Assessing Long-term Impacts of Vulnerabilities on Crop Production Due to Climate Change in the Coastal Areas of Bangladesh

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ABBREVIATION

AEO-Agriculture Extension Officer

BARC-Bangladesh Agricultural Research Council

BARI-Bangledsh Agricultural Research Institue

BRRI-Bangladesh Rice Research Institute

BCAS-Bangladesh Centre for Advanced Studies

BUET-Bangladesh University of Engineering and Technology

BWDB-Bangladesh Water Development Board

BIWTA-Bangladesh Inland Water Transport Authority

B-Boron

CC-Climate Change

CCC-Climate Change Cell

CEP-Coastal Embankment Project

CEGIS-Centre for Geographic Information System

ds/m-desicymole/meter

DAE-Department of Agricultural Extension

Ec-Electrical conductivity

EC-European Commission

FAO-Food Agriculture Organization

FGD-Focus Group Discussion

GCM-Global Circulation Model

GO-Government Organization

GOB-Government of Bangladesh

HYV-High Yielding Variety

HHs-Households

IPCC-Intergovernmental Pannel on Climate Change

K-Potassium

Kh-I-Kharif I

Kh-II-Kharif II

MDG-Mellinium Development Goal

MPO-Master Plan Organization

MOEF-Ministry of Environment and Forest

NAPA-National Adaptation Plan of Actions

NFPCSP-National Food Policy Capacity Strengthening Programme

NCA-Net Cultivable Area

N-Nitrogen

NCA-Net Cultivable Area

PRSP-Poverty Reduction Strategy Paper

PRECIS-Providing Regional Climates for Impacts Studies

POA-Plan of Action

P-Phosphorous

SMRC-SAARC Meteorological Research Council

SAAO-Sub-Assistant Agricultural Officer

SOM-Soil Organic Matter

S-Sulpher

STW-Shallow Tube Well

T.Aman-Transplanted Aman

T.Aus-Transplanted Aus

t/ha-ton/hectare

USAID-United States Agency for International Development

UAO-Upazila Agricultural Officer

WFS-World Food Summit

EXECUTIVE SUMMARY

People living in different coastal areas of Bangladesh have been suffering from lack of food security. There are many reasons behind that such as lower crop productivity and less cropping intensity due to increased salinity, increased incidences of pests & diseases, erratic rainfall, higher temperature, drought, tidal surges, cyclone, submergence,large fallow lands/water bodies, land degradation, poor road network, poor marketing facilities and unemployment with long-term cumulative effects of soil-related constraints, climate risks and socio-economic problems. Since people do not have ample employment opportunities round the year, their food security situation is vulnerable and is a matter of great concern for the policy makers. Majority of the people in coastal areas are involved in crop cultivation and fishing and they remain frequently unemployed due to tidal flooding and other natural disasters resulting food insecurity in the areas. With technical support from the National Food Policy Capacity Strengthening Programme (NFPCSP) of the FAO and the Ministry of Food and Disaster Management and financial support from USAID/EC, the present study **"Assessing Long-term Impacts and Vulnerabilities on Crop Production due to Climate Change in the Coastal Areas of Bangladesh"** was undertaken to analyze the climate impacts on crop production systems and to suggest appropriate coping strategies and adaptation options for improving coastal agriculture for increased agricultural production and better livelihood of the vulnerable farming community.

Bangladesh has made a remarkable progress in the last three decades towards achieving self-sufficiency in food grains due to substantial intensification of cropping, introduction of high yielding crop varieties, expansion of irrigated areas and increased use of chemical fertilizers. Among the factors, contribution of fertilizers leading to increased production is about 50 percent. But recently, declining or stagnation of major crop yields have been recorded due to cumulative effects of many soil-related constraints and climatic risks viz. depletion of soil organic matter, imbalanced use of fertilizers, nutrient mining, degradation of soil physical and chemical properties, erratic rainfall, temperature rise, droughts, floods, soil salinity, water salinity, tidal surges, water-logging, cyclone, scanty use of bio and organic fertilizers and poor management practices. The proportion of different nutrients used in agriculture without soil testing in recent years is highly deleterious to soil productivity. Nitrogen alone constitutes about 83 percent of total nutrient use in the country, while the use of phosphorus and potassium is limited to only about 7.75 and 9.1 percent respectively.

The present challenges for plant nutrient management are to maintain (and where possible to increase) sustainable crop productivity to meet the growing demands for food and raw materials and to enhance the quality of land and water resources. Bangladesh is presently facing a serious challenge in agricultural production to feed the growing population in the context of shrinking agricultural land and climate change impacts. The population has been projected to grow to 191 million in 2030 from the current 148 million. **The major challenges** for increased growth and production for agriculture sector are:

- Arresting conversion of good agricultural land into non- agricultural purposes;
- Reversing trend of nutrient mining and depletion of soil organic matter (SOM) due to mono-culture in intensive crop agriculture;
- Utilization of remarkable areas of agricultural land (30-50% of NCA in concerned districts) that remains fallow or seasonal fallow in drought prone, flood prone and coastal area due to environmental stress factors which will be aggravated further due to climate change;

- Introduction of location specific production packages and agricultural adaptation technologies to facilitate the growth of agriculture sector;
- Reduction of yield gap and large scale adoption of proven agro-technologies at farm level;
- Making adequate quality seeds available at farmers' level;
- Developing suitable salt-tolerant crop varieties for coastal region and coastal char lands; drought-tolerant varieties for drought prone areas and Floodplain char lands and submergence tolerant varieties for water-logged soils;
- Improving marketing facilities and **Farmer's Group** in agro-processing using value added crops;

Bangladesh is one of the most vulnerable countries in the world to disasters and climate change impacts. Different types of natural hazards such as floods, droughts, cyclones and storm surges, tidal surges and intrusion of saline water causing salinity, increase of soil salinity and river water salinity, water-logging, tidal flooding, river bank erosion, tornadoes etc significantly affecting the agriculture production systems and overall economic and social development of the country. These vulnerabilities have direct and/or indirect implications on the performance of crops, livestock, fisheries and agro-forestry. The vulnerabilities due to climate change are likely to aggravate more in the future. These vulnerabilities hinder the agriculture production systems, economic and social development through two processes:

- **Firstly, damaging the crops, livestock, fisheries and agro-forestry, natural resources and infrastructure;**
- **Secondly, pulling back the on-going development, business and trade at local, regional and even global levels.**

In Bangladesh, over 30 % of the net cultivable area is in the coastal region. Out of 2.85 million hectares of the coastal and off-shore areas, about 0.828 million hectares of the arable lands, which constitutes about 52.5 percent of the net cultivable area in 64 upazilas of 13 districts. But these vast cultivable areas are under great threat of vulnerabilities of the climate change and crop production is rapidly declining. The Bangladesh climate is controlled primarily by summer and winter winds, and partly by pre-monsoon and post-monsoon circulation. Saline water intrusion, sea level rise, water stagnancy, cyclone and storm surges are major climatic hazards affecting the low lying coastal areas. **Coastal agriculture is highly vulnerable to climate change.** The intensity of disasters such as cyclones and hazards like sea level rise, tidal surges, soil salinity due to salt water intrusion in the coastal belt have increased. Consequently, the crop area is reducing and the cultivation of aus , boro and rabi (dry season) crops are getting restricted. To address the above issues, a systematic study was taken up under this project for **assessing the long-term impacts and vulnerabilities on crop production due to climate change in the coastal region of Bangladesh.**

Ten costal districts covered under the study: Khulna, Bagerhat, Satkhira, Barisal, Bhola, Barguna, Pirojpur, Patuakhali, Cox's Bazar and Noakhali districts. A multi-disciplinary, participatory and interactive method have been followed in carrying out the study Both primary and secondary data on land use, climate change and land degradation have used and trend of crop productivity etc. were collected, reviewed and incorporated in the study. Upazila-wise data/information on land use systems, major crops/cropping patterns, conversion of agricultural land, climatic parameter (rainfall, temperature etc.), climatic risk factors affecting crop production systems, identification & documentation of adaptation options/practices of the project areas have been assessed through Focus Group Discussion (FGD).Household

survey and some case studies were conducted in some selected upazilas for evaluating farmers' response on adaptation options/practices for improvement of coastal agriculture, better health and nutrition. The major findings are discussed as under:

i) **Utilization of land in crop agriculture and changes in crops/cropping patterns:** It was found that the average cropping intensity in the coastal areas has not increased as much compared to Flood Plain Agriculture during 1975-76 to 2005-06. The average cropping intensity ranges from 155-181 % except Bhola and Noakhali districts. But there was a great change in the use of agricultural lands into other purposes due to climate change.

ii) **Fallow lands:** Study showed that a sizeable amount of cultivable land (about 30-50 % of NCA of concerned districts) remains fallow in rabi and Kharif-I seasons. The main reasons of which are: soil wetness/water stagnancy, tidal surges, late harvest of T.Aman, drought and increased salinity, expansion of shrimp culture, poultry farm and brick field etc.

iii) **Yield reduction:** The main reasons of yield reduction (20-40 % yield loss) in T.Aman crop are erratic rainfall, increased intensity and frequency of drought, increased salinity, tidal surges, floods, cyclone, use of local varieties, increased incidences of pests & diseases etc in the context of climate change. Total yield loss of T.Aman crop has been estimated to about 6.93 lakh ton per year based on last 5-10 years of climate change scenarios. Similarly, average yield level of HYV Boro is being affected (30-40 % yield loss) by high temperature (causing sterility) and increased salinity and that of T.Aus/Aus crop is being affected (20-40 % yield loss) by tidal surges. Vegetables, pulses, oilseed crops and fruit crops are being affected (20-40 % yield loss) by drought, increased salinity, soil wetness, excessive rainfall and water-logging and tidal surges in most coastal districts. From the study, total crop loss for major crops (viz. cereals, potato, pulses, oil seeds, vegetables, spices and fruit crops) due to different climate risks has been estimated to about 14.05 lakh tons per year based on last 5-10 years of climate change scenarios within the areas of ten project districts. But the people are to live with these climatic vulnerabilities and risks in the coastal region.

iv) **Changes in annual rainfall**: Erratic nature of rainfall, number of days without rainfall and more rain is occurring in short duration. Total rainfall in Kharif season is decreasing that affects the cultivation of rainfed crops in the coastal region. But the total rainfall during rabi season is increasing in Noakhali, Cox's bazaar and Khulna districts that affecting the cultivation of rabi crops.

v) **Changes in temperature:** Temperature is generally increasing in the monsoon, average monsoon maximum & minimum temperatures show an increasing trend annually 0.05oC and 0.03oC respectively. Level of rabi max. temperature is increasing compared to min. temperature affecting winter crops. Level of both Kh-I & Kh-II max. and min. temperatures is increasing. Temperature rises in all three seasons indicate a sign of global warming in the coastal region.

vi) **Increasing soil salinity:** Long-term data demonstrate that there is an increasing trend of pH level due to increasing salinity. The salinity level (Ec:ds/m) has increased almost double (Ec: 2.8-18.5 to 4.0-42.8 ds/m) in Sharankhola Upazila of Bagerhat district, Dumuria Upazila of Khulna district and Shyamnagar Upazila of Satkhira district.

vii) **Increasing salt affected areas:** Study showed that salt affected areas have significantly increased (26.71 % increase) to 950,780 hectares in 2009 from 750,350 hectares in 1973 in the project areas of coastal region.

viii) **Increasing river water salinity:** There is an increasing trend of river water salinity (12.9-24.5 % increase) in Bishkhali river at Pathorghata point, Andarmanik river at Kalapara point and Payra river at Taltali point during 2001 to 2009.

ix) DTW/STW water salinity: There is an increasing trend of ground water salinity (5.8-25.6 % increase) in Pirojpur and Bhola districts during 2005 to 2009.

x) Sea Level Rise and Salt Water Intrusion: Time series data/information on water level (in meter max/min level) of different measuring points were collected from local offices of BIWTA and BWDB during field visits and FGDs at project sites. Data on sea level rise based on water level measured/recorded near to sea shore at Galachipa River, Patuakhali ,Swandip, Khepupara, Charchanga, Hiron point and Cox's bazaar (BIWTA) showed an average increase of 0.283 M(at min.water level) and average increase of 0.415 M (at max.water level) which is an average increase of sea level during last 30-31 years(1.38 cm/yr) at max. water level. A summary of sea level rise is shown below:

Salt Water Intrusion during dry season.

2007:130,588.00 ha inundated (41.4 cm sea level rise during last 30 years)

2050:215,972.5 ha to be inundated (59.34 cm sea level rise during next 43 years)

xi) Increasing Water-logged Areas: Water-logged areas have significantly increased to 147,917.00 hectares in 2008-09 from 61,929.00 hectares in 1975-76 due to seasonal submergence, tidal surges, drainage congestion, increased roads & embankments, faulty sluice gate, increased shrimp culture under gher areas and heavy clays in the coastal region.

xii) Increasing Vulnerable areas of Droughts, Floods, River Bank Erosion and Tidal Surges: Study showed that the vulnerable areas of drought prone, flood prone, river bank erosion and tidal surges have remarkably increased to 152,285.00 ha, 114,365.00 ha, 95,324.00 ha and 130,588.00 ha respectively in 2008-09 compared to 1975-76 due to climate change.

xiii) Degradation of Land Quality and Nutrient mining: The availability of phosphorus, potassium, sulphur, zinc and boron in all sites has significantly decreased. But there is some indications of sulpher build up in Bhola, Porojpur and Noakhali. However, changes in nutrient status showed a significant depletion of plant nutrients supporting the over all degradation of land quality and soil fertility due to continuous cropping in the context of climate change.

xiv) Household survey on food security: The household survey dealt with farmers' response to questions on causes of poverty and food insecurity, long-term impacts of climatic risk factors affecting crop production, adaptation strategies and innovative practices and introduction of suitable crop varieties etc were considered. The causes or factors of poverty and food insecurity were found to be as follows: natural disaster/climate change> insufficient income> landless> crop loss> low crop yield> lack of educational awareness>human health and nutritional deficiency etc in the Cox's bazaar, Patuakhali, Pirojpur, Barguna, Barisal, Bhola, Satkhira, Khulna and Bagerhat districts.

xv) Local Perception on Climate Risks: Local perception of the impacts of climate hazards in coastal areas was assessed during FGDs and household survey. Participants stated that the current climate in this region is behaving differently than in the past on the following climate risk factors affecting crop production:

- Frequent droughts
- Changes in seasonal rainfall pattern
- Quantity/amount of seasonal rainfall

- Long dry spells
- Increase of soil salinity
- Increase of tidal surges

In addition, participants perceived that temperature has increased over the years and duration of winter has been shortened affecting the potential growing period of winter crops. Cultivation of wheat is being affected at grain filling stage due to high temperature and increased incidences of pests and diseases. Increased intensity of soil salinity was perceived by the farmers as white crust of salts on soil surface and crop burning during drier months in the coastal areas.

xvi) Farmers' response on crop loss: In the coastal zone, crop is lost due to increased salinity, flood/water stagnancy or tidal surges. The main reasons of yield reduction (> 30 % yield loss) in T.Aman crop are erratic rainfall, increased intensity and frequency of drought, salinity, floods, cyclone, use of local varieties, increased incidences of pests & diseases etc. Average yield level of HYV Boro is being affected (30-40 % yield loss) by high temperature (causing sterility) and salinity and that of T.Aus/Aus crop is being affected (20-40 % yield loss) by tidal surges. Vegetables, pulses, oilseed crops and fruit crops are being affected (20-40 % yield loss) by drought, salinity, soil wetness, excessive rainfall and water-logging in most coastal districts. Extent of crop loss due to climatic risks varies significantly from one district to another. Further more, no crop is cultivated during kharif season due to high depth of standing water in the field of some areas. Flood/tidal surge water recedes late from the crop field. Rabi crops can not be grown here due to soil wetness of swelling clays creating problems in land preparation. For want of vegetables, the affected community suffers from malnutrition owing to dearth of minerals and vitamins in their diet. Consequently, the people especially the women and children suffer from various diseases and malnutrition.

xvii) Farmers' response about adaptation options: Zero tillage (potato/maize/ pulses/garlic), sorjan system of cropping, rice-fish dual culture, utilization of bunds as vegetables/spices production in gher areas, floatinrg bed agriculture and homestead gardening with introduction of salt-tolerant & drought tolerant crop varieties etc have been identified as potential adaptation options for development of coastal agriculture for increased agricultural production in attaining food security, better health and nutrition of the vulnerable farming community in the coastal region.

xviii) Status of human health and nutrition: Study showed that the vulnerable people especially women and children are suffering from malnutrition>cold/fever>dysentery/ diarrhea>skin diseases> asthma/jaundice.

