then sometimes the river water enters into field. When the salts water enters into field then the soil become alkaline. When this soil become alkaline the PH value of these area become rich. Then the field crops color become in pale (FGD).

For this reason the total yield of the area becomes reduce. According to the seed dealers and the villagers they said due to change of soil quality some vegetables are not grown in this area. The farmers are trying to adapt by using HYV.

Salinity ingress also causes an increase in soil salinity, especially when farmers irrigate their lands with slightly saline surface water at the beginning of the low flow period. SRDI (1997) reported that, soil salinity levels south of Khulna, Bagerhat and Bariasal ranged between 8 to 15 ds/m during the low flow season. The anticipated results of salinity ingress will be, at a minimum, of the same order for climate change induced low flow regime compared to similar effects. The anticipated sea level rise would produce salinity impacts in three fronts: surface water, groundwater and soil. Increased soil salinity due to climate change would significantly reduce food grain production.

Even at present, some parts of southern lands are not being utilized for crop production, mostly due to soil salinity; and this situation would aggravate further under a climate change scenario. Under the changed climate conditions, the index of aridity would increase in winter. Consequently, higher rates of capillary action from an increased rate of topsoil desiccation would accentuate the salinity problem. Salinity problem received very little attention in the past. Nevertheless, symptoms of such land degradation with Stalinization are becoming too pronounced in recent years to be ignored.

In the saline soils rice, sugarcane, pulses, oilseeds, spices, vegetables and fruits are grown, but their contributions to cropping intensity vary greatly with Banaripara. Local transplanted Aman rice (July-November) is the dominant crop in Banaripara. During wet season, local Aman rice is grown extensively in Banaripara with normal yields between 2.5 and 3.0 tons per hectare. Transplanted Aman-fallow is the most dominant cropping pattern. Winter crops, such as wheat, potato and vegetables are grown, which cover a small area (KII, UEO & seeds dealer).

Adopting of HYV rice cultivars varied considerably. Some coverage of HYV rice during Aman season is also found in Banaripara. But almost no HYV Aus rice is grown here and Hybrid is very absent. However, there is potential to HYV Aman rice cultivation. The low land use in saline area is mainly due to unfavorable soil salinity in dry season and unavailability of quality irrigation water (FGD & seeds dealer, Bisherkandi).

4.5: Discontinuous Rainfall:

We know that rainfall is a major climatic factor for crop production. It is essential element that we called water. Without the water no plant can survive. So physiologically the crops cannot complete their life cycle without water. Due to taking of rain water some crops in Banaripara is not cultivation. Some stages of crops when need water then they will not get sufficient water. For this reason the yield is seriously affected. According to the speech of FGD and the local people the discontinuous rainfall greatly hampered the vegetables and wheat cultivation.

Rainfall is one of the major climatic factors for crop production. All crops have critical stages when it needs water for their growth and development. Moreover excessive rainfall may occur flooding and water logging condition that also lead to crop loss. It is found that1mm increase in rainfall at vegetative, reproductive and ripening stages decreased Aman rice production by 0.036, 0.230 and 0.292 ton respectively (KII, UEO).

Variability of rainfall, uncertain dates of onset and recession of seasonal floods and risk of drought restrict cultivation of Aus and Aman rice. Uncertain rainfall delays sowing / transplanting and flood damages Aus and Aman crops. Heavy monsoon rainfall causes delay in transplanting of Aman. In the coastal saline belt with short winter season timely sowing/planting of Rabi (winter) crops is essential but this is restricted by late harvest of Aman rice. Many times late rainfall at the end of the rainy season causes great harm of vegetables in Robi season. The farmers cannot cultivate vegetables in due time because of rain water in their cropland due to climate change. For this reason the production of crop decreases day by day. The reason behind this is the changes in the behavior of climatic patterns. Continued wetness of soil due to erratic rainfall, and therefore the sowing time of the crops, is also affected. Various insects and diseases attack rice crops and vegetables (FGD & KII – Fertilizer dealer).In order to reduce the loss burden, it may appear to be necessary to harvest premature standing crops (vegetables, spinach etc.) if there is a threat of such crops being inundated.

4.6: Frequent Storm and Cyclone:

We know that in Bangladesh from mid-March to mid-May is the mostly cyclone prone time. So this time not only cyclone but also storm surge is a present time problem. Due to frequently cyclone and storm surges the problem of crop cultivation is going to seriously to danger. According to views of the FGD groups and local farmers they said the cyclone is a great problem for the crop cultivation.

Now-a-days the storm surge is a serious problem. For this effect the farmers are losing their interest to cultivate crops. The resultant effect of climate change the cyclone and the storm surge is increasing and effecting the crop cultivation in my study area day by day.

Over the last 50 years, 15 severe cyclones with wind speed ranging from 140 to 225 km/hr have hit the coastal area of Bangladesh of which 7 hit in pre-monsoon and rest in the post-monsoon season (FAO/GIEWS Global Watch, 2007). Tropical cyclones are the most talked about climatic events in the subcontinent especially in Bangladesh and India. The coastal area of Bangladesh is more vulnerable to cyclones in the Bay of Bengal Regions.

Cyclone cause huge damage to production of crop. Food and Agricultural Organization/GIEWS Global Watch (2007)16 reported at the time of the passage of cyclone SIDR, the main 2007 “Aman” rice crop, accounting for about 70% of the annual production in the most affected area, was nearing harvest.

4.7: The Range of Temperature:

For the completion life cycle of plants the temperature is an important factor. In my study area I found that the due to higher temperature the wheat cultivation is greatly hampered. The Aus rice is losing their viability. According to the voice of the villagers and the UAO office they demonstrate that the wheat fertilization is greatly disturbed by affecting of temperature.
Globally significant amount of agricultural production being lost every year because of different calamities derived from the above sources. With the change in temperature (by 20˚C and 40˚C), the prospect of growing wheat and potato would be severely impaired. Production loss may exceed 60% of the achievable yields. Higher temperature has negative effect on soil organic matter also (Karim 1996).

4.9: Sustainable Land Management Practices:

Land is the base for crop production. Soil resources of the country are experiencing pressure for increased food production. Increasing cropping intensity and mineralization of soil organic matter exhausts the soils capacity to support crops. Soil Resources Development Institution (SRDI) of the MoA is working to improve soil health and preserve it for future generation.21 The institute prepared Upazilla Land and Soil Resources Utilization Guide for 459 upazillas throughout thecountry that will help farmers to apply fertilizers according to the need based on fertility status of the soil. Moreover, MoA is working with the Ministry of Land to enact proposed Agricultural Land Conservation and Land Use Act, 2011 to safeguard agricultural lands from encroachments for developments. Fertile soil is the prerequisite for better production. Organic manures can increase soil fertility and productivity. The MoA is encouraging farmers to use organic fertilizers like compost, farmyard manure to safeguard soil health. The farmers are advised to use green manure and bio fertilizers instead of chemical fertilizers to sustain soil health. Agronomic practices like intercropping with leguminous crops, reduced tillage, alternate cropping, soil mulching, etc. are applied by the farmers to maintain soil fertility. These actions will reduce the use of chemical fertilizers, thereby mitigate emissions from them.

4.10: POLICY AND INSTITUTIONAL ARRANGEMENTS:

Climate change impacts are not unknown to the policy makers. The National Adaptation Program of Actions (NAPA) provides guidance for adaptation measures taken up to combat climate change impacts. The revised version of National Agriculture Policy of 2011, has included climate change as one of its three priority areas. Some issues related to the impact from temperature rise and variation in precipitation on agriculture needs further attention. The Agriculture Extension Policy of 1996 puts emphasis on sustainable agricultural however and explicit consideration extension of climate resilient variety or cropping pattern need incorporation. Similarly, the Integrated Pest Management Policy of 2002 need to provide guidance on climate change and disaster risk reduction issues. There is an implicit mentioning that the policy should increase self reliance of farmers by promoting locally developed and crop management practices which eventually address adaptation to climate change. National Seed Policy need to put priority on seed production likely to be affected by climate change through technologies.

	Adaptation Options
Management Practices Cropping pattern	• Boro rice-T.aman rice/Jute • Wheat-Mug dal (Pulse)-T.aman/Jute • Chilli-T.aman/Jute • Maize-T.anian/Jute • Mustard-Mug dal (Pulse)-Jute • Mustard-Mug dal (Pulse)-Taman • Sweet gourd-Taman/Jute • Potato-Mug dal-T.amanlJute
Seed	Short duration born ricevarieties —BRRI*dhan2* • Short duration and saline tolerant boro rice varietiesBRR1 *dhun47* • Saline tolerant rice varieties during *kharif* season-BRR1 *dhan40,* BRRI *dhan4* I, BRRI *dhan53,* BRRI *dhan54* • Short duration rice varieties during *kharif* season-BRRI *dhan39,* BRRI *dhan33* • Drought tolerant rice varieties during *kharif* seasonBRRI *dhan42,* BRRI *dhan43* • Saline tolerant jute varieties-CVL-I,HC-95 • Saline tolerant sugarcane varieties-ISWARDI-40 • Low water requirement and short duration wheat varieties-Hash i • Short duration pulse varieties-BARI Mug-6 • Cold tolerant potato varieties-Diamond, Cardinal
Irrigation management	• Supplemental irrigation • Excavation of **mini** ponds and surface water harvesting for supplemental irrigation • Dry seed bed preparation during *kharif* season for Taman rice • Re-excavation of ponds for supplemental irrigation and fish cultivation • Cultivation of wheat for water use efficiency
Crop intensification	• Integrated rice-fish cultivation • Integrated rice-fish-vegetables cultivation • Integrated duck-fish-vegetables gardening (GUK, 2011) • Homestead gardening over the years • Before 15 January for boro rice transplantation • 1 June for T.aman rice transplantation

4.12: Conclusion:

There are many effects of climate change that is always hampering the total vegetation in the world. So in my study area in Banaripara Upazila, in Barisal. The activities that can be followed.To ensure that natural resources and used within their capability. To minimize the impacts arising from the use of natural resources. To ensure that native flora and fauna are properly are protected.To promote appropriate planning and management.To preserve places having cultural heritage values.