Some Policy Recommendations are given below based on research findings:

- **More study is needed for making location-specific production plan for better coastal agriculture based on soil-crop-climate suitability through proper assessment of soil-related constraints, climate risks and socio-economic problems presently affecting crop production systems and livelihood of the vulnerable people of the coastal region.**
- **Livelihood Strategies:** There are many risk management non-farm activities but now they are becoming less common and climate change may push these practices further and may create unemployment. There will be a change in livelihood pattern of the farming community in the vulnerable areas. **So, sustainable livelihood strategies/ options should be developed based on adaptation options.**

- **Dissemination and Extension of Adaptation Options-** The viable adaptation options need to be tested and disseminated at pilot villages for their acceptance.
- **Developing Climate Change Scenarios based on GCMs .**
- **Encourage Women Involvement in Agriculture** (viz. homestead gardening, seed production & preservation, compost making, agro-processing etc)
- Conduct **capacity building training** for the vulnerable people.
- **Conduct crop demos/block farming on adaptation practices.**
- Introduce risk prone crop varieties in agriculture with emphasis on crop diversification.
- Arrange TOT and farmers' training on innovative and adaptation practices.
- Develop road net work, marketing infrastructures and agro-processing.
- Improve management of coastal saline soils through protective embankment, proper sluice gate, land leveling, improve drainage systems, organic amendments etc.
- Promote rain water harvest technology
- **Coordinated Actions for Continuous Adaptation –**Adaptation to reduce the vulnerability of agriculture and allied sectors to the impacts of climate change requires coordinated actions, proper planning, financial resources for implementation and community involvement for improving coastal agriculture.

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1.0 INTRODUCTION

Bangladesh has made remarkable progress in the last three decades towards achieving self-sufficiency in food grains due to substantial intensification of cropping, introduction of high yielding crop varieties, expansion of irrigated areas and increased use of chemical fertilizers. Among the factors, contribution of fertilizers leading to increased production is about 50 percent (Miah, etal. Fertilizer Guide-2005). But recently, declining or stagnation of major crop yields have been recorded due to cumulative effects of many soil-related constraints and climatic risks viz. depletion of soil organic matter, imbalanced use of fertilizers, nutrient mining, degradation of soil physical and chemical properties, temperature rise, erratic rainfall, droughts, floods, salinity, tidal surges, water-logging, cyclone, scanty use of bio and organic fertilizers and poor management practices. It is noted that the proportion of different nutrients used in agriculture without soil testing in recent years is highly deleterious to soil productivity. Nitrogen alone constitutes about 83 percent of total nutrient use in the country, while the use of phosphorus and potassium is limited to about 7.75 and 9.1 percent only. Clearly these factors pose as major risks for optimal crop production systems.

The present challenges for plant nutrient management are to maintain (and where possible to increase) sustainable crop productivity to meet the growing demands for food and raw materials and to enhance the quality of land and water resources.

Bangladesh is presently facing a serious challenge in agricultural production to feed the growing population in the context of shrinking agricultural land and climate change impacts. The population has been projected to grow to 191 million in 2030 from the current 148 million. **The major challenges** for increased growth and production for agriculture sector are:

- Arresting conversion of good agricultural land into non agricultural purposes;
- Reversing trend of nutrient mining and depletion of soil organic matter (SOM) due to mono-culture in intensive crop agriculture;
- Utilization of remarkable areas of agricultural land (30-50% of NCA of concerned districts) that remains fallow or seasonal fallow in drought prone, flood prone and coastal area due to environmental stress factors which will be aggravated further due to climate change;
- Introduction of location specific production packages and sustainable/adaptation agricultural technologies to facilitate the growth of agriculture sector;
- Reduction of yield gap and large scale adoption of proven agro-technologies at farm level;
- Ensuring accessibility/availability of standard fertilizers and problems of using balanced fertilizers at farm level;
- Soaring price of agricultural inputs (viz. seeds, fertilizers, irrigation, machinery etc.)
- Ensuring efficient on-farm water management for maximizing water productivity;
- Making adequate quality seeds at farmers' level;
- Unavailability of suitable salt-tolerant crop varieties in coastal region;
- Developing drought-tolerant varieties for drought prone areas and floodplain & coastal char lands;
- Developing submergence tolerant crop varieties for water-logged soils;

- Improving marketing facilities and Farmer's Group in agro- processing using value added crops;
- Ensuring adequate agricultural technical facilities/information on agricultural production
- Organizing farmers' training for adoption of location specific sustainable production packages for maximizing crop yield.

Bangladesh, with a population of about 148 million, is one of the poorest and most vulnerable countries in the world to disaster and climate change impacts. Different types of natural hazards including floods(e.g. river flood, urban flood and flash flood), cyclone and storm surges, tidal surges/intrusion of saline water, salinity, water-logging/submergence, drought, river bank erosion, tornadoes etc affect the country almost every year. These catastrophic events significantly hinder the agriculture production systems, economic and social development of the country through two processes: firstly, damaging the crops, livestock, fisheries and agro-forestry, natural resources, establishments and infrastructures and secondly, pulling back the on-going developments, business and trade at local, regional and even global levels.

The pattern and behavior of climate, including variability and extreme events, play a significant role in freshwater availability; agriculture and its productivity; function of natural ecosystems and biodiversity; human health; and livelihoods of the people those depend on natural resource base. These characteristics of climate either create favorable condition for a system to function better or put risk on a system and increase vulnerability. Therefore, economic growth and performance of a nation and society greatly rely on the behavior of climate and climatic risks.

In Bangladesh, over 30 % of the net cultivable area is in the coastal region. Out of 2.85 million hectares of the coastal and off-shore areas about 0.828 million hectares of the arable lands, which constitutes about 52.5 percent of the net cultivable area in 64 upazilas of 13 districts. But these vast cultivable areas is under great threat of vulnerabilities of the climate change and crop production is rapidly declining due to climate risk factors. Saline water intrusion, sea level rise, water stagnancy , cyclone and storm surges are climatic hazards affecting the low lying coastal areas.

The climate of Bangladesh is influenced by monsoon climate and characterized by high temperature, heavy rainfall, often-excessive humidity and marked seasonal variations. Although more than half the area is north of the Tropics, the effect of the Himalayan mountain chain is such as to make the climate more or less tropical throughout the year. The climate is controlled primarily by summer and winter winds, and partly by pre-monsoon (March to May) and post-monsoon (late October to November) circulation. The Southwest Monsoon originates over the Indian Ocean, and carries warm, moist and unstable air. The easterly Trade Winds are also warm, but relatively drier. The Northeast Monsoon comes from the Siberian Desert, retaining most of its pristine cold, and blows over the country, usually in gusts, during dry winter months.

People living in different coastal areas of Bangladesh have been suffering from lack of food security. There are many reasons behind that such as lower crop productivity, less cropping intensity, unemployment, large fallow lands/water bodies and land degradation due to various soil-related constraints, climate risks and socio-economic problems. Since people do not have ample employment opportunities round the year, their food security situation is vulnerable and is a matter of great concern for the policy makers. Majority of the people in coastal areas are involved in crop cultivation and fishing and they remain frequently unemployed due to tidal flooding and other natural disasters resulting food insecurity in the areas. As a part of

policy support to the National Food Policy Capacity Strengthening Programme (NFPCSP) of the Ministry of Food and Disaster Management supported by FAO/USAID/EC for proper implementation of the National Food Policy 2006 for ensuring food security to all at all

times, the present study **"Assessing Long-term Impacts and Vulnerabilities on Crop Production due to Climate Change in the Coastal Areas of Bangladesh"** was undertaken to analyze/evaluate the climate impacts on crop production systems and to suggest appropriate coping strategies and adaptation options for improving coastal agriculture for increased agricultural production and better livelihood of the farming community.

The Government of Bangladesh (GoB) is strongly committed to the World Food Summit (WFS) target of reducing the number of undernourished people by half by 2015 and the MDG1 target of eradicating hunger and poverty by halving the proportion of people in the world who are undernourished and living on less than $1 a day (POA:2008-2015).

Bangladesh has made substantial progress in enhancing food security by increasing production of food grains, piarticularly rice, improving infrastructure, making food delivery to the poor more efficiently and liveralizing the agricultural input and utput markets in Floodplain Agriculture. Also, the emphasis placed on rice production has resulted in an increased dependency on imports for non-food grain commodities such as pulses, oilseeds and fruits which remain unaffordable to many consumers, especially vulnerable consumers of the coastal region.

Arsenic contamination has now become a major concern in coastal region for both agricultural sustainability and food safety. Climate change issues pose an additional burden on crop production and food security, especially in areas where agriculture and water resources are already under stress due to adverse meteorological conditions.

Under this context, strengthened efforts to raise productivity and efficiency in food grain production to support agricultural commercialization and diversification, in due consideration of environmental impacts will be paramount. Actions are needed on many fronts, including location-specific technology development, identifying sustainable adaptation options for vulnerable areas, input (good seeds, standard fertilizers, irrigation , macininery) supply and access expansion and critically rural financing which stands currently far below rural producers' seeds.

Malnutrition from macro and micronutrient deficiencies in early life has long lasting effects on subsequent growth, morbidity, cognitive development, educational attainment and productivity in adulthood. There are evidences that malnutrition prevalence in Bangladesh especially in coastal region is not confined to poorer households. Whilst women and children malnutrition is generally higher among the poorest quintiles.

1.1 Climate Change Scenario

The contexts of vulnerability to climate change vary across the country and may be characterized by geographical region with predominant ecosystem systems. The existing vulnerability of the country is related to flood (riverine and flash flood), drought, salinity,

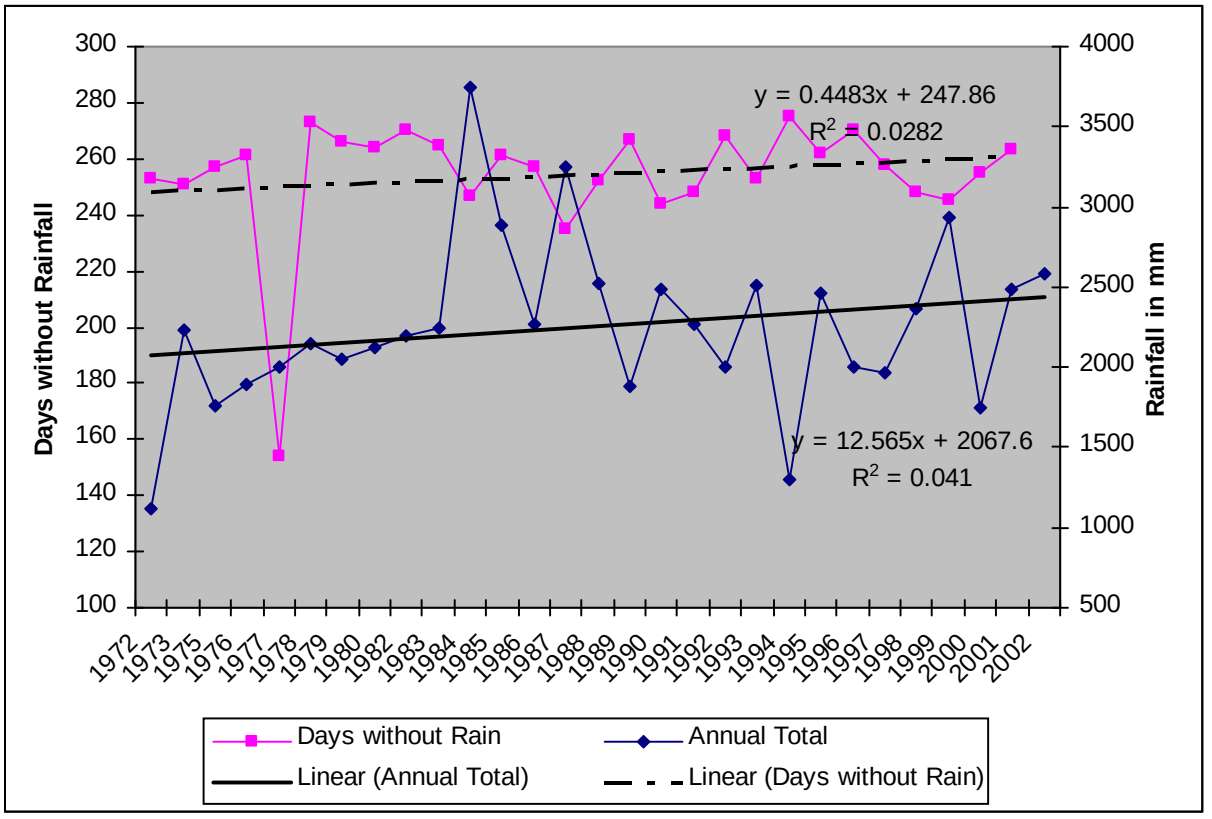
cyclone and storm surges, and river bank and soil erosion. The north-western region of Bangladesh is prone to seasonal drought where extreme temperature and erratic behaviour of rainfall are key issues related to climate change. Salinity intrusion, sea level rise, and cyclone and storm surges are key issues for the low lying coastal area. The floodplain ecosystem spread over mostly in the central region of the country which will face frequent and intense floods due to climate change. The north-eastern and hilly areas of the country will face more devastated flash flood and soil erosion. A summary of the characteristics of the climate related vulnerability context by major geographical region and ecosystems are given below.

The observed climatic data from 1971 to 2002 indicates that the temperature is generally increasing in the monsoon season (June, July and August). The average monsoon maximum and minimum temperatures show an increasing trend annually at 0.05oC and 0.03^{o}C respectively.

The mean annual rainfall of the country is about 2300 mm, but there exists a wide spatial and temporal distribution. Annual rainfall ranges from 1200 mm in the extreme west to over 5000 mm in the east and north-east (MPO, 1991). It is 1220 mm in the north-western part, 1490mm in the central part, 3380mm in the coastal areas, and over 5000mm in the north-eastern part - across the borders from Cherapunji and Mawsyriem, two of the rainiest places in the world (Rashid, 1991). It was observed that the last monsoon (2006) there was lower rainfall resulted in reduction of *Aman* crop production of about 25-30% (Karim, 2006). The most remarkable change of rainfall is the change in duration of rainy season. Bangladesh NAPA states that the duration of rainy season has been decreased but the total annual rainfall remains more or less same. It means that heavy rainfall is occurred within short period. This erratic behaviour of rainfall mostly affects agriculture sector and other livelihood systems.

It is found from the analysis that number of days without rainfall in Bogra station is showing an increasing trend while total annual rainfall is showing decreasing trend. It is also to be noted that the change is not significant and relationship is not very strong. It is found from the analysis that both number of days without rainfall and annual total rainfall in Rangpur is increasing, which means more rain is occurring in short duration. It also reflects erratic behaviour of rainfall. It is also to be noted that the change is not significant and relationship is not very strong. Figure 1 shows changes in annual rainfall and days without rainfall with their trend in Rangpur Station.