In Bangladesh, different climate change induced events such as recurring floods, riverbank erosion, drought in dry season, salinity intuition have been augmenting vulnerability in many regions and leaving impacts on the yields of crops. Contextual analysis suggests that unless urgent actions are taken, climate change will undermine efforts to ensure food security. The research finds that the changing pattern of temperature and rainfall for the selected three regions are significantly higher compared to IPCC prediction over the world in last 100 years, which have considerable negative impacts on crop production. Therefore, location-wise and scientifically based sustainable adaption practices are essential to cope up with the changing climatic conditions. Otherwise, it would be very difficult to make communities more resilient towards adverse impacts of climate change and ensuring food security. From the field study, it is ”observed that most of the farmers of these locations pursue as is available cropping patterns. During kharif season, they have been particularly facing difficulties’ in harvesting their cultivated crops due to climate induced natural events. The study has shown that there has been changing pattern of temperature and rainfall in 33 years (l976 to 2008) in all 18 metrological stations surrounding the selected three locations and the change of those climatic parameters are significant during this period. Considering the main climate induced natural events, adaptation practices in terms of cropping pattern, choice of seed, management of irrigation, intensification of crops and selection of suitable date for transplantation have been suggested to help farmers adapt to climate change. However, it is difficult to confirm a crop as adaptive to climate change situations unless at least three years of experimentation is carried out. The selected crop varieties, irrigation management, cropping pattern, crop intensification and selection of suitable date for rice transplantation for both robi and kharif season are needed to be confirmed by trails.Farmers’ low quality seeds still meet about 95% seed requirement. For quality seed production, they should be given massive training on seed production, preservation, and processing. It is also important to support them through credit supply on easy terms and at low interest rate.

CHAPETR-5

LOCAL ADAPTATION MEASURES TO address CLIMATE CHANGE IMPACTin the study area

Adaptation and Mitigation in Agriculture:

5.1 Introduction:

This chapter sets out the Adaptation of the study. It has got 18 (Eighteen) sections. The first section is adaptation while the second section climate change mitigation and adaptation in agriculture.The other sections are as follows tolerant varieties , short duration crops,heat tolerant varieties,flood tolerant varieties,Short duration varieties,virus tolerant varieties, Sarjan cultivation,Floating seedbed, Delivery of quality seed,crop diversification, conservation of the rain water by using shed, using the pesticide and fertilizer, proper management of land and by using the farmers Innovation idea. This chapter ends with conclusion.

Given the vulnerabilities that Bangladesh faces and their nature and extent, adaptation is the prime need. Agriculture, however, is one of those few sectors where mitigation may also be important. While Bangladesh emits only a very tiny percentage of world total emissions, nevertheless, she is committed to do whatever she can by way of mitigation. Her attempts and thinking on mitigation in agriculture is part of that commitment. We shall discuss these issues in the sub-section after the next.

5.2 Adaptation*:*

How should Bangladesh cope with the vulnerabilities discussed in the preceding section? Of course climate change will have ramifications for many sectors and some of these will reinforce the others while adaptation in one sector may yield benefits for others. Keeping these in mind, and also acknowledging that so far there has been little research on probable impact of climate change on non-crop agriculture, we may delineate the following areas for adaptation in agriculture. Drawing upon the National Climate Change Strategy and Action Plan (NACCSAP), these may be enumerated as follows:

- Development of climate resilient cultivars. This means research to develop varieties which are flood tolerant, resilient to warmer climate, resistant to drought, of shorter maturity so that they may be harvested before the deepening of drought or the full onslaught of floods. Note that the needs of the two main rice seasons are quite different as may be understood from their characteristics as discussed earlier. Both have to be equally emphasized although for somewhat different reasons as we shall point out shortly.
- Not simply new cultivars, the research system shall also have to develop new cropping systems which are climate resilient in the sense that if crops fail fully or partially, planting may be done with other varieties or crops which are more suitable for that period and for that area.

- Research must be carried out to find the resilience of fish and livestock to various climate related stresses and manage them accordingly.
- The agricultural extension systems also needs to be geared up to take upon the challenge.
- Risk management through various means against crop and output failure in non crop sub-sectors becomes a major issue in adaptation. As insurance issues raise the problems of moral hazard and adverse selection, these need to be critically looked at for proper application in case of climate induced risks. Crop diversification is one way to minimize risks and needs to be encouraged although the experiences in this country in this regard is not very positive.
- Early warning becomes a major issue. So is long-range forecasting. If farmers know beforehand that rain is not falling during the next two weeks, their behavior may be different than if they know that it will almost certainly fall. And that save the country from spending huge amount of money for importing food.
- Such forecasting has to be regionally made with smaller grids than at present and be available in real time to all countries and farmers.
- Finally, one has to also have an early warning system for food production and remain ready to import food as the situation demands.

5.3: CLIMATE CHANGE – MITIGATION AND ADAPTATION IN AGRICULTURE:

- ✓ Assist farmers in coping with current climatic risks by providing value-added weather services to farmers. Farmers can adapt to climate changes to some degree by shifting planting dates, choosing varieties with different growth duration, or changing crop rotations.
- ✓ An Early warning system should be put in place to monitor changes in pest and disease outbreaks. The overall pest control strategy should be based on integrated pest management because it takes care of multiple pests in a given climatic scenario.
- ✓ Participatory and formal plant breeding to develop climate-resilient crop varieties that can tolerate higher temperatures, drought and salinity.
- ✓ Developing short-duration crop varieties that can mature before the peak heat phase set in.
- ✓ Selecting genotype in crops that have a higher per day yield potential to counter yield loss from heat-induced reduction in growing periods.
- ✓ Preventive measures for drought that include on-farm reservoirs in medium lands, growing of pulses and oilseeds instead of rice in uplands, ridges and furrow system in cotton crops, growing of intercrops in place of pure crops in uplands, land grading and leveling, stabilization of field bunds by stone and grasses, graded line bunds, contour trenching for runoff collection, conservation furrows, mulching and more application of Farm yard manure (FYM).

- ✓ Efficient water use such as frequent but shallow irrigation, drip and sprinkler irrigation for high value crops, irrigation at critical stages.
- ✓ Efficient fertilizer use such as optimum fertilizer dose, split application of nitrogenous and potassium fertilizers, deep placement, use of *neem, karanja* products and other such nitrification inhibitors, liming of acid soils, use of micronutrients such as zinc and boron, use of sulphur in oilseed crops, integrated nutrient management.
- ✓ Seasonal weather forecasts could be used as a supportive measure to optimize planting and irrigation patterns.
- ✓ Provide greater coverage of weather linked agriculture-insurance.
- ✓ Intensify the food production system by improving the technology and input delivery system.

5.4: Tolerant varieties:

The many research institute of Bangladesh is working heart and soul for developing resistant variety. We know that the agriculture of Bangladesh is mostly famous in the world for their activities. There are many natural disaster in Bangladesh. The disaster is occurring for the effect of climatic change. To overcome this situation tolerant variety is important element. In my study area to adapt this climate change effect they are using tolerant crops varieties (FGD).As it mentioned in the earlier section that the farmers are cultivating different tolerant varieties ofcrops to cope with changing climatic environment. Pest and disease is another phenomenon which farmers are facing currently due to climate change. Scientist of BARI have developed numbers of crop varieties which are being cultivated in the locality with greater popularity than local varieties.

Some tolerant varieties cultivated in the upazila are listed below.

Name of Crops	Name of Varieties	Characteristics	Comment
Rice	BRRIDhan-40,41,47,53,5455,74,	Salinity tolerant	
Rice	BRRI Dhan-36,55	Cold tolerant	
Rice	BRRI Dhan-51,52	Flood tolerant	
Rice	BRRI Dhan-28,45	Short Duration	Escape flood
Rice	BRRI Dhan-43,56,57	Drought Tolerant	
Rice	BINA-8,BINA-10	Short duration	
Wheat	BARI-GOM 25,26,27,28	Heat tolerant	Suitable for southern belt
Mustard	BARI- SARISA-14	Short Duration	Escape summer high temperature

5.5: Short Duration Crops:

To overcome the climatic change effects in my study area all over the Banaripara Upazilla in eight union they are using short duration crops. For an example in Motherkati village.I found that the farmers are using BRRI Dhan-28 variety that short duration crops to fetch the climate change effects. The villagers illustrate that they are somehow overcome the natural disaster by using short duration crops.

Photograph-5.1: Short Duration variety, BRRI Dhan-28

5.6: Heat tolerant varities:

We know that according to the report and some statistical data says that the temperature of the world is increasing day by day. Due to increasing CO2 gas and the green house effect that is causing for the temperature rising in the World. In my study area to overcome the overheat problems they are using BARI GOM -26 that is called heat tolerant varieties .

Photograph -5.2: Heat tolerant BARI GOM 26 (Photo source: DAE, Banaripara)

5.7: Flood Tolerant Varieties:

In our country especially in the southern region of Bangladesh flood eg. Water flood is a great problem .According to the voice and statement of the FGD and common people I found that they are using some flood tolerant varieties BRRI Dhan 52 and they are getting results.

Photograph -5.3: Farmers cultivating flood to**lerant** BRRi Dhan-52

5.8: Short Duration Varieties:

At recently the DAE invented some short Duration varieties for the adaptation of the climatic change effect. In my research area I found that some farmers are cultivating the short duration varieties .For an Example the farmers of Soliabakpur village in Banaripara they are adapting the climatic Change effect by cultivating short duration modern Mustard Varieties. The name of the variety is BARI Sharisha-14.

Photograph-5.4: Farmers cultivating short duration modern mustard varieties (source: DAE)

Photograph -5.5: Farmers cultivating BRRI Dhan-52(Flood tolerant),at Banaripara.

5.9: Virus Tolerant Varieties:

We know that they are major 3 pathogens that are affecting the plants. They are as follows a. Fungus b. Bacteria c. Virus etc. The virus pathogen is more harmful than other pathogen. For the climatic change effect the environment of the pathogen is connected. So the pathogen should be controlled by the various ways. According to the farmers statement and the common people and the UAO Banaripara they said that all over the Upazila virus tolerant variety Such as BARI Mung-6 is positively affected and the farmers is adapting their climatic change.

Photograph-5.6: Farmers cultivating Virus tolerant mung bean varieties (BARI-Mung-6)

5.10: Sarjan cultivation.

As majority of land in Banaripara is medium low land. It makes farmers hard to cultivate early vegetable. During rainy season it is really a challenge for the farmers of Banaripara to produce summer vegetable. Despite farmers grow vegetable on raised bed which is locally called "Sarjan" method. This adaptation technique is unique among farmers of Banaripara which is considered an important tool for climate change mitigation.

Photograph-5.7: Farmers preparing raised bed to adapt to cultivate in the low lying areas (DAE, Banaripara)

Photograph **-5.8: Farmers cultivating bottle gourd in Sarjan Banaripara method.**

Photograph-**5.9: Farmers cultivating vegetable by sarjan method l**

Photograph-5.10: Banana Garden in low lying areas of Banaripara,By sarjan meth**od**

5.11: Floating Seedbed:

Floating seed bed is a common practice at Bisarkandi Upazila which is recently declared as World Heritage by WFO. This an ancient method which is practiced by the local farmers for hundreds of years. This technology is considered an important way to adapt with changing climate especially in the coastal low lying areas. More than 1000 farmers of Banaripara upazila are involved with this type of Cultivation. This floating beds are prepared with locally grown water hyacinth and bamboo. Initially a bamboo structure is made. Then water hyacinth and some

other local weeds are piled upon the structure. Then Seedling of Vegetables are transplanted on the bed made by water hyacinth.