Figure 1: Changes in Trend of Annual Rainfall and Days-without Rain (Rangpur Station)



1.1.1 *Future Climate Change Scenario*

Global Circulation Model (GCM) and Providing Regional Climates for Impacts Studies (PRECIS) have been run to develop future climate change scenarios for Bangladesh. The GCM is a global scale model where PRECIS is a regional scale model. Both the models outputs indicate a steady increase in temperatures along with increased trend of summer monsoon precipitation with higher level of inter seasonal variability. Global Circulation Model (GCM) predicts an average temperature increase of 1.0ºC by 2030, 1.4ºC by 2050 and 2.4ºC by 2100. The results also revealed somewhat more warming during the winter months than during the summer. GCM also estimates that precipitation will increase between 6-12% during monsoon months (June, July and August) during 2030 to 2100 while small decreases during the winter months (December, January and February) also predicts. However, value of standard deviation from mean suggests that changes are not statistically significant (Agrawala et al., 2003).

The PREICS model result shows that temperature (maximum and minimum) and rainfall vary over space and time. Projection shows that rainfall in monsoon and post-monsoon seasons will increase while rainfall in the dry season will remain closer to historical amount. Rainfall in pre-monsoon shows erratic nature. It predicts that rainfall will increase about 4, 2.3 and 6.7 percent in 2030, 2050 and 2070 respectively in reference to the observed baseline period 1961-1990 (BUET, 2008). Table 1 shows summary of future climate change scenario generated by using GCM and PRECIS model while Table 2 shows climate change scenarios of different seasons and geographical region of the country.

Table 1: Climate Change Scenario for Bangladesh

Model	Year	Temperature change (°C) Mean (standard deviation)			Precipitation change (%) Mean (standard deviation)			Sea Level Rise (cm)
		Annual	DJF	JJA	Annual	DJF	JJA	
GCM	**2030**	1.0	1.1	0.8	5	- 2	6	14
PRECIS	**2030 (Max)**	0.3	-0.02	1.3*	4	-8.7	3.8	
	2030 (Min)	1.18	0.65	1.78*				
GCM	**2050**	1.4	1.6	1.1	6	- 5	8	32
PRECIS	**2050 (Max)**	0.2	0.07	0.89*	2.3	-4.7	3.0	
	2050 (Min)	1.24	0.59	1.65*				

Source: MoEF, 2005, BUET, 2008 *Note:* * JJAS

Table 2: Climate change scenarios of different seasons and geographical region of the country

		2030				
Rainfall Change (%)		**DJF**	**MAM**	**JJAS**	**ON**	**Ann**
	NE	-9.6	9.0	4.2	24.6	7.0
	SE	-5.3	3.3	-3.3	14.3	2.3
	NW	-17.9	2.0	27.0	4.6	3.9
	SW	-3.6	-2.9	-5.5	19.8	2.0
	BD	-8.7	4.1	3.8	16.6	4.0
Maximum Temperature Change (C)	NE	0.22	-0.05	-0.26	-0.33	-0.10
	SE	0.10	0.56	0.70	-0.59	0.30
	NW	-0.31	0.03	0.16	-0.26	-0.06
	SW	-012	0.09	0.30	-0.90	-0.06
	BD	-0.03	0.16	0.23	-0.52	0.02
Minimum Temperature Change (C)	NE	0.20	0.69	0.48	0.13	0.40
	SE	0.27	0.41	0.78	-0.46	0.35
	NW	0.06	0.42	0.69	0.20	0.38
	SW	0.01	0.40	0.62	0.33	0.36
	BD	0.13	0.48	0.64	0.05	0.37

Source: BUET, 2008

1.1.2 Changes in Sea Level and Salinity Intrusion

Change in the sea level at local level depends on several factors and therefore future sea level rise projected in the assessment report of the Intergovernmental Panel on Climate Change (IPCC) will not be uniform all over world. One of the critical factors related to Bangladesh coast is vertical land movement (subsidence/uplift). Seasonal variation of salinity intrusion also depends on freshwater flow in the river system and cyclonic storm surges.

The SAARC Meteorological Research Council (SMRC) carried out a study on recent relative sea level rise in the Bangladesh coast. The study has used 22 years historical tidal data of the three coastal stations. The study revealed that the rate of sea level rise during the last 22 years is many fold higher than the mean rate of global sea level rise over 100 years, which shown the important effect of the regional tectonic subsidence. Variation among the stations was also found. Table 3 represents the trend of tidal level in three coastal stations.

Table 3: Trend of tidal surges in three coastal stations

Tidal Station	Region	Latitude (N)	Longitude E)	Datum (M)	Trend (mm/year)
Hiron Point	Western	$21^{O}48'$	$89^{O}28'$	3.784	4.0
Char Changa	Central	$22^{O}08'$	$91^{O}06'$	4.996	6.0
Cox's Bazar	Eastern	$21^{O}26'$	$91^{O}59'$	4.836	7.8

Source: SMRC, No. 3

The IPCC 3rd Assessment report estimated that the global rise in sea level from 1990 to 2100 would be between 9 and 88 cm. T he Third Assessment Report has also projected global sea level rise for the year 2020, 2050 and 2080 using different emission scenarios. Future projection of Global Sea Level Rise is given below.

Table 4: Sea Lever Change under different Emission Scenarios

A2 (High Emission Scenario)	**Sea Level Rise (cm)**		
	2020	2050	**2080**
High	6	27	**62**
Low	-	5	**9**
B1 (High Emission Scenario)			
High	5	23	**48**
Low	**-**	**8**	**15**

A recent study result revealed that about 13% more area (469,000 ha) will be inundated in monsoon due to 62 cm sea level rise for high emission scenario A2 in addition to the inundated area in base condition. The most vulnerable areas are the areas without polders like Patuakhali, Pirojpur, Barisal, Jhalakati, Bagerhat, Narail. Due to increased rainfall in addition to 62cm sea level rise, the inundated area will be increased and about 16% (551,500 ha) more area will be inundated in the year 2080. On the contrary, in the dry season due to 62cm sea level rise about 364,200 ha (10%) more area will be inundated (inundation more than 30cm) for A2 scenario in the year 2080. However, 15cm sea level rise has insignificant impact on inundation in dry season.

Salinity intrusion on soil surface and saline water intrusion is highly seasonal in Bangladesh. Salinity and its seasonal variation are dominant factor for coastal echo-system, fisheries and agriculture. Therefore, any changes in the present spatial and temporal variations of salinity level will affect the

biophysical system of coastal area. Distribution of salinity level and landward intrusion in the rivers and surface water for the base condition has been assessed using the southwest region model and Bay of Bengal model for dry and monsoon season. For the base year 2005, it is found that in monsoon (June to September), the saline water is fully flushed out of the Meghna Estuary, but in the western part of the lower delta it is still saline due to scarcity of fresh water flow from upstream. It is found that 5 ppt isohaline (line of equal salinity level) intrude more than 70 km landward in the western part of Sundarbans, through the lean flowing Jamuna-Malancha-Raimangal river system, whereas comparatively higher freshwater flow through Pussur-Sibsa river system pushes the 5 ppt saline front more downward and keeps it at the estuary mouth. Similarly, the Baleswar-Bishkhali river systems with higher monsoonal freshwater flow from the Padma-Lower Meghna, keeps this south central region almost saline free during monsoon. During dry season (December to March) deep landward intrusion occurs through various inlets in the western part of coastal zone and through Meghna Estuary.Salinity will intrude more landward specially during dry season due to sea level rise. Consequently brackish water area would increase and it is seen that sea level rise of 27 cm causes 6% increase of brackish water area compared to base condition. About an additional area of 327,700 ha would become high saline water zone (>5 ppt) during dry season due to 60 cm sea level rise. In the monsoon about 6% of sweet water area (276,700 ha) will be lost. Impact of 15 cm sea level rise on salinity intrusion under low emission scenario B1 in the year 2080 is insignificant.

Table 5: Changes in fresh and brackish water area [Ha] in dry and monsoon

Scenario	Dry Season			Monsoon Season		
	Fresh water area (<1 ppt)	Brackish water area (>1 ppt)	Change (%)	Fresh water area (<1 ppt)	Brackish water area (>1 ppt)	Change (%)
Base	2,562,500	2,152,000		3779600	9403	
A2, 27cm [2050]	2273300	2441200		3665400	10508	114200
A2, 62cm [2080]	2135700	2578800	426800	3502800	12111	276700

1.1.3 Extreme Climatic Events

Natural disasters are regular phenomenon in Bangladesh. Key natural disasters are riverine and flash flood, tropical cyclones, tornados, and droughts due to its unique geographical location (Himalaya to the north and Bay of Bengal to the south). It is reported that between 1991 and 2000, 93 major disasters occurred in Bangladesh, resulting in nearly 200,000 deaths and causing US $ 5.9 billion in damages with high losses in agriculture and infrastructure (CCC, 2007). Since then, the country is experiencing extreme climatic events frequently. It is revealed from the records of last three decades that frequency of natural disasters is increasing over time. The following table shows that frequency of flood and tornado has increased in last two decades.

Table 6: Frequency of Hazards occurred in Bangladesh

Decades	No. of events			
	Flood	Cyclone	Tornado	Drought
80s	1	7	2	3
90s	3	4	1	3
00s	9	7	6	1
01s	6	1	5	0
Total	19	19	14	7

Source: BWDB (2007), CEGIS & SMRC

1.1.4 Changes in Flood Frequency

Flood is a regular natural disaster occurring in Bangladesh entailing huge damage to the economy. Four main types of natural floods occur in Bangladesh:

Table 7: Different types of flood occurring in Bangladesh

Type of Flood	Causes of occurrence	Time/duration	Tentative affected area
Flash Flood	Run-off during exceptionally heavy rainfall occurring in neighbouring upland areas	Pre- monsoon months of April and May	The foot of the Northern and eastern hills of Bangladesh
Rainwater flood/ Monsoon Flood	Heavy rainfall occurring over flood plane and terrace areas within Bangladesh.	April-May June-August	In the south-western part of the country
River Flood	Snow melt in high Himalayans, Heavy monsoon rainfalls over the Himalayans, the Asam Hills, the Tripura Hills and the Uppar Brahmaputra and Ganges flood plains	April-May and June-September	Catchment areas of three major rivers.
Coastal Flood	In case of important cyclones the entire coastal belt is flooded. Coastal areas are also subjected to *tidal flooding*	Tidal flood occurs from June to September	South western coastal areas.

Source: Ahmed, 2006

The projected increase in rainfall during monsoon would be reflected in the flow regimes of the rivers of Bangladesh. Increased flooding and drainage congestion, therefore, are the expected consequences from a warmer and wetter condition. The increased runoff would also aggravate the existing drainage problem and create new ones. Bangladeshi rivers, especially the major ones, have lost gradient during the past several decades. Consequently their conveyance capacity has diminished significantly. Furthermore, snow melting in the Himalayan region along with simultaneous rise in sea level will eventually result in prolonged and devastating flood.

From historical point of view, it has been observed that the frequency, intensity and magnitude of flood have increased as well. Since 1954, 48 small, medium and big floods have struck Bangladesh. Among those, 7 events were severe where more than 30% of land area was inundated. The following table shows comparative situation of flooded areas from 1954 to 2007.

Table 8: Flood with area coverage (Sq. Km) in Bangladesh

Flood											
Year	**Sq. Km.**	**%**	**Year**	**Sq. Km.**	**%**	**Year**	**Sq. Km.**	**%**	**Year**	**Sq. Km.**	**%**
1954	36,800	25	1969	41,400	28	1983	11,100	7.5	1995	32,000	22
1955	**50,500**	**34**	1970	42,400	29	1984	28,200	19	1996	35,800	24
1956	35,400	24	1971	36,300	25	1985	11,400	8	**1998**	**1,00,250**	**68**
1960	28,400	19	1972	20,800	14	1986	6,600	4	1999	32,000	22
1961	28,800	20	1973	29,800	20	**1987**	**57,300**	**39**	2000	35,700	24
1962	37,200	25	**1974**	**52,600**	**36**	**1988**	**89,970**	**61**	2001	4,000	2.8
1963	43,100	29	1975	16,600	11	1989	6,100	4	2002	15,000	10
1964	31,000	21	1976	28,300	19	1990	3,500	2.4	2003	21,500	14
1965	28,400	19	1977	12,500	8	1991	28,600	19	**2004**	**55,000**	**38**
1966	33,400	23	1978	10,800	7	1992	2,000	1.4	2005	17,850	12
1967	25,700	17	1980	33,000	22	1993	28,742	20	2006	16,175	11
1968	37,200	25	1982	3,140	2	1994	419	0.2	**2007**	**62,300**	**42.21**

Source: BWDB, 2007 (Annual Flood report, 2007)

In the context of return period of different scale of flood, it is also found that a flood event which inundates 37% of land usually occurs once in every 10 years. But it was also found that flood with land inundated 37% occurred 5 times in last 30 years and 3 times in last 10 years. Similarly, flood which inundates 60% area supposed to occur once in every 50 years but in last 30 years such flood has occurred twice and in last 10 years has occurred once. It is therefore quite evident that frequency and intensity of flood have increased significantly in last 30 years.

1.1.5 Changes in Drought

Bangladesh experiences major droughts once in 5 years. Droughts at local scale are much more frequent and affect part of the crop life cycle. The western part of the country is vulnerable to drought during pre-monsoon period. Severe drought occurred in the country

During the last 50 years, Bangladesh suffered about 20 drought conditions. The drought condition in north-western Bangladesh in recent decades had led to a shortfall of rice production of 3.5 million tons in the 1990s. If other losses, such as, to other crops (all rabi crops, sugarcane, tobacco, wheat, etc) as well as to perennial agricultural resources, such as, bamboo, betel nut, fruits like litchi, mango, jackfruit, banana etc. are considered, the loss will be substantially much higher. Current severe drought can affect yield in 30% of the country, reducing national production by 10%. 2030 Temperature increase of 0.5°C and annual rainfall reduction of 5% could reduce runoff into the Ganges, Brahmaputra and Meghna Rivers by 14%, 11% and 8%, respectively. With 12% reduction in runoff, the population living in severe drought-prone areas increases from 4% to 9% under moderate climate change.

Table 9: Drought prone areas (in mha) of Bangladesh

Drought Class	Rabi	Pre-Kharif	Kharif
Very Severe	0.446	0.403	0.344
Severe	1.71	1.15	0.74
Moderate	2.95	4.76	3.17
Slight	4.21	4.09	2.90
No Drought	3.17	2.09	0.68
Non-T. Aman			4.71

Source: Drought Manual, BARC, 2003

2050 Future droughts may increase the probability of a dry year, meaning a year with a certain percentage of below-average rainfall, by 4.4 times. Temperature increase of 1.3°C and precipitation decrease of 9% would reduce runoff into the Ganges, Brahmaputra, and Meghna Rivers by 27%, 21% and 15%, respectively. If runoff drops 22% in kharif season, drought-prone areas would expand to include north-western to central, western and south-western regions (GoB, 2005).

Evidences of climate change are already visible in many parts of the world. These include erratic behavior of rainfall and temperature, increased occurrences of extreme weather events such as flood, drought and cyclone, increased tidal height, and intrusion of salinity in the surface water and soil. Changes in the climatic physical system are already affecting development efforts and effects will be more pronounced in future. These adverse impacts will put additional stresses on agricultural production systems and continue to pose challenges towards achievement of the Millennium Development Goals particularly those related to eradicating poverty and hunger, human health and environmental sustainability.