Photograph-5.11: Vegetable seedling on floating seed bed DAE,Banaripara)

Photograph-5.12: Vegeable seedling on floatting seed bed DAE,Banaripara)

Photograph-5.13: Vegetable seedling on floating seed bed(DAE, Banaripara)

5.12: Delivery of Quality Seed:

Everybody knows that quality seeds plays vital role for the crop cultivation. Without quality seed we cannot think good quality production. Now-a-days for climatic change the production field specially for the seasonal crops are seriously hampered. In Bangladesh governmental organization BADC is working for the seed production, marketing packing and they certify the quality seed .Many people in Banaripara Upazila they said that they get seed from the government trough upazila Agriculture Office. But the amount of seed is not handsome.

For the adaptation of climate change effect they need more amount of seeds for crop cultivation.The FGD of all union parishad they say that quality seeds is essential elements for production. If the seed germinate in time they will get yield properly.

A majority of the growers, however, use seeds collected from their own crop grown from unstandardized varieties of unknown description. Because of using unreliable seeds of improper or unknown description, many problems arise such as:

- Total crop failure often occurs when early varieties are planted late. For example, buttoning in cauliflower is common when early varieties are planted late in the winter leading to total crop failure.
- Crops mat fail due to seed borne disease.
- Low yield is obtained when a variety is not genetically uniform in different characters
- Low seed vigor at planting leads to poor germination and poor yield.

5.13: Crop diversification:

In the world the crop the crop diversification is a modern concept. The total environment is not fully favorable for the crop cultivation. The scientists invented some way or techniques how we can overcome the climatic change situation. For this reason crop diversification is included in my study area. In my study area the local farmers and that they are using the cropping following ways and the changing cropping system due to climate change.

5.14: Conservation the Rain water By using shed:

For the agricultural cultivation rain water is positively needed for the growth and other physiological function of a plant. We know that rain water contains some minerals that is important for growth and fertilization and germination of the seeds. Due to effect of climate change is not continuous but it becomes discontinuous. When the crop needs raining but in the environment then find drought. On the other hand when the raining is not needed then we find heavy rain falls.

For the phasing dissimulation we can use water shed for reserve the rain water. As per the statement of common villagers (FGD) I found that in their locality somebody use water reserved and taking rain water then they use as irrigation water. In this they are adapting the climate change effect.

5.15: Using the pesticide and fertilizer:

For the maintaining cropping pattern the pesticide and fertilizer is more an important elements. According to the statement of the farmers they are using fertilizer and pesticide to adapt or mitigation the effect of climate change. If they get the fertilizer in time it is very much easy for them to maintain the cultivation of agricultural of crop.

On the other hand pesticide is an important factor to increase the yield of crops. If the pesticide is not use in time the yield of crops will be hampered. Proper or balance fertilizer or pesticides is helpful for the farmers to mitigate climate change effect.

5.16: Proper Management of Land:

We know that land is the part and parcel of crop management. The cropping pattern is fully depend on land management. Sea level rice is the other climatic factor that is disfavor for crop cultivation. It can be minimized by using land management. Local people take proper step in odd situation. They maintain the proper system to mitigate disposition of crop production.

When the water is increasing the high-up the soil and then they use seed bed and other activities. According to the statement FGD and farmers who are common people they illustrate they adapt the climate change by using proper management of land.

5.17: By Using Farmers Innovative Idea:

Farmers innovative idea is practical oriented. They are basic master of crop cultivation. They know what is the general, What is the basic, and what is the created problem. When the problem is arise then the farmers invent innovation. When field problem they will be conscious about the duty and responsibility. According to the statement of local farmers (FGD) when they rise add difficulties then they think how solve the problem. By thinking they will invent the solution.

Figure 8: Suggested Crop Calendar for Southern region

Month/ Crops	January February I March April IMay JuneJuly AugustSeptember October			November December
	ParishMagh FalguniChoure-) Boishakh Joisinho		*Asharhi Srabon Bhadro Ash•in*	*Karin,: OgrahayonPerish*
Boro rice-	BRRI *dhan* 47 (Salinity Tolerant-12-		BRRI *dhan* 40 and ERR! *dhan* 41 (Salinity Tolerant-8	BRRI *Arm* 47
Wheat-Mug dal-T.Arnan	Wheat (Hashi developed by BARI)	Mug dal (BARI Mug 6)	BRRI *dhan* 40 (Salinity Tolerant-8 ds/m)	Wheat (Hashi developed by BARI)
Chilli-T aman	BRRI *dhan* 47 (Salinity Tolerant-12-14 ds/m)		Jute (CVL-1 and HC-95) (Salinity Tolerant-8 ds/m)	BRRI *Aim* 47
Maize-Taman	Maize		BRRI *dhan* 40 and BRRI *dhan* 41 (Salinity Tolerant-8 ds/m)/ Jute (CVL-1	Maize
Mustard-Mug dal-Jute	Mustard	Mug dal (BARI Mug)	BRRI *dhan* 40 and ERR! *dhan* 41 (Salinity Tolerant-8 ds/m)/ Jute (CVL-1 and HC-95) (Salinity Tolerant-8 ds/m)	Mustard
Mustard-Mug dal-'F.airian	Sugarcane (ISWARD1-40)			

Fig-5.1: Suggested crop calendar for southern region. Source: Developed by authors after detailed discussions with BRRI, BARI. BM', BSRI and BRRI Rich Farming division, and local farmers, 2011

5.20: Financial Adaptation:

For the first time the government, apart from subsidies And rehabilitation, has given various incentives to farmers for crop production. Recently, financial assistance of around BDT 750 core for diesel fuel used to irrigate *boro* rice was distributed among the farmers through their bank accounts. Farmers affected by the flash flood will be given free seeds and fertilizers that will cost BDT 48 core for the *boro* season in 2011. To compensate the loss of *boro* rice by flash floods in *haor*areas, fertilizers worth BDT 26 core were distributed free among 346,100 farmers for

enhanced *Aus* production and this programme is ongoing in 2011.The Bangabandhu National Agriculture Award, 1415 is awarded to 32 farmers and entrepreneurs to encourage more foodproduction. Increased allocation for fertilizer subsidy, irrigation and other inputs and research activities are some notable financial contributions of the public sector. Such augmentation of support for enhanced production is a crucial adaptive measure for.

5.21: Conclusion:

Climate change, the outcome of the "Global Warming" has now started showing its impacts worldwide. Climate is the primary determinant of agricultural productivity which directly impact on food production across the globe. Agriculture sector is the most sensitive sector to the climate changes because the climate of a region/country determines the nature and characteristics of vegetation and crops. Increase in the mean seasonal temperature can reduce the duration of many crops and hence reduce final yield. Food production systems are extremely sensitive to climate changes like changes in temperature and precipitation, which may lead to outbreaks of pests and diseases thereby reducing harvest ultimately affecting the food security of the country. The net impact of food security will depend on the exposure to global environmental change and the capacity to cope with and recover from global environmental change.
Coping with the impact of climate change on agriculture will require careful management of resources like soil, water and biodiversity. To cope with the impact of climate change on agriculture and food production, India will need to act at the global, regional, national and local levels.

In this chapter we can reach in some concluding points. The major problems with their impacts and management practices for improving crop cultivation. The Old canals of the union wise found mostly closed or silted up due to the unplanned construction of different manmade interventions which were making barriers to natural flow of water and thus had created severe drainage congestion and hampering timely cultivation of T-Aman paddy in my study area Banaripara.

The unions of Banaripara upazila faces lots of specific problems like moderately to deep monsoon flooding which causes severe crop damage, encroachment of valuable agricultural land for different other uses , higher price , low quality, lack of different agricultural inputs, over doses of chemical fertilizer , pesticides / insecticides , scarcity of surface water for irrigation , siltation , water logging , inadequate drainage systems essential plant nutrients deficiencies lack of farmers knowledge on up-date information and agricultural technology which restricts intensive agricultural practice of lands.

CHAPTER 6
CONCLUSION AND RECOMMENDATIONS:

This chapter sets out the conclusion and the suggested recommendations of the study. It has got 2 (two) sections. The first section describes the conclusion, while the second section is Recommendations of the study.

6.1: CONCLUSION:

Climate change impacts on Bangladesh are not a future issue. The country is affected by salinity, flood and flash floods, droughts, temperature variations, erratic rainfall etc. which result in crop losses. Despite the country has shown resilience to climate change. The target of rice production was increased and being subsequently achieved in the recent years. Price subsidy for fertilizer and other agricultural inputs has contributed to make them affordable to the farmers. Research on stress tolerant technologies (seed, fertilizer, irrigation, agronomic practices) and their expansion acts as positive adaptive action against climate change. Comprehensive and coordinated study on the real time impacts of climate change on crop production and assessment of the needs to avert the crisis must be carried out for making correct policy decision. Financial assistances for production and to compensate crop losses were channeled to the farmers in a comparatively transparent way through their bank accounts. Use of e-Agriculture through internet and village based AICCs allowed farmers to get instant expert opinion on problems of their crop fields. These Bangladesh is the forerunner in formulating andadopting NAPA and BCCSAP in compliance to the BaliAction Plan. The country has been participating in theCOP of the UNFCC and has been raising concerns of thecountry to the international forum. Climate ChangeTrust Fund is established locally with domestic funding.Major policy documents of the government included climate change and thorough considerations may be required for policies supporting agriculture and other natural resources to combat the detrimental effects. However, sect oral cooperation and coordination is required for the success. A balance is to be maintained among the quality & quantity of food produced maintaining sustainability of the environment and natural resources.
(Ministry of Environment and Forests)

The high yielding modern varieties cultivated in my study area Banaripara Upazila. Here the varieties are BRRI Dhan 48, BRRI Dhan 27 ,and BRRI Dhan 26.
T Aman rice is very much popular crops in the southern part of Bangladesh. Here the main fact is the time when T Aman is planted then the season is safe. The possibility of natural disaster is minimum. The pest and pathogen is under control. There are some tolerant modern varieties cultivated in Banaripara Upazila. Not only Banaripara these varieties are cultivated all over the southern part of Bangladesh. The following varieties are cultivated in Kharif -2season.BRRI Dhan- 22 ,BIRRI Dhan -23,BRRI Dhan 33 , BRRI Dhan -51, BRRI Dhan -52 and BRRI Dhan-40.By cultivating those varieties the farmers overcome the bad effect of climate change in the southern part of Bangladesh specially in Banaripara, Barisal.