Bangladesh is among the most disaster prone countries in the world and the frequency of and severity of yearly flooding episodes are growing. Further, the catastrophic "once in a generation" floods are also occurring more regularly. This includes eight major floods between 1974 and 2004, many of which are considered by hydrologists to be at a size expected only once in every 20 years. During the 2007 monsoon, Bangladesh experienced several floods with serious consequences for the national economy and the livelihoods of millions of people and not least the cyclone Sidr late 2007 had devastating consequences for more than 5 million people in the southern part of the country. For Bangladesh, this means coping with the impacts of floods, droughts, salinity, cyclones, and extreme temperatures on a more regular basis.

The major environmental issues identified and addressed in the Fifth Five-Year Plan are natural disasters, industrial pollution, deterioration of soil health, human health and sanitation, deforestation, desertification, changes in climatic condition, increased intensity of droughts, severity of floods, increased salinity/tidal surge or water stagnancy and deteriorating habitat of flora and fauna. Since the Fifth Five Year Plan, there had been no other national development plan. But the government has prepared a Poverty Reduction Strategy Paper (PRSP) which has more or less reiterated the same concerns in various forms within the document apart from a separate chapter on environment which include resource management, environmental health, biodiversity and multilateral environmental agreements including those related to climate change. The Government of Bangladesh is in a process of preparing second Poverty Reduction Strategy for Bangladesh and adverse impacts of climate change is being considered as one of the key challenges in achieving different targets including millennium development goals.

In Bangladesh, over 30% of the net cultivable area is in the coastal area. Out of 2.85 million hectares of the coastal and off-shore areas about 0.828 million hectares of the arable lands, which constitutes about 52.5 percent of the net cultivable area in 64 upazilas of 13 districts. But these vast cultivable areas is under great threat of vulnerabilities of the Climate Change and crop production is rapidly declining.

Coastal Agriculture is being seriously affected by different levels of climatic risks caused by integrated effects of the following factors: soil salinity, water salinity, sea level rise, tidal surge, cyclone, heavy soils, soil wetness/water stagnancy, fallow /seasonal fallow land, incidence of pests and diseases, poor marketing infrastructure, problem of agro-based industries, poor health, livelihood, fishermen's are jobless, migration to cities, unsafe drinking water, etc.

The coastal belt is highly vulnerable due to the climate change. The intensity of Disasters like sea level rise, tidal surge, salinity intrusion and cyclone in coastal belt is being increased. The

salinity intrusion is a major factor which impedes the crop production at large in the coastal belt. Water and Soil salinity is a common hazard in many parts of the coastal zone. Consequently, the crop area is reducing and the cultivation of aus (summer rice), boro (dry season rice and other rabi (dry season) crops are being restricted. The major causes behind expansion of salinity are:

- Salinity is expected to be exacerbated by climate change and sea-level rise.
- Decrease of upstream flow due to Farrakka Barrage
- Expansion of shrimp farms
- CEP (Coastal Embankment Project), implemented during the 1960s

The freshly deposited alluvium from upstream in the coastal areas of Bangladesh becomes saline as it comes in contact with sea water and continues to be inundated during the high tides and ingress of sea water through different inlets. The factors which are contributing significantly to the development of saline soils are : tidal flood during wet seasons(June-October), direct inundation by saline or brackish water, and upward or lateral movement of saline ground water during dry season (Nov-May). The severity of salinity problems in Bangladesh increased with the desiccation of the soil in the dry season.

The major districts which are affected by the high level of salinity are: Bagerhat, Barguna, Barisal, Bhola, Cox's Bazar, Noakhali, Khulna, Patuakhali, Pirojpur and Satkhira. These districts are included in the project as study areas.

During the wet monsoon the severity of salt injury is reduced due to dilution of the salt in the root zone of the standing crop. The dominant crops grown in the saline areas are local transplanted aman rice with poor yields. Salinity problem received little attention in the past but due to increased demand for growing more food to feed the booming population for the country, it has become imperative to explore the potentials of these lands for crop production. Under this project, different factors of coastal vulnerabilities will be identified and assessed thoroughly in the context of present farming practices with recommendations of adaptation measures.

Coastal Agriculture

Presently, Coastal Agriculture is being seriously affected by cumulative effects of soil-related constraints, climatic risks and socio-economic problems. These are:

Soil-related constraints

- Problems of increasing soil salinity and water salinity
- Scarcity of quality irrigation water during dry season
- Heavy soil consistency due to swelling/cracking clays
- Problems of tillage operations for land preparation
- Soil wetness and late drainage conditions in early dry season
- Large fallow lands or water bodies/seasonal fallow lands
- Deficiencies of N,P,S and Zinc
- Iron (Fe) toxicity and arsenic (As) contamination
- Water-logging and drainage congestion

Climatic risks

- High temperature, erratic rainfall and droughtiness

- Sea level rise, tidal surges/flooding and intrusion of salt water
- Cyclone/stormy wind
- Incidences of pests and diseases

Socio-economic problems

- Poor marketing infrastructure
- Problems of road network and communication
- Problems of agro-based industries
- Poor human health and nutrition
- Lack of employment opportunities
- Problems in fishing activities
- Population migration
- Unsafe drinking water etc.

The intensity of disasters like sea level rise, tidal surge, salt water intrusion and cyclone in coastal belt is being increased affecting crop production systems in the coastal belt.

2.0 OBJECTIVES OF THE STUDY

The main objective of the research project is to assess short term and long term impacts of Climate Change on crop production in the coastal areas of Bangladesh. The main research questions are:

→ What are the impacts of CC on crop production?

→ What are the consequences of CC in the study areas?

→ What are the coping mechanisms being used?

The specific objectives are:

- To identify and assess the different risk factors with extent and severity affecting crop production systems in the coastal region.
- To identify possible opportunities and options for increasing crop production in coastal region.
- To identify and evaluate the present status of crop based food production systems in the salinity affected soils of the coastal belt.
- To make recommendations (short term, mid term and long -term basis) for increasing crop based food production in coastal region.

2.1 Expected Outputs

Output-1 : Improved knowledge and understanding on the risk factors affecting present agricultural practices at different environmental conditions.

Output-2 : Inventory of risk factors that affecting crops and crop production systems.

Output-3 : Familiarization with improved and innovative practices as a means of adaptation measures to face existing impacts of vulnerabilities.

Output-4 : Support policy and decision making process and future research programs and practices on the matter of coastal climatic vulnerabilities in agriculture and food security.

Output-5 : Documentation and dissemination of information and lessons learned.

2.2 Work Plan

Activities (List of major activities)

	Major Activities
1.	Arrange project Inception Meeting
2.	Review of relevant reading materials
3.	Preparation of FGD checklist/questionnaire and collection of survey tools
4.	Arrange Inception Workshop/FGD at district level for the Collection of Upazila-wise information/ data on major crops/cropping patterns, land use, conversion of agricultural land into other purposes, land degradation, identification of environmental risk factors affecting crop production and crop production practices.
5.	a. Conduct household survey for the collection of data from study sites for Identification of risk factors affecting crop production in study areas and farmers' responsiveness on changes/impacts of different risk factors on crop production systems and livelihood.
	b. Creating awareness on sustainable land use
6.	a. Processing of data b. Analysis of data c. Drafting of report d. Holding the seminar on draft report
7.	Printing/publishing the final report

3.0 METHODOLOGY

3.1 Approach and Analytical Tools, Sources and Methodology of Data Collection

A multi-disciplinary, participatory and interactive method has been followed in carrying out the study. Both primary and secondary data were reviewed and incorporated in the following ways:

- The secondary data collected and reviewed on land use, climate change and land degradation.
- Data/information on land use systems, major crops/cropping patterns, conversion of agricultural land, climatic parameter (rainfall, temperature etc.), land/soil data on different parts of the country etc. being collected from pertinent institutions.
- Collection of information/data from primary sources
- Field visits and discussion with farmers about the problems and prospects of coastal agriculture and documentation of farmers' experiences on innovative practices.
- Focus Group Discussion (FGD) conducted of different districts for collection of information from upazila level.
- Household Survey conducted for collecting farmers' response on adaptation practices.
- Case Study on Health and Nutritional Aspects
- Arrange Stakeholders' Workshops at Regional/District and National Level on Draft Project Completion Report.

3.2 Development of checklist for FGD

To obtain information from the FGDs a checklist was prepared **(annexure-II)**. The checklist contained some indicators on which information was obtained. The major indicators were presented below:

- Particulars of interviewee
- Site description
- Major crops and cropping patterns
- Causes of changing crops/cropping patterns
- Identifying factors of climate change those responsible for crop loss/yield reduction
- Assessing long-term impacts of climate change on crop production systems.
- Identifying the problems and prospects related crop production systems
- Estimation of problem areas (eg. coastal char lands, salinity/tidal surge or water stagnancy) due to climate change.
- Identifying different innovative farming practices in salinity/tidal surge areas.
- Identifying location-specific adaptation practices to cope up with vulnerabilities due to climate change.
- GO/NGO interventions to address climate change problems/hazards.
- How climate change is affecting food security
- Action /measures needed for vulnerable areas

  - Immediate measures

  - Mid-term measures

3.3 Pre- testing and finalizing the checklist

The checklist was pre tested to identify its validity. On the basis of the feedback obtained from the pre- testing the checklist was finalized.

3.2.5. Commissioning of the FGD team

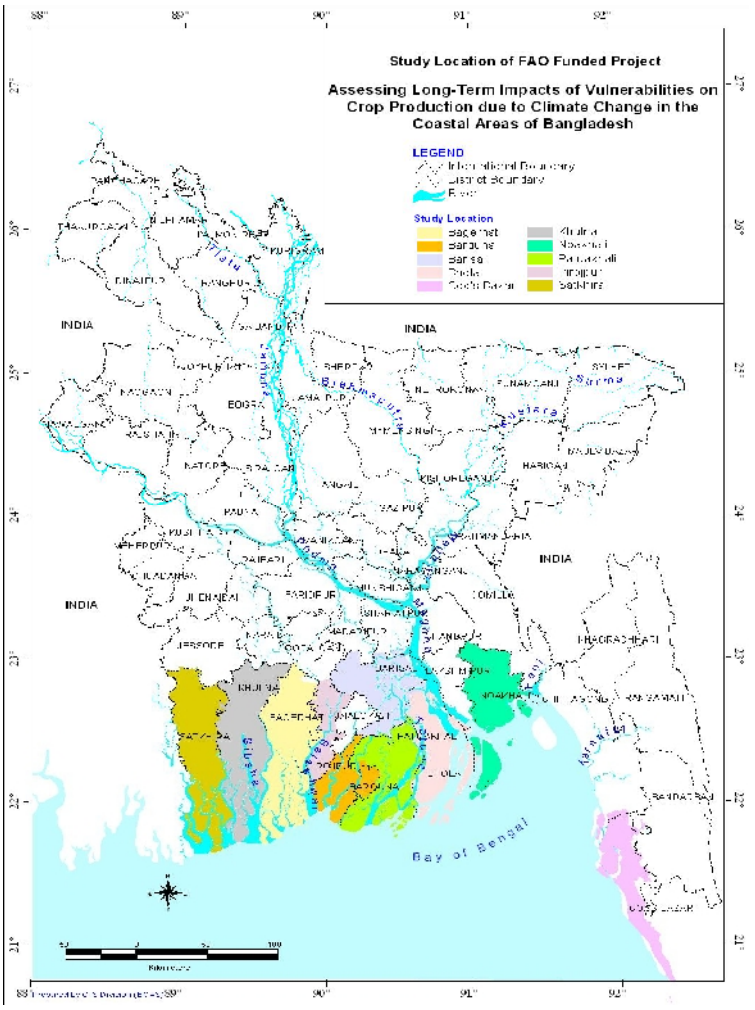
A three member multidisciplinary FGD team comprising of one Principal Investigator/ Coordinator, one environmentalist and one Agriculturist was formed.

3.2 Study Locations and Sampling Sites

As per project proposal, following 10 (ten) relevant and important costal districts were included under this study:

- Khulna
- Bagerhat
- Satkhira
- Barisal
- Bhola
- Barguna
- Pirojpur
- Patuakhali
- Cox’s Bazar
- Noakhali

Figure 2: Project sites shown in Map



From each district, 3 Upazilas have been selected for household survey based on climatic risks and variabilities affecting agriculture production systems. During household survey, 3 villages from 3 different Union have been selected from each Upazila.

4.0 RESULTS AND DISCUSSION

4.1 Literature Review and Analysis

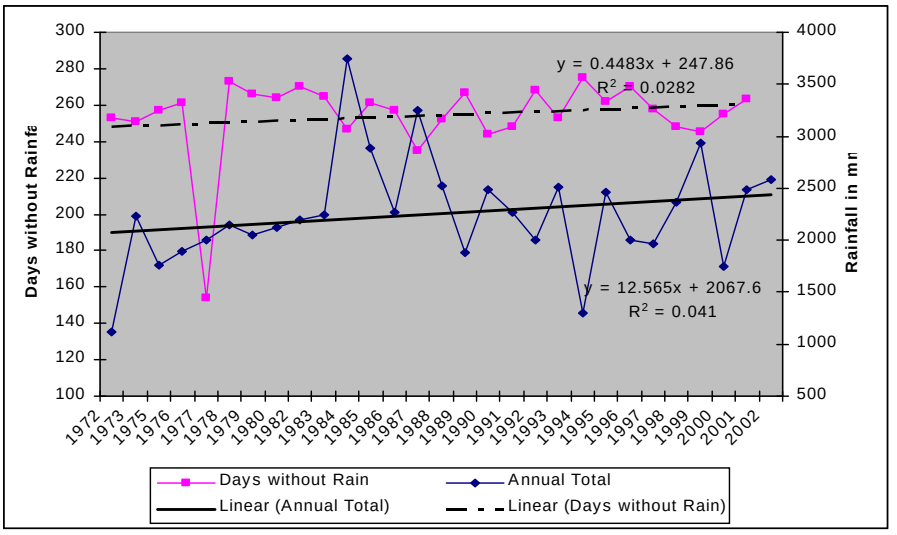
a) Present Challenges in Agriculture

- Bangladesh is the most vulnerable country in the world to disasters and climate change impacts affecting the agriculture production systems and overall economic and social development of the country.
- Arresting conversion of good agricultural land into non- agricultural purposes;
- Reversing trend of nutrient mining and depletion of soil organic matter (SOM) due to mono-culture in intensive crop agriculture;
- Remarkable areas of agril land (30-50% of NCA in concerned districts) that remains fallow or seasonal fallow in drought prone, flood prone and coastal area due to environmental stress factors which will be aggravated further due to climate change;

- Lack of location specific production packages and agricultural technologies to facilitate the growth of agriculture sector;
- Reduction of yield gap of proven agro-technologies at farm level;
- Unvailability of standard fertilizers and problems of balanced fertilizers at farm level;
- Soaring price of agricultural inputs (viz. good seeds, standard fertilizers, irrigation, machinery etc.) at farm level;
- Lack of efficient on-farm water management for maximizing water productivity;
- Unavailability of adequate quality seeds at farmers' level;
- Unavailability of suitable salt-tolerant and drought-tolerant crop varieties in coastal region and char lands and submergence tolerant varieties for water-logged soils;
- Lack of marketing facilities, road net work and agro- processing units;
- Lack of organized farmers' training for adoption of location specific sustainable production packages for maximizing yield.

b) Climate Change Scenarios

Figure 3: Changes in Annual rainfall and without rainfall (Rangpur Station)



- Extreme temperature
- Number of days without rainfall is increasing
- Erratic nature of rainfall
- More rain is occurring in short duration

c) Climate Change (Temperature, Precipitation and Sea-Level Rise)

Scenario for Bangladesh

Long-term impacts of climate change (viz. changes in temperature, erratic rainfall, sea level rise etc) were critically reviewed based on time series data base. The changes in temperature, precipitation and sea level rise were summarized in the following table-10.

Table 10: Changes in Temperature, Precipitation and Sea-Level Rise

Model	Year	Temperature change (°C) Mean (standard deviation)			Precipitation change (%) Mean (standard deviation)			Sea Level Rise (cm)
		Annual	DJF	JJA	Annual	DJF	JJA	
GCM	2030	1.0	1.1	0.8	5	- 2	6	14
PRECIS	2030 (Max)	0.3	-0.02	1.3*	4	-8.7	3.8	
	2030 (Min)	1.18	0.65	1.78*				
GCM	2050	1.4	1.6	1.1	6	- 5	8	32
PRECIS	2050 (Max)	0.2	0.07	0.89*	2.3	-4.7	3.0	
	2050 (Min)	1.24	0.59	1.65*				

Source: MoEF, 2005, BUET, 2008 *Note:* * JJAS

- Temperature is generally increasing in the monsoon
- Average monsoon max. and min. temperatures show an increasing trend annually 0.05 °C and 0.03°C respectively
- Lower rainfall in Aman season
- Global Circulation Model (GCM) precipitation will increase between 8-12%

d) Trend of tidal surge in three coastal stations

Table 11: Trend of tidal surge in three coastal stations

Tidal Station	Region	Latitude (N)	Longitude (E)	Datum (m)	Trend (mm/year)
Hiron Point	Western	21°48′	89°28′	3.784	4.0
Char Changa	Central	22°08′	91°06′	4.996	6.0
Cox's Bazar	Eastern	21°26′	91°59′	4.836	7.8

Source: SMRC, No. 3

4.2 Field Level Activities

a) Collection of secondary information/data from Upazilla level

b) Stakeholders' Consultation/FGD

Stakeholders' consultation/FGDs were arranged in the conference room of Deputy Director (Agril. Extension) at district level for collecting Upazila-wise information/data on land degradation, land use, vulnerable areas, changes in major crops/cropping patterns, changes in climatic factors (temperature, rainfall etc), climatic risk factors affecting crop production and for identifying/documenting innovative/adaptation practices etc in the context of climate change in the vulnerable areas of salinity/tidal surges from the following districts using a structured questionnaire/checklist. A short training/briefing on checklist was also arranged for the participants for filling up the questionnaire for providing the desired information/data on climate change.

Focus Group Discussions (FGDs) were arranged in all project sites as follows:

District	Upazila	# of Participants	Level/particulars of participants
1.Cox's bazaar	Chakaria, Pekua, Ramu, Cox's bazaar(S), Ukhia, Teknaf, Maheskhali, Kutubdia	25	Selected DAE Dist. Officers, NARS local scientists, all UAOs/ AEOs, selected SAAOs and progressive armers
2. Patuakhali	Dumki, Baufal, Dashmina, Galachipa, Mirzaganj, Patuakhali(S), Kalapara	25	-do-
3. Barguna	Barguna(S), Betagi, Pathorghata, Bamna, Amtali	25	-do-
4. Pirojpur	Pirojpur(S), Bhandaria, Kawkhali, Nazirpur, Zianagar, Nesarabad, Mathbaria	25	-do-
5. Barisal	Barisal(S), Hizla, Bakerganj, Babuganj, Banaripara, Uzirpur, Agailjhara, Gouranadi, Muladi, Mehendiganj	25	-do-
6. Noakhali	Noakhali(S), Hatiya, Senbagh, Chatkhil, Companiganj, Subarnachar, Begumganj, Sunaimuri	25	-do-
7. Satkhira	Satkhira(S), Kalaroa, Tala, Debhatta, Shymnagar, Assasuni, Kaliganj	25	-do-
8. Khulna	Rupsa, Dumuria, Fultala, Digholia, Terokhada, Koyra, Dacope, Batiaghata	25	-do-
9. Bgerhat	Bagerhat(S), Sharankhola, Mongla, Fakirhat, Rampal, Morrelganj, Chitalmari, Kachua, Mollahat	25	-do-
10. Bhola	Lalmohan, Monpura, Daulatkhan, Borhanuddin, Bhola(S), Tazumuddin, Charfasion	25	-do-

c) Household Survey done in 10 (ten) districts

Household survey was conducted in the selected Upazilas of the project 10 (ten) districts as follows(Table 12):

Table 12: Locations of Household survey

District	Selected Upazila	# HHs surveyed	DAE Field Staff in HHs survey	Climate vulnerabilities
Cox's bazaar	Cox's bazaar (S) Maheskhali Chakaria	60x3 =180	Concerned SAAOs	-Soil salinity, tidal surges -Soil erosion, flash flood -Expansion of shrimp culture
Satkhira	Tala Shymnagar Assasuni	60x3 =180	Concerned SAAOs	-Soil salinity, tidal surges -Tidal flood, waterstagnancy -Expansion of shrimp culture
Khulna	Dumuria Batiaghata Terokhada	60x3 =180	Concerned SAAOs	-Soil salinity, tidal surges -Ground water salinity -Expansion of shrimp culture
Bagerhat	Rampal Mollahat Sharankhola	60x3 =180	Concerned SAAOs	-Soil salinity, tidal surges -Water stagnancy, cyclone -Expansion of shrimp culture
Barisal	Barisal Sadar Banaripara Ujirpur	60x3 =180	Concerned SAAOs	-Soil salinity, tidal surges -Soil erosion, flash flood -Expansion of shrimp culture
Bhola	Charfashion Tajumuddin Borhanuddin	60x3 =180	Concerned SAAOs	-Soil salinity, tidal surges -Water stagnancy, cyclone -Problems of communication
Pirojpur	Pirojpur Sadar Nazirpur Nesarabad	60x3 =180	Concerned SAAOs	-Soil salinity, tidal surges -Water stagnancy, cyclone -Expansion of shrimp culture
Barguna	Barguna Sadar Amtali Betagi	60x3 =180	Concerned SAAOs	-Soil salinity, tidal surges -Water stagnancy, cyclone -Expansion of shrimp culture
Patuakhali	Dumki Kalapara Galachipa	60x3 =180	Concerned SAAOs	-Soil salinity, tidal surges -Water stagnancy, cyclone -Ground water salinity
Noakhali	Subarnachar Hatiya Senbag	60x3 =180	Concerned SAAOs	-Soil salinity, tidal surges -River erosion, cyclone -Ground water salinity

d) Case Study on Health and Nutritional Aspects

Some Case Studies were conducted in assessing the status of human health and nutrition of the vulnerable people in the project sites. The study showed that the vulnerable people especially women and children are suffering from malnutrition>cold/fever>dysentery/ diarrhea>skin diseases> asthma/ jaundice. The detailed problems of health and nutritional aspects of the vulnerable people have been listed in the following table-13:

Table 13: Locations of Case Study on Health and Nutrition

District	Upazila	# HHs surveyed	DAE Field Staff in HHs survey	Major problems of health & nutrition
Barisal	Barisal Sadar Banaripara	42	SAAOs	Malnutrition: 23.3 %, dysentery: 20.4%, skin disease: 11.6%, cold/fever: 11.6%, gastric: 10.1% and diarrhea and asthma:8.7%
Pirojpur	Pirojpur Sadar Nazirpur	40	SAAOs	Cold/fever: 22.2%, dysentery: 20.4%, malnutrition:16.2%, diarrhea:15.5%, skin disease: 13.4%, and asthma:3.5%
Patuakhali	Dumki Kalapara Galachipa	60	SAAOs	Cold/fever: 27.6%, malnutrition: 25.3 %, asthma and jaundice:10.5-11.3% and skin disease, gastric and dysentery: 6-7%20.
Satkhira	Tala Shyamnagar	40	SAAOs	Malnutrition: 23.3 %, dysentery: 20.4%, cold/fever: 15%, skin disease: 11.6%, and asthma:8.0%

4.3 Results and Discussion of Field Activities

a) Survey and Focus Group Discussion (FGD)

i) Land use and changes in major crops and cropping patterns

Time series data and information (during 1975-76 and 2005-06) on major crops and cropping patterns were collected from all project sites during visits of local DAE Offices, field visits, survey/FGDs and discussion with farmers. The data were compiled in the Table-14. Data showed that the average cropping intensity in the coastal areas has not increased as much compared to Flood Plain Agriculture during 1975-76 to 2005-06. The average cropping intensity ranges from 155-181 % except Bhola and Noakhali districts. But there was a great change in the use of agricultural lands in other purposes due to climate change.

Table 14: ***Land use and changes in major crops and cropping patterns***

District	Average Cropping intensity (%) in 1975-76	Average Cropping intensity (%) in 2005-06	% increase
Bagerhat	160.50	170.25	6.07
Barguna	128.00	155.00	21.09
Barisal	166.00	170.00	2.40
Bhola	141.50	223.33	57.83
Cox's Bazar	160.00	172.00	7.50
Noakhali	170.00	225.00	32.35
Khulna	124.00	174.00	40.32
Patuakhali	130.00	157.00	20.77
Pirojpur and	156.00	170.00	8.97
Satkhira	113.50	181.00	59.47
National cropping Intensity (%) CI % FP Agriculture	156	197.00	27.00
(Mymensingh) CI % FP Agriculture (Jessore)	178 167	221.00 255.00	25.00 41.00

Source : DAE, District Office and SRDI

ii) Estimation of Seasonal Fallow Lands in the Coastal Districts

Upazila-wise seasonal fallow lands that remain fallow in Rabi, Kharif-I and Kharif-II seasons were estimated during survey and FGDs conducted at different districts under the project. The main reasons of fallowing were also identified during FGDs. A summary of seasonal fallowing (during 2005-2008) is shown below (Table 15).

Table 15: ***Seasonal Fallow Land in the Coastal Districts***

District	Total cultivable land (in ha)	Seasonal fallow (in ha)			Total	Main reasons of fallowing
		Rabi	Kharif-I	Kharif-II		
Cox's bazaar	66000	37,890	74,912	22,649	135,451	Salinity, drought , flash flood, shrimp culture, tidal surge
Patuakhali	220000	71,926 (32.7%)	103,480 (47.04%)	905	176,311	Soil wetness, lack of water supply, tidal surge, salinity, drought, late harvest of T.Aman, submergence
Barguna	104081	45,963 (44.2%)	55,325 (53.2%)	1,668	102,956	Late aus, soil wetness, drought, lack of irrig facilities, late harvest of T.Aman, salinity, submergence
Pirojpur	88400	46,290 (52.4%)	41,083 (46.5%)	10,755	98,128	Late harvest of T.Aman, submergence, salinity, soil wetness, salinity, clayey soils
Barisal	186220	39,325 (21.1%)	61,782 (33.2%)	18,535 (10%)	119,642	Submergence, salinity, lack of irrigation facilities, Low SOM, drought, short winter, river erosion, lack of irrigation facilities
Noakhali	141000	69,640	128,359	53,527	251,526	Salinity, water-logging, scarcity of irrig. water, tidal surge
Satkhira	120000	47,000	81,470	24,530	153,000	Water stagnancy, salinity, drought, scarcity of sweet water, salinity, shrimp culture, drainage problems
Khulna	111000	52,955	64,070	13,460	130,485	Soil & water salinity, lack of fresh irrig. Water, salinity, floods, submergence, river erosion, shrimp culture
Bagerhat	134010	61,690 (46.0%)	57,983 (43.3%)	11,583 (8.6%)	131,256	Salinity, Shrimp culture, water-logging, salinity intrusion, flood, pests & diseases, drainage problems
Bhola	175662	22,404 (12.7%)	68,153 (38.8%)	1,412	91,969	Lack of irrigation facilities, long duration rabi crops Late harvest of T.Aman, soil wetness, late boro, salinity
Total		**495,083**	**776,617**	**159,024**	**1,430,724**	

Source : DAE, District Office and SRDI

iii) Upazila-wise Seasonal Fallow Land in different districts(during 2005-2008)

Upazila-wise seasonal fallow lands with reasons of fallowing have been described and are shown in the following Table-16.

Table 16: ***Upazila-wise Seasonal Fallow Lands in the Coastal Districts***

District	Upazila	Seasonal fallow(in ha)			Main reasons of fallowing
		Rabi	Kharif-I	Kharif-II	
1. Cox's Bazaar	Cox's bazaar(s)	5,560.00	23.00	5,350.00	Salinity, drought & flash flood
	Chakaria	3,957.00	22,276.00	5,297.00	Salinity, shrimp cultivation
	Pekua	4,139.00	7,256.00	1,239.00	Salinity, drought, flash flood
	Ramu	2,980.00	10,190.00	1,790.00	Salinity, embankment failure, pests
	Ukhia	3,043.00	8,737.00	500.00	& diseases
	Teknaf	16,323.00	18,085.00	8,323.00	Salinity, excess rainfall
	Maheskhali	1,608.00	8,340.00	150.00	Salinity, lack of irrigation facilities
	Kutubdia	280.00	5.00	-	Salinity, ground water problems,
	Total	**37,890.00**	**74,912.00**	**22,649.00**	tidal surge
					Salinity, flash flood, cyclone, tidal surge
2. Patuakhali	Dumki	3,000.00	4,000.00	-	Soil wetness, lack of water supply,
	Kalapara	20,100.00	20,900.00	100.00	tidal surge
	Patuakhali (s)	6,137.00	10,650.00	50.00	Salinity, drought, late harvest of
	Mirzaganj	3,875.00	4,000.00	50.00	T.Aman, cyclone
	Galachipa	17,500.00	32,500.00	155.00	Late harvest of T.Aman, salinity,
	Dashmina	7,114.00	14,230.00	-	drought
	Bauphal	14,200.00	20,200.00	550.00	Salinity, lack of surface irrigation,
	Total	**71,926.00**	**103,480.0**	**905.00**	submergence
					Late harvest of T.Aman, drought, tidal surge
					Soil wetness, late harvest of T.Aman, tidal surge
					Late harvest of T.Aman, lack of irrigation
3. Barguna	Barguna Sadar	7,650.00	12,022.00	533.00	Late aus, soil wetness, drought,
	Betagi	3,030.00	2,040.00	75.00	lack of irrig.
	Pathorghata	8,800.00	17,073.00	100.00	Late harvest of T.Aman, salinity,
	Bamna	1,950.00	700.00	400.00	submergence
	Amtali	24,553.00	23,490.0	560.00	Salinity, lack of irrigation, tidal
	Total	**45,963.00**	**55,325.00**	**1,668.00**	surge
					Late harvest of T.Aman, soil wetness, seed bed
					Soil wetness, late harvest of T.Aman, salinity
4. Pirojpur	Pirojpur Sadar	9,077.00	8,243.00	720.00	Late harvest of T.Aman,
	Bhandaria	5,673.00	2,915.00	150.00	submergence, salinity
	Kawkhali	4,540.00	2,150.00	95.00	Late harvest of T.Aman, soil
	Nazirpur	2,875.00	7,400.00	8,700.00	wetness, salinity
	Zianagar	4,800.00	4,200.00	10.00	Late harvest of T.Aman, tidal
	Nesarabad	6,325.00	2,175.00	1,060.00	surge, salinity
	Mathbaria	13,000.00	14,000.00	20.00	Clayey soils, excess moisture,
	Total	**46,290.00**	**41,083.00**	**10,755.00**	salinity, high rains
					Clayey soils, soil wetness, drainage, salinity
					Late harvest of T.Aman, problems in seed bed
					Late harvest of T.Aman, salinity, drought
5. Barisal	Babuganj	685.00	3,385.00	175.00	Rainfall variation, salinity, Lack of
	Bakerganj	15,476.00	9,104.00	193.00	irrigation
	Hizla	3,464.00	10,100.00	1,225.00	Low SOM, drought, short winter,
	Barisal Sadar	4,230.00	4,250.00	350.00	rever erosion
	Wazirpur	900.00	14,000.00	10,000.00	Low SOM, lack of irrig. Facilities,
	Banaripara	200.00	6,110.00	1,200.00	fogginess
	Gournadi	1,200.00	3,200.00	3,300.00	High rainfall, floods, pests
	Mehendiganj	7,500.00	7,010.00	980.00	&diseases
	Muladi	5,670.00	4,623.00	1,112.00	Excess rainfall, water-logging,

District	Upazila	Seasonal fallow(in ha)			Main reasons of fallowing
		Rabi	Kharif-I	Kharif-II	
	Total	**39,325.00**	**61,782.00**	**18,535.00**	canal problems Soil wetness, submergence, rainfall Submergence, drainage problems Flood, submergence, lack of irrigation Soil wetness, flood, drought, cyclone
6. Noakhali	Noakhali (S)	9,339.00	14,139.00	500.00	Salinity, water-logging, scarcity of irrig. water
	Subarnachar	14,667.00	16,440.00	-	Salinity, water-logging
	Companyganj	5,000.00	12,000.00	200.00	Salinity, lack of irrigation water
	Kabirhat	1,000.00	2,000.00	-	Salinity, tidal surge
	Begumganj	630.00	16,300.00	15,950.00	Flash flood, high rainfall
	Sunaimuri	1,974.00	12,260.00	12,317.00	Salinity, submergence
	Senbag	5,410.00	10,620.00	3,950.00	Drought, short winter, water-logging
	Chatkhil	20.00	7,500.00	8,000.00	Water-logging, high water level
	Hatiya	31,600.00	37,100.00	12,610.00	Salinity, embankment failure, bank erosion
	Total	**69,640.00**	**128,359.0**	**53,527.00**	
7. Satkhira	Satkhira Sadar	1,423.00	2,250.00	2,000.00	Water stagnancy, salinity, drought
	Shyamnagar	36,070.00	38,220.00	16,970.00	Scarcity of sweet water, salinity, shrimp culture
	Kaliganj	5,000.00	6,000.00	1,500.00	Salinity, shrimp culture, drainage problems
	Kolaroa	117.00	11,000.00	860.00	Salinity, water-logging, shrimp culture
	Tala	-	12,000.00	3,000.00	Siltation, salinity, water-logging
	Debhatta	150.00	6,000.00	-	Salinity, water-logging, shrimp culture
	Assasoni	5,000.00	6,000.00	200.00	Salinity, flood, shrimp culture
	Total	**47,000.00**	**81,470.00**	**24,530.00**	
8. Khulna	Batiaghata	17,000.00	13,500.00	400.00	Soil & water salinity, lack of fresh irrig. Water
	Dacope	19,100.00	19,000.00	255.00	Salinity, floods, river erosion, high rainfall
	Koyra	5,800.00	1,200.00	500.00	Salinity, fresh water scarcity, iron toxicity
	Rupsa	990.00	200.00	1,400.00	Flood, tidal surge
	Paikgachha	-	350.00	4,255.00	Salinity, shrimp culture
	Terokhada	5,215.00	9,250.00	3,150.00	Water salinity, flood, water-logging
	Dumuria	3,000.00	5,300.00	1,100.00	Salinity, water-logging, ground water salinity
	Fultala	600.00	1,500.00	1,000.00	Salinity, water-logging
	Digholia	1,250.00	13,770.00	1,400.00	Water-logging, irrigation problems
	Total	**52,955.00**	**64,070.00**	**13,460.00**	
9. Bagerhat	Chitalmari	150.00	4,000.00	5,000.00	Salinity, Shrimp culture, water-logging
	Morrelganj	10,000.00	5,000.00	250.00	Salinity intrusion, flood, pests & diseases
	Rampal	19,000.00	1,500.00	1,400.00	Salinity, scarcity of irrigation water, shrimp
	Fakirhat	5,023.00	9,360.00	1,988.00	Salinity, erratic rainfall, Shrimp culture
	Mongla	12,255.00	12,625.00	1,385.00	Salinity, submergence, soil
	Sharankhola	6,540.00	6,890.00	30.00	
	Bagerhat (S)	510.00	275.00	195.00	
	Kachua	4,629.00	6,988.00	450.00	
	Mollahat	3,583.00	11,345.00	885.00	

District	Upazila	Seasonal fallow(in ha)			Main reasons of fallowing
		Rabi	Kharif-I	Kharif-II	
	Total	**61,690.00**	**57,983.00**	**11,583.00**	pollution River water salinity, high rains, submergence Salinity, drought, water-logging Water salinity, water-logging, problems in irrig. Salinity, flood, drainage problems
10. Bhola	Bhola Sadar	9,894.00	11,231.00	247.00	Lack of irrigation, long duration rabi crops
	Lalmohan	2,890.00	12,000.00	335.00	Late harvest of T.Aman, soil wetness, late boro
	Monpura	380.00	7,100.00	220.00	Salinity, lack of irrigation, excessive rainfall
	Daulatkhan	2,103.00	3,610.00	-	Lack of irrigation, river bank erosion
	Borhanuddin	5,250.00	7,375.00	250.00	Lack of irrigation, late sowing of boro
	Tazumuddin	845.00	2,642.00	210.00	Lack of water source, late harvest of T.Aman
	Charfasion	1,042.00	24,195.00	150.00	Salinity, drought, tidal surge
	Total	**22,404.00**	**68,153.00**	**1,412.00**	

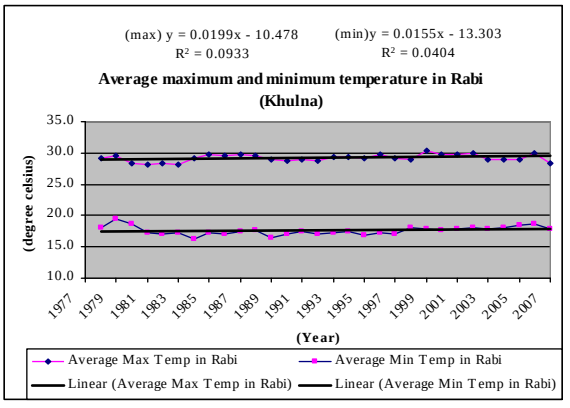
Source : DAE, District Office and SRDI

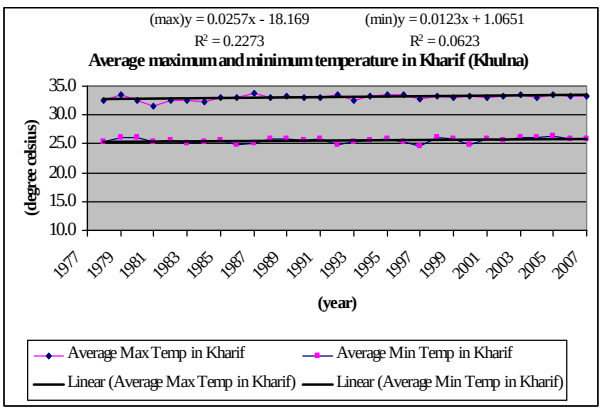
iv) Long-term Impacts of Climate Change on Crop Production Systems

During the study, time series data/information on land use systems, conversion of agricultural land, **climatic parameters (erratic rainfall, changes in temperature, humidity, sunshine, day length, fogginess etc.),** land/soil data on different crops and crop performance and yield etc were collected and studied for assessing the yield trend. The long-term changes in temperature and rainfall in different project sites affecting crop production systems are shown below graphically:

a) Changes in Temperature during 1975-76 to 2005-06 in coastal districts

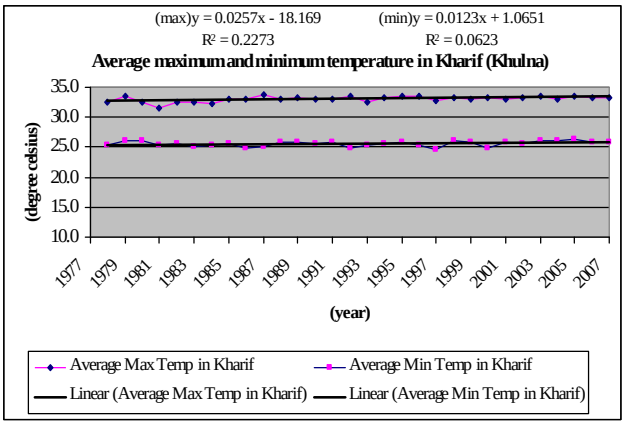
Figure 4: **Changes in Temperature *(Khulna District)***

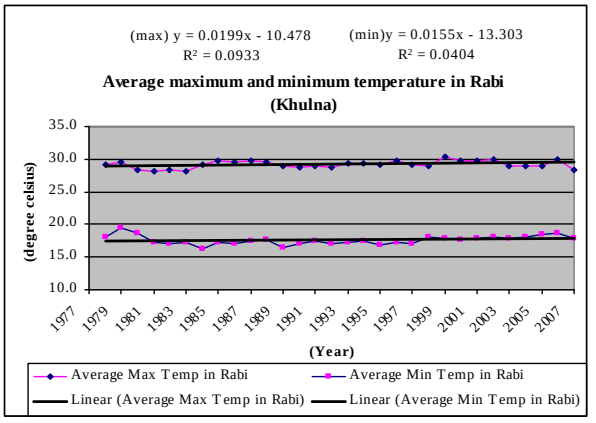




Comments: There is an increasing trend of average max.& min. temperature in rabi season that affecting rabi crops. Temperature rise both in rabi and kharif seasons indicates a sign of global warming.

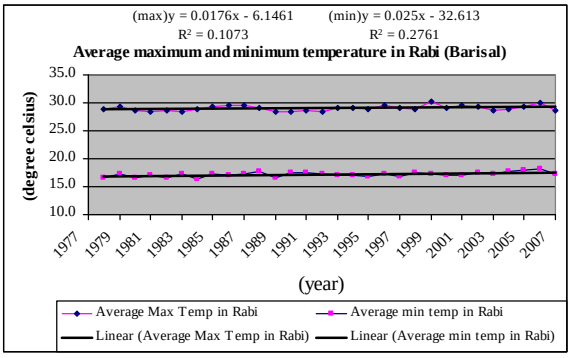
Fugure 5: Changes in temperature (Satkhira District)

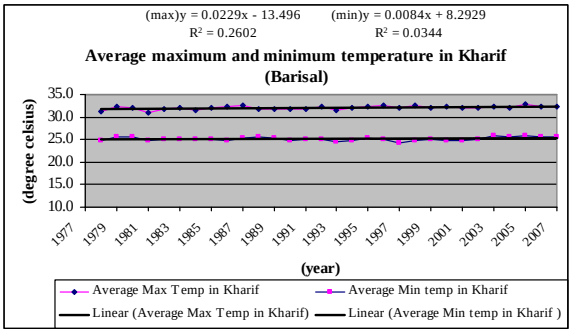




Comments: There is an increasing trend of average max. & min. temperature in rabi season that affecting rabi crops. Temperature rise both in rabi & kharif seasons indicates a sign of global warming

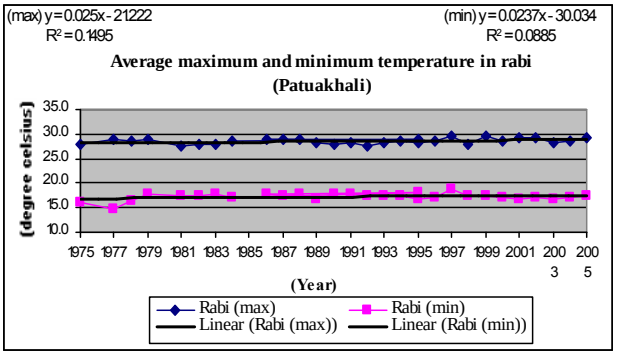
Figure 6: Changes in temperature (Barisal District)

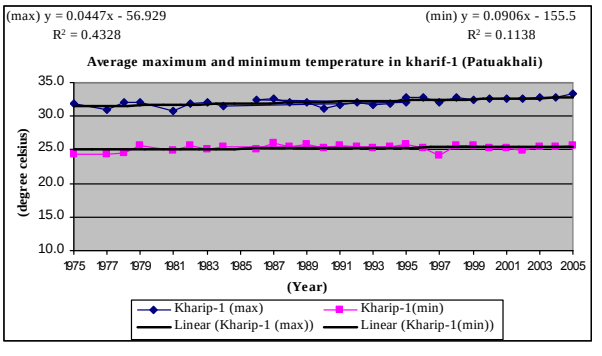




Comments: There is an increasing trend of max. and min. temperature both in rabi and kharif seasons affecting the cultivation of rabi crops. Increase of temperature in both season indicates a sign of global warming.

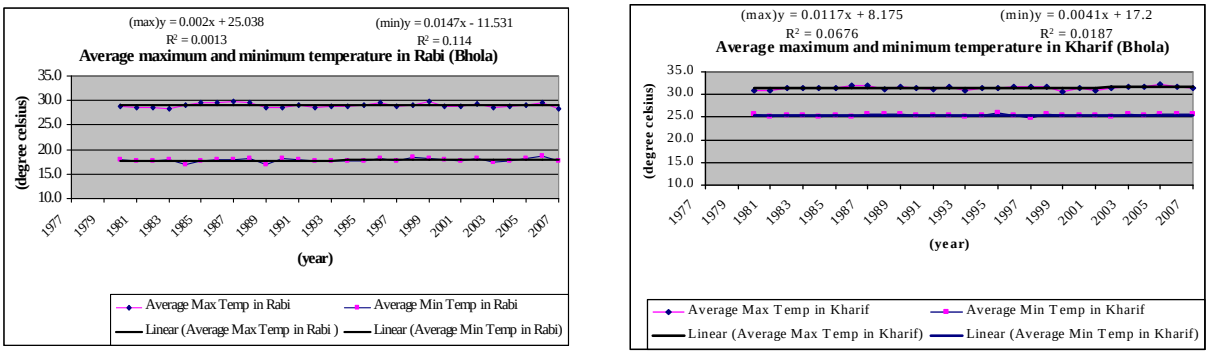
Figure 7: Changes in temperature (Patuakhali District)





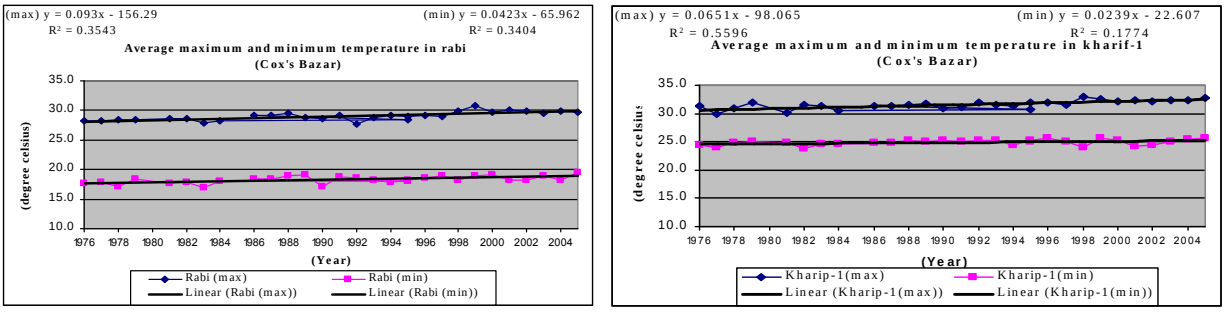
Comments : There is an increasing trend of max. and min. temperature both in rabi and kharif seasons affecting the cultivation of rabi crops. Increase of temperature in both season indicates a sign of global warming.

Figure 8: Changes in temperature (Bhola District)



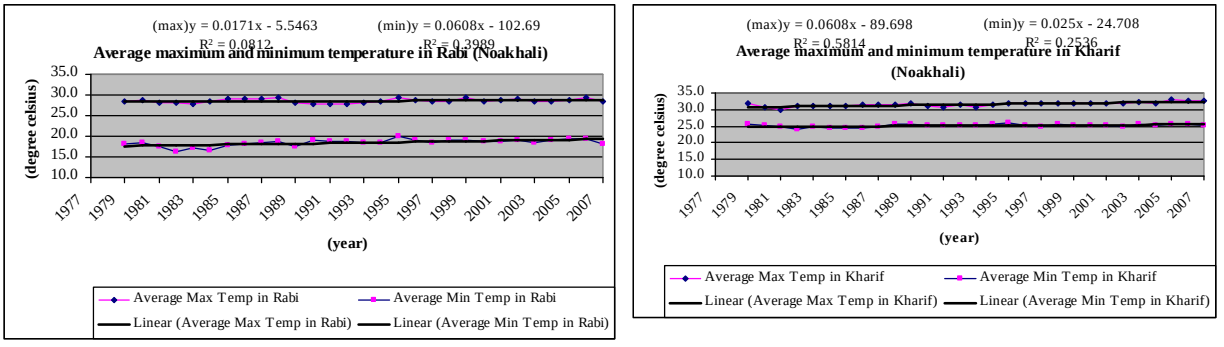
Comments : Temperature increase (both max. & min.) in rabi and kharif season indicates a sign of global warming. Temperature increase in rabi sesaon affecting the cultivation of rabi crops

Figure 9: Changes in temperature (Cox's Bazar District)



Comments: Increasing trend of temperature (max. & min) in rabi and kharif season indicates a sign of global warming. Increasing temperature inrabi season affecting the cultivation of rabi crops.

Figure 10: Changes in temperature (Noakhali District)



Comments: Increasing trend of temperature (max. and min.) both in rabi and kharif seasons indicates a sign of global warming. Temperature increase in rabi season affecting the cultivation of rabi crops.

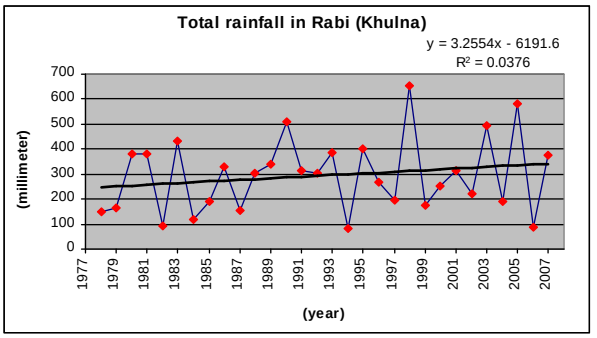
General Comments on Temperature Rise:

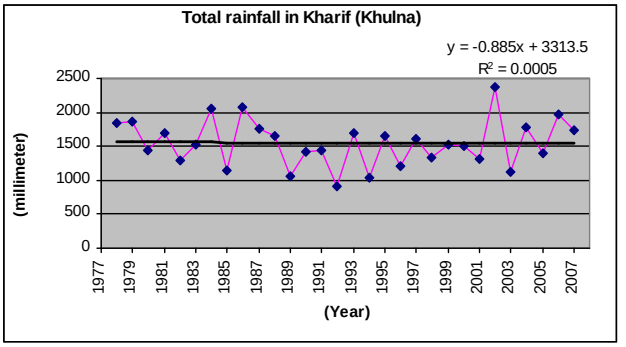
- Level of rabi max. & min. temperature is increasing compared to min. temperature affecting the cultivation of winter crops.
- Level of Kh-I max. and min. temp. is increasing.

- Level of Kh-II max. and min. temp. is increasing.
- Temp. rise in all three seasons indicates a sign of global warming
- Increasing trend of temperature in kharif season affecting the cultivation of rainfed crops.

b) Changes in rainfall during 1975-76 to 2005-06 in coastal districts

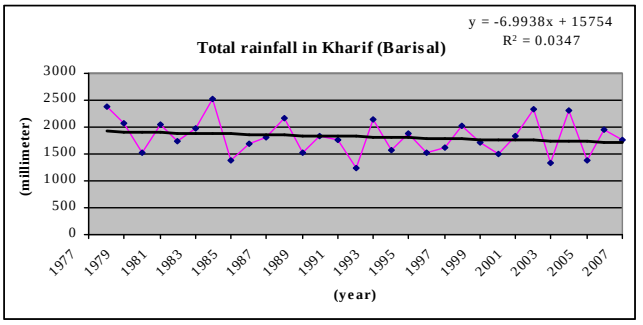
Figure 11: Rainfall pattern (Khulna and Satkhira Districts)

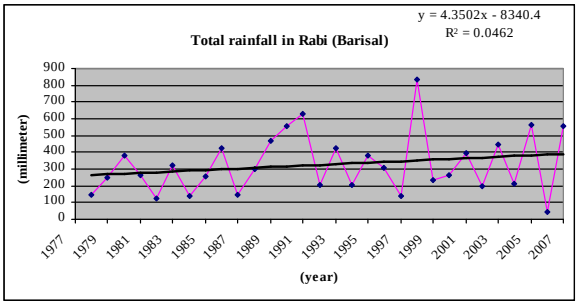




Comments: Total Rainfall pattern in Kharif season is decreasing that affects the cultivation of rain fed crops.

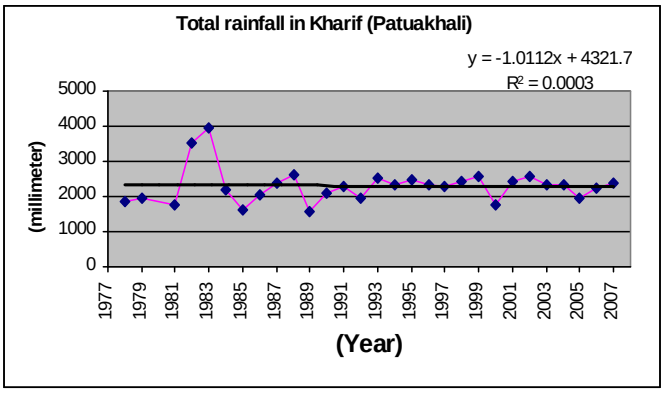
Figure 12: Rainfall pattern (Barisal District)

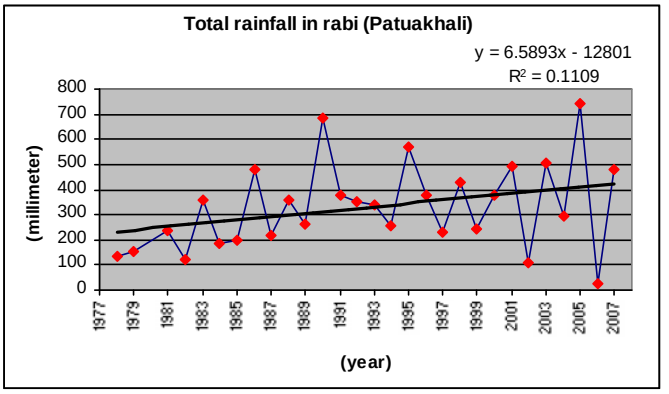




Comments: There is an increasing trend of rainfall both in rabi and kharif season that favours the cultivation of rabi and kharif crops

Figure 13: Rainfall pattern (Patuakhali District)

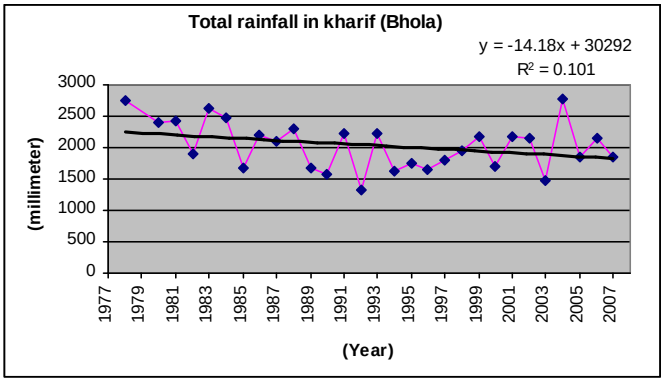


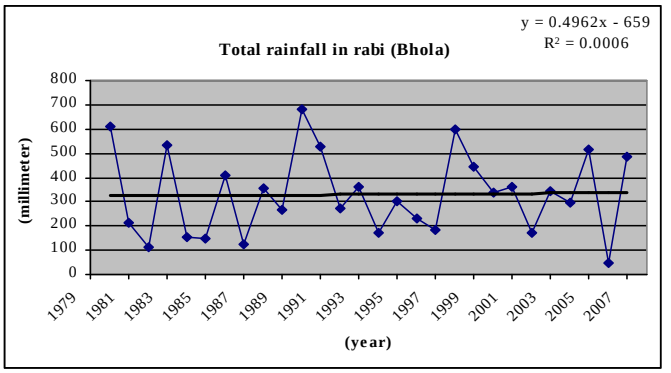


Comments : The decreasing trend of rainfall in kharif season affects the cultivation of rainfed crops. But increasing trend of rainfall in rabi season favours the cultivation rabi crops.

Comments : The increasing trend of rainfall in rabi season favours the cultivation of rabi crops. But decreasing trend of rainfall in kharif season affects the cultivation rainfed crops.

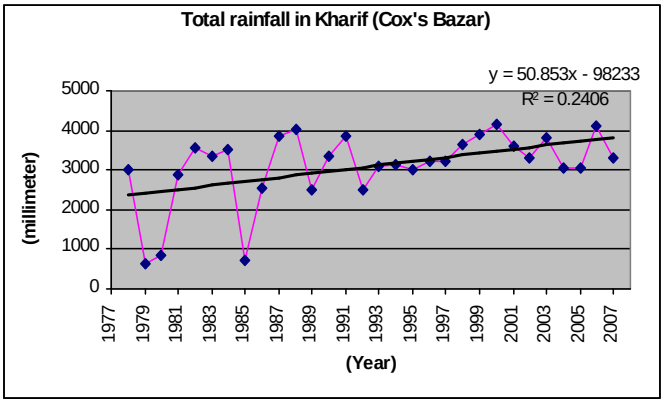
Figure 14: Rainfall pattern (Bhola District)

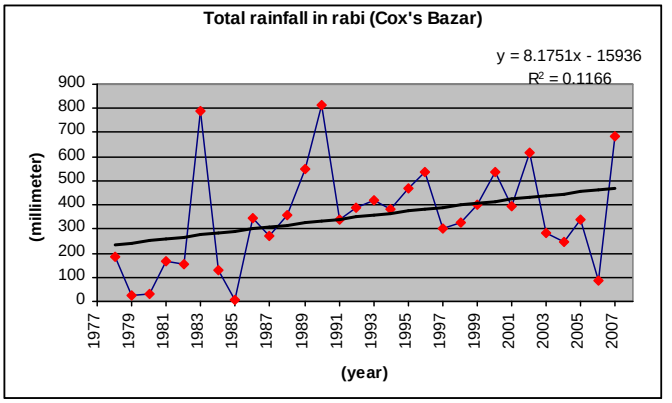




Comments : Total Rainfall pattern in both rabi & Kharif season is decreasing that affecting the cultivation of rabi and rain fed crops.

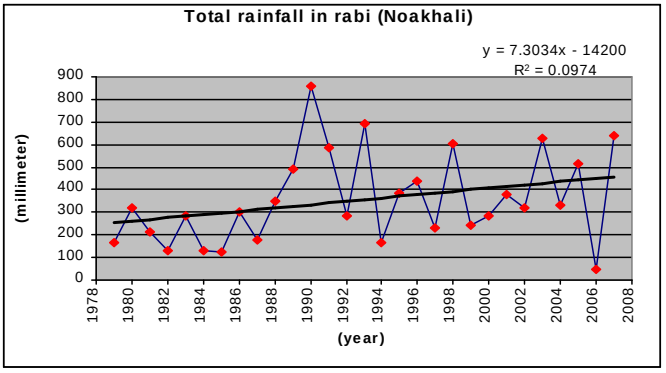
Figure 15: Rainfall pattern (Cox's Bazar District)

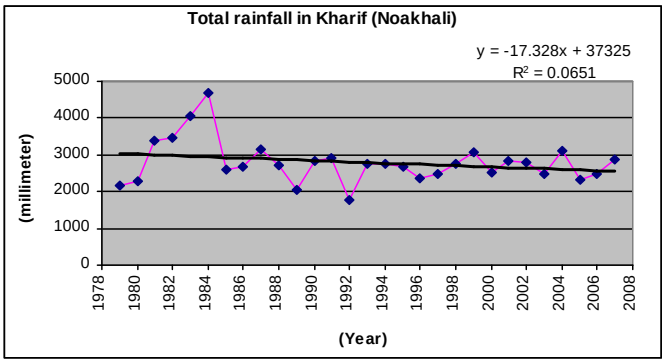




Comments : High rainfall trend in rabi & kharif seasons affecting the cultivation of rabi crops

Figure 16: Rainfall pattern (Noakhali District)





Comments : Total Rainfall pattern in Kharif season is decreasing that affects the cultivation of rain fed crops.

c) Changes in River water salinity in the Coastal Regions

Time series data/information on changes in river water salinity of some coastal districts (viz. Patuakhali, Pirojpur, Jhalkati, Barisal and Bhola) were collected from local offices of SRDI, DAE ,BWDB and BIWTA during survey and FGDs. The data have been compiled in the following Tables. The data showed that river water salinity has remarkably increased (12.9-24.5 % ds/m:3.1-25.3) in Patuakhali during last 8-10 years.

Table 17: Changes in River water salinity in the Coastal Regions

1. Patuakhali District

River	River water salinity (Ec:ds/m) Year: 2001	River water salinity (Ec:ds/m) Year: 2009	% increase of salinity level
1. Bishkhali river, Patharghata	March/2001: 3.10	April/2009: 3.85	24.5
2. Payra river, Taltali	April/2001: 8.50	April/2009: 9.71	14.23
3. Andarmanik river, Kalapara	March/2001: 22.40	April/2009: 25.30	12.95

Interpretation:

The data showed that there is an increasing trend of river water salinity (12.9-24.5 % increase) in Bishkhali river at Pathorghata point, Andarmanik river at Kalapara point and Payra river at Taltali point during 2001 to 2009.

2) River/Khal water salinity (Ec:ds/m) of Pirojpur, Jhalkati and Barisal districts during 2001-09

River/Khal water salinity (Ec:ds/m) of Pirojpur, Jhalkati, Barisal and Bhola districts have been shown in the following Table -18. Data showed that River/Khal water salinity (Ec:ds/m) of Pirojpur, Jhalkati and Barisal districts during 2001-09 has remarkably increased from 0.88 ds/m to 6.87 ds/m (6.5-208.6% increase). The details of salinity level measured in peak period of the year have been described in Table-18-19 below:

Table 18: **River/Khal water salinity (Ec:ds/m) of Pirojpur, Jhalkati and Barisal districts during 2001-09**

River	River/khal water salinity (Ec:ds/m)		% increase of salinity level
	Month/Year	Month/Year	
1. Shapleza khal, Shapleza bazaar/Mathbaria	April/2001: 3.98	March/2009: 6.87	72.6
2. Tushkhali khal, Tushkhali bazaar/Mathbaria	April/2001: 2.08	March/2009: 6.42	208.6
3. Kacha river, Charkhali/ Bhandaria	April/2001: 0.88	April/2009: 2.11	139.7
4. Baleswar river, Char Ragunathpur/Nazirpur	April/2001: 5.82	April/2009: 6.19	6.4
5. Tarabunia khal, Tarabunia market/Nazirpur	April/2001: 2.43	April/2006: 2.60	7.0
6. Gozalia river, Bashanda/Jhalkati Sadar	April/2001: 2.43	April/2006: 2.60	7.0
7. Kirtonkhila river, Barisal launchghat/Barisal Sadar	April/2001: 0.30	April/2009: 0.27	-

Source: SRDI database

3) River/Khal water salinity (Ec:ds/m) of Bhola district during 2001-09

River water salinity (Ec:ds/m) of greater Khulna district have been shown in the following Table -19.

Table 19: River/Khal water salinity (Ec:ds/m) of Bhola district during 2001-09

River	River/khal water salinity (Ec:ds/m)		% increase of salinity level
	Month/Year	Month/Year	
1. Tetulia river, Bhola kheyaghat/Bhola Sadar	May/2001: 0.31	April/2008: 0.84	170.9
2. Illisha river, Illishaghat/Bhola Sadar	April/2001: 1.71	April/2009: 0.94	-
3. Tazumuddin khal, Fakirhat/Tazumuddin	April/2001: 2.03	April/2009: 0.59	-
4. Aslampur khal, Aslampur/Charfession	April/2001: 0.65	May/2009: 1.44	121.5
5. Shahbazpur river, Betua/Charfession	April/2001: 4.90	April/2009: 13.58	177.1

Source: SRDI database

4) River water salinity (Ec:ds/m) of Greater Khulna district during 2004-09

River water salinity (Ec:ds/m) of greater Khulna district have been shown in the following Table -20. Data showed that river water salinity (Ec:ds/m) of Khulna district during 2004-09 has remarkably increased from 0.90 ds/m to 27.7 ds/m (20.5-433.3 % increase). The details of salinity level measured in peak period of the year have been described in Table-20 below:

Table 20: **River water salinity (Ec:ds/m) of Greater Khulna district during 2004-09**

River	River water salinity (Ec:ds/m)		% increase of salinity level
	Month/Year	Month/Year	
1. Madhumati river, Mollahat, Bagerhat	May/2004: 0.90	May/2009: 4.8	433.3
2. Rupsa river, Rupsa Ferryghat, Khulna	April/2004: 16.4	May/2009: 24.3	48.1
3. Shilmari river, Koira bazaar, Dumuria, Khulna	April/2004: 7.5	April/2009: 19.0	153.3
4. Vadra river, Khornia, Dumuria, Khulna	May/2004: 16.0	May/2009: 20.5	28.1
5. Betna river, Benerpota, Satkhira Sadar	April/2004:20.2	April/2009:27.7	37.1
6. Kakshiali river, Kaliganj, Satkhira	April/2004:36.6	May/2009:26.3	-
7. Morichan river, Ashashuni, Satkhira	May/2004:34.2	May/2009:27.0	-
8. Shibsha river, Paikgacha HQ, Khulna	April/2004:36.4	April/2009:24.8	-
9. Kazibachha river, Batiaghata, Khulna	May/2004:21.7	May/2009:26.6	22.6
10. Passur river, Mongla, Bagerhat	April/2004:31.3	April/2009:25.6	-
11. Daratana river, Bagerhat ferryghat, Bagerhat	April/2004:15.1	April/2009:18.2	20.5

Source: SRDI database

5) DTW/STW water salinity (Ec:ds/m) of Pirojpur and Bhola districts during 2005-09

Time series data/information on salinity level (Ec:ds/m) of DTW/STW in Pirojpur and Bhola districts were collected from local offices of SRDI and DAE during field visits and FGDs at project sites. Data showed that salinity level has significantly increased from 0.78 to 3.23 ds/m (6.0-25.6 % increase) during 2005-2009 period.The findings are shown below in Table-21:

Table 21: DTW/STW water salinity (Ec:ds/m) of Pirojpur and Bhola districts during 2005-09

DTW/STW	DTW/STW water salinity (Ec:ds/m)		% increase of salinity level
	Month/Year	Month/Year	
1. STW, Mathbaria/Pirojpur	April/2005: 3.05	April/2009: 3.23	5.9
2. STW, Charkhali/Bhandaria	April/2005: 3.78	April/2009: 4.0	5.8
3. STW, Char Ragunathpur/ Nazirpur	April/2005: 1.74	April/2009: 1.85	6.3
4. DTW, Illisha/Bhola Sadar	April/2005: 0.78	April/2009: 0.80	25.6

Source: SRDI database

d) Changes in Sea Level and Salinity Intrusion

Change in the sea level at local level depends on several factors.

- freshwater flow in the river system
- cyclonic storm surges
- temperature rise

Data/information on water level (in meter) are recorded by BIWTA near to Sea Shore.Time series data/information on water level (in meter max/min level) of different measuring points were collected from local offices of BIWTA and BWDB during field visits and FGDs at project sites. Data on sea level rise based on water level measured/recorded near to sea shore at Galachipa River, Patuakhali ,Sandip, Khepupara, Charchanga, Hiron point and Cox's bazaar (BIWTA) showed an average increase of 0.283 M(at min.water level) and average increase of 0.415 M (at max.water level) which is an average increase of sea level during last 30-31 years(1.38 cm/yr) at max.water level. A summary of sea level rise is shown below:

Salt Water Intrusion during dry season.

2007:130,588.00 ha inundated (41.4 cm sea level rise during last 30 years)

2050:215,972.5 ha to be inundated (59.34 cm sea level rise during next 43 years)

The detailed information/data on sea level rise at different measuring points have been shown in Table 22-23.

i) Location: Galachipa River, Patuakhali (BIWTA)

Table 22: Changes in Sea Level and Salinity Intrusion

Month/Year	Water level (in meter)		Month/Year	Water level (in meter)	
	Maximum	Minimum		Maximum	Minimum
July/1987	3.73	0.84	September/1998	3.76	0.82
June/1988	3.69	0.37	August/1999	3.80	0.70
July/1989	3.65	0.85	August/2000	3.86	0.50
August/1990	3.78	0.85	September/2001	3.30	0.63
August/1991	3.62	0.82	September/2002	4.13	0.74
June/1992	3.57	0.43	August/2003	3.79	1.00
July/1993	3.47	1.01	September/2004	3.82	0.76
June/1994	3.38	0.83	September/2005	4.00	1.01
September/1995	3.52	0.94	August/2006	3.77	0.60
August/1996	3.79	1.04	August/2007	3.71	1.01
August/1997	3.75	1.07	September/2008	3.99	1.44
Average of 5 years (1987-91)	3.69	0.75	Average of 5 years (2004-08)	3.88	0.96
Water level rise(during 22 years) near to sea shore: 0.19 M or 19 cm					

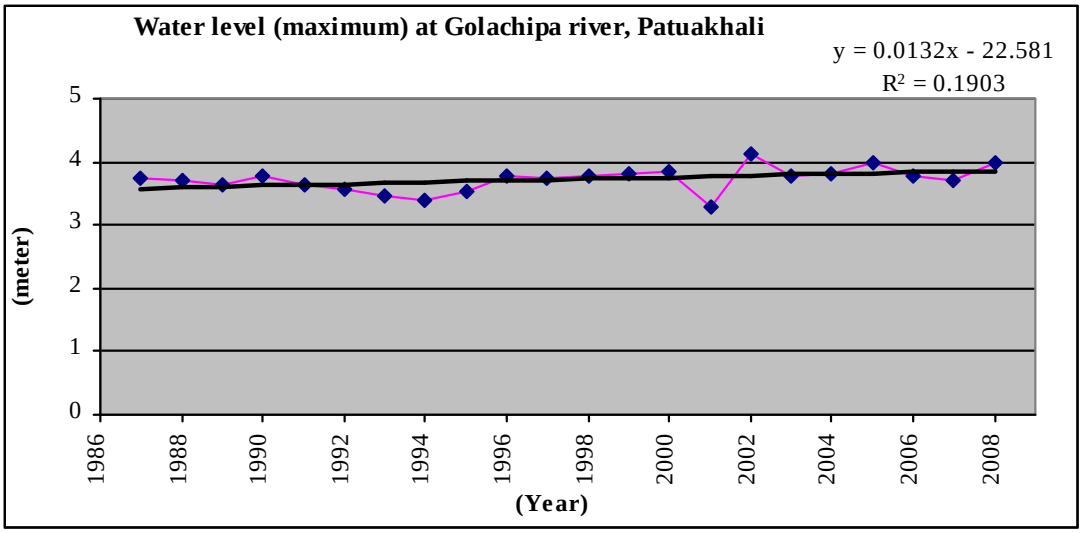
Source: BIWTA, Galachipa, Patuakhali, April/2009.

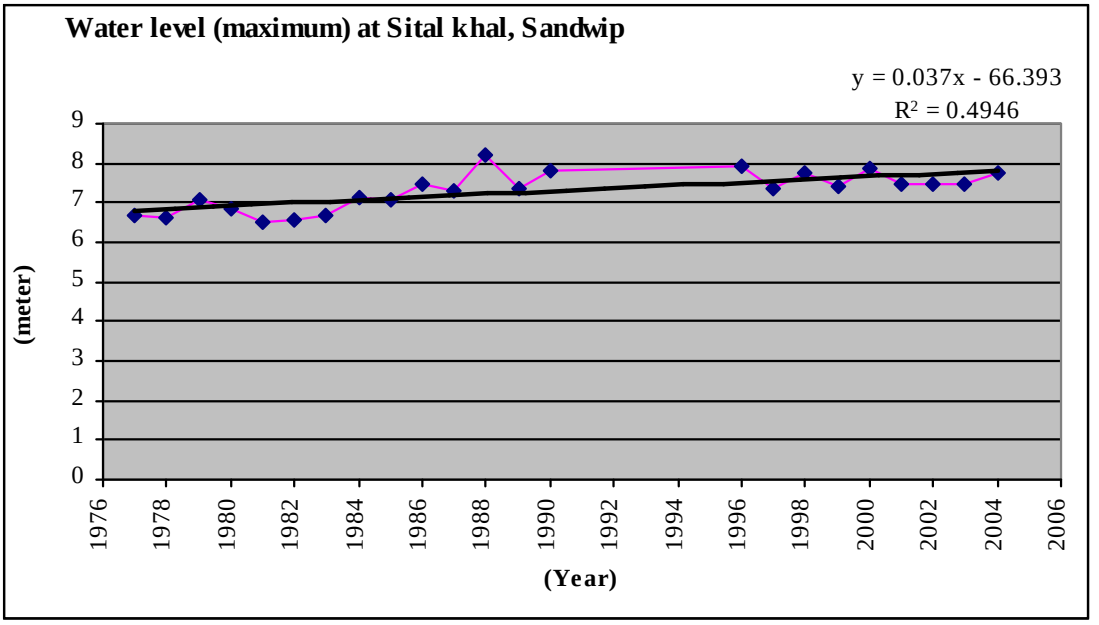
Table 23: Changes in Sea Level (in meter) and Salinity Intrusion of different measuring points of BIWTA and BWDB

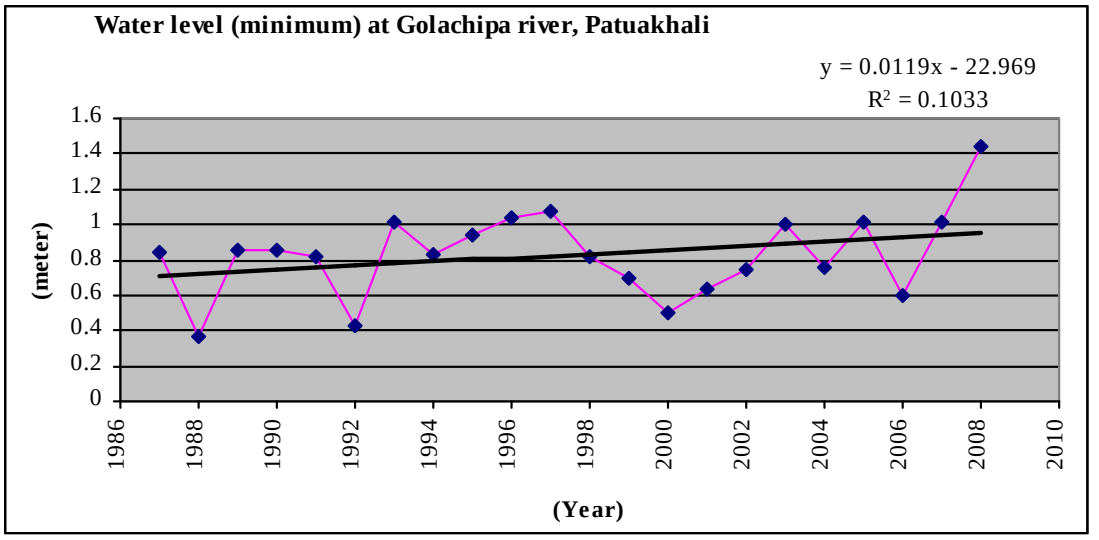
Location	Year	Water level rise (in meter)		Remarks
		Maximum	Minimum	
1. Golachipa river, Patuakhali	2008	3.99	1.44	22 years
	1987	3.73	0.84	
	Difference	**0.26**	**0.6**	
2. Sitalkhal river, Sandwip	2004	7.75	0.32	28 years
	1977	6.66	-0.27	
	Difference	**1.09**	**0.59**	
3. Nilganj river, Khepupara	2006	4.75	0.6	29 years
	1978	4.27	0.39	
	Difference	**0.48**	**0.21**	
4. Shahbazpur river, Charchanga	2005	4.43	0.12	24 years
	1982	4.31	-0.11	
	Difference	**0.12**	**0.23**	
5. Possur river, Hiron point	2007	3.66	-0.15	31 years
	1977	3.46	-0.09	
	Difference	**0.20**	**0.06**	
6. Baghkhali river, Cox's Bazar	2005	4.47	0.03	23 years
	1983	4.13	0.04	
	Difference	**0.34**	**0.01**	
Average	**Difference**	**0.415**	**0.283**	

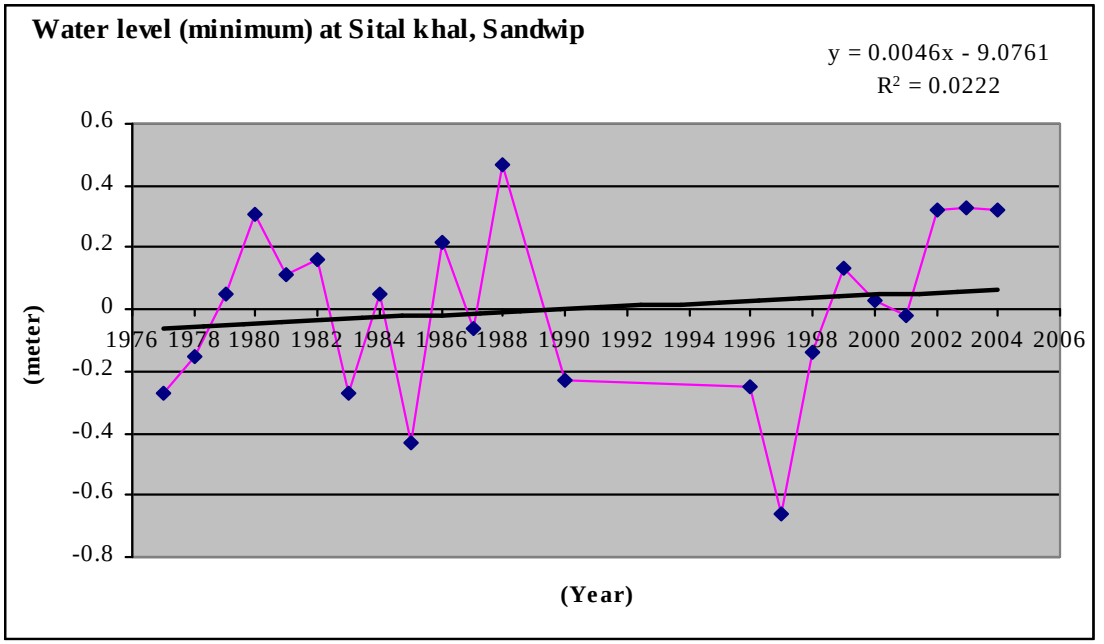
Source: BIWTA, Galachipa, Patuakhali