The existing cropping pattern in Banaripara is Fallow-T-Aman—Fallow and Local Fallow-T-Aman-Boro Cultivation.

These types of cropping pattern may be changed by the following ways. It can be changed by the following ways. It can be changed like Summer vegetable like Okra(Dharosh) Leafy Vegetables –T–Aman-Boro cultivation or Okra—T-Aman and then Tomato cultivation.

Some important field crops that are grown in the Robi Season. The crops Boro rice, Wheat and Maize.Existing cropping Pattern is Boro—Wheat—Maize.But due to climate change effect the farmers are cultivating some winterVegetables like Cabbage, Cauliflower and Leafy Vegetables and sweet gourd instead of Wheat cultivation.

In Banaripara upazilla some non rice Rabi Crops they are changing their position from lower level to higher level. The following vegetables potato, sweet potato , Mustard, Lemtil, Black Gram, Mung bean, Chilli, Onion and Sessame.

The effect of climate change there is a significant challenges on the agricultural sector that is causes bad effect on the livelihood and the total GDP and there is an impact of national economy of Bangladesh.

The clear symptoms of the weather like Sea Level Rise, Drought,heavy and unusual rainfall Cyclones, water flash flood, storm and water stagnant lengthy condition. On the other hand the temperature rising that is very much alarming for the agricultural production.
The majority farmers of my study area they suggested that the proper the proper and scientific digging of canal there they want to involve .By using the canal they can reserve the fresh water and when water is needed they can use and when land is over flooded by using the canals water will pass out.

In my study area the majority farmers gave their opinion that they are in some problems that have been identified through this study –lack of proper fund, lack of irrigation water, quality seeds , quality pesticides and the professional training. In my study area the chemical fertilizer is difficult to manage but the organic fertilizeris not problem.

Due to lacking of proper education the always try to use chemical fertilizer and the chemical pesticides. They are not agree to wait and to use the organic fertilizer. They are not interest to control the insect by using the biological method.

They are in belief in result demonstration but they are not in belief in method demonstration. I found that adaptation in kharif-1 season is not in large amount. They are not cultivating Aus rice because of water problem. They are using some tolerant varieties (Rice) in Kharif-2 and mitigate the climatic change effect.

Due to high temperature the lack of proper rain water the wheat cultivation is reducing year to year. They are interested to cultivate Rabi vegetables in this period.

By adapting the organization supervision, co-operation, monitoring and proper co-ordination can help for the success. By maintaining sustainability for the quality and quantity of food production. The environmental and natural resources should be considered.

To mitigate the effect of climate change and adaptation of climate change effect the following ways that can be considered.

- There should be implementation of all ways follow-up mechanism. The follow-up consist co-ordination monitoring and evaluation. There should be employment some experts who can do those activities properly.
- There are should be a well plan that is specified for agriculture should be produced. We should to create awareness in the world level. Eg. National and International level.
- Every sector Governmental and Non-Governmental sector should be conscious about the climate change. The capacity of these organization should be built up superficially. By imposing the facilities of Governmental and non-Governmental Institutions should be improved.
- We should put deep attention on the forest tree. The community based forest tree or social forest tree that will be helpful to mitigate the environmental pollution.
- Improvement the environment of crop production. To cyclone forecasting system the early warning system the sms sending system can be applied. The modern technology such as floating bed system, improving drainage system and modern irrigation system can be applied.
- By using research methodology and field testing or field experiences. We should create a new varieties that will survive in adverse condition. It will be used in lieu of local varieties.
- We can apply the knowledge of genetic and plant breeding concept of food safety and Genetically Modified (GM) technology can be used for the adaptation.
- Well organized or fruitful innovative idea that is effective in odd condition and that is good for all. It can be promoted for a large scale.
- The activities of soil research and training institute every local level the supply of soil testing kids should be ensured.
- In our country many farmers are using traditional practices to adapt the climate change effect. By imposing modern technology we can improve the activities of the farmers. We should make our farmers up to mark knowledge in contrary the global context. They should be modern by learning.

- By using the agricultural extension personnel to spread out the innovative farming system idea and the knowledge of the indigenous farmers should be changed.
- We should develop the embankment by using the knowledge the practical based oriented. We can take some idea or knowledge from the Beel Dakatia which is located in Khulna.
- Awareness build up program should be considered in local level about the environmental pollution. There are should apply the knowledge about the way of escaping the pollution.

6.2: Recommendations:

- It is essential to review the present land use policy with the relevant experts, professionals, and farmer's representatives and update it based on their comments and suggestions. The policy should be enacted and put into operation immediately to stop further loss of arable land. Khas lands that are arable should not be diverted for housing.
- It is highly imperative that the twin problem of arable land loss and population growth.
- It is addressed by the government simultaneously to ensure production sustainability and food security. Both the issues need to be categorically spelled out in the new National Agricultural Policy (NAP) under preparation by the Ministry of Agriculture.
- The government should urge BRRI, BARI, and other NARS institutes, private companies and NGOs to develop their own hybrid variety programmes of rice, vegetables and other crops within the country.
- Strong political commitment must be ensured to implement the present "Climate Change Strategy and Action Plan". It is also extremely important that both Poverty Reduction Strategy Paper (PRSP-II) and Sixth Fiver-Year Plan under preparation contain clear provisions to address the issue.
- To encourage the use of balanced fertilizers, chemical fertilizers must be integrated with organic manures. The government should clearly spell out the need for balanced fertilizers in its new NAP in the interest of sustainable production. Farmers should as well be motivated to reduce their dependence on the use of chemical fertilizers to maintain soil fertility.
- Irrigation should be applied at the appropriate growth stages of crops for efficient use of water. Growing crops under minimum tillage, relay cropping and mixed cropping practices may also be strengthened for rainfed farming. Farmers may be motivated to grow low-water requiring crops like pulses, wheat, etc. Different NGOs may as well be used to excavate derelict ponds, canals, etc. for the conservation of rain water for irrigation in dry seasons.
- It is also necessary to expand biotechnology and 1PM practice to other economic crops, such as oilseeds, pulses, spices, and fruits for the management of pests and diseases. The new NAP should emphasize the importance of the use of these environment-friendly frontier technologies in pest management.

To mitigate the effect of climate change and the adaptation of climate change effect the following ways that can be considered:

Missions for Adaptation & Mitigation:

- 8 National Missions for Adaptation and Mitigation that is suggested for National level.
  - ✓ National Solar Mission.
  - ✓ National Mission for Enhanced Energy Efficiency.
  - ✓ National Mission for Sustainable Habitat.
  - ✓ National Water Mission.
  - ✓ National Mission for Green India.
  - ✓ National Mission for Sustainable Agriculture.
  - ✓ National Mission on Strategic Knowledge for climate change.
  - ✓ National Mission for Sustaining Himalayan Ecosystem.Climate change is global in its causes & consequences and response requires international collective action.

- Third world countries must play prominent role in global governance of climate change issues and negotiations.
- Accelerate low carbon transformation by integrating climate action & risks into strategic economic decision making & development planning.
- Collaborative research in future low-carbon technology & access to IPRs as global public good.
- Prioritize investments in appropriate R & D activities & scale up innovation in key low carbon & climate resilient technologies.
- Effective management and conservation practices for natural resources.
- Mitigation (measures to reduce GHG emissions that cause climate change).
  - ✓ Focus on non renewable sources of energy
  - ✓ Energy efficiency of generation, transmission, residential & commercial buildings
  - ✓ Make connected & compact cities the preferred form of urban development (Climate Smart cities)
  - ✓ Less dependence on fossil fuel
  - ✓ Halt deforestation of natural forests
  - ✓ Proper land use planning (restore degraded forests & agriculture land)
  - ✓ Plan for a forestation, agro-forestry, urban forestry.

- Preparedness and Adaptation:
  - ✓ Capacity building of community & NGOs.
  - ✓ Disaster Preparedness & better response management.
  - ✓ Crop improvement, changes in cropping pattern, pest management.
  - ✓ Social safety nets i.e. crop insurance, credit support to farmers.
  - ✓ Empowerment of poor etc.
  - ✓ Environment protection & conservation.
  - ✓ Drought proofing.
  - ✓ Preparing for public health impacts of climate change.
  - ✓ Strengthening Institution & Infrastructure building.
  - ✓ Strengthening Environmental governance.
  - ✓ Relocation of communities living close to the sea.
  - ✓ Sustainable development.

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Appendix
FGD Guideline

1. Have you any idea about climate?
2. Can you say something about climate change?
3. What kinds of problems usually happened in your locality?
4. What kinds of disaster that you usually face in your area?
5. When the disaster occur have you any idea about the causes of disaster?
6. What is the effect of climate change on cropping pattern?
7. What types of crops that are going in disaster period?
8. Are you phase any problem of rainy water?
9. Do you cultivate any water tolerant variety? Will you give some names of crop like paddy varieties?
10. Have any reservoir in your area for sweet water irrigation?
11. What types of paddy varieties do you cultivate in Aman, Aus and Boro?
12. What kinds of challenges do you face in cultivation due to climate change?
13. What types of crops that are going by using canal water?
14. How you will mitigate the natural disaster?
15. What kinds of new varieties that you cultivate due to climate change?
16. What types of problems do you face due to lack of regular rain rainy pattern?
17. What kinds of crops disease do you face in the time of cultivation of crops ?
18. How you solve the disease?
19. Have you any idea about climate?
20. Can you say something about climate change?
21. What kinds of problems usually happened in your locality?
22. What kinds of disaster that you usually face in your area?
23. When the disaster occur have you any idea about the causes of disaster?
24. What is the effect of climate change on cropping pattern?
25. What types of crops that are going in disaster period?
26. Are you phase any problem of rainy water?
27. Do you cultivate any water tolerant variety? Will you give some names of crop like paddy varieties?
19. Have any reservoir in your area for sweet water irrigation?
20. What types of paddy varieties do you cultivate in Aman, Aus and Boro?
21. What kinds of challenges do you face in cultivation due to climate change?
22. What types of crops that are going by using canal water?
23. How you will mitigate the natural disaster?
24. What kinds of new varieties that you cultivate due to climate change?
25. What types of problems do you face due to lack of regular rain rainy pattern?
26. What kinds of crops disease do you face in the time of cultivation of crops?
27. How you solve the disease?
28. What kinds of pesticide do you used and what is the reason?
29. Is there any changing of using fertilizer?
30. What types of fertilizer do you prefer to use in your crop field and why?
31. What kinds of crops that you cultivate before time?
32. What kinds of crops that you cultivate at present time?
33. Have you any idea about cropping pattern?
34. Have you any idea about cropping calendar?
35. What soil PH value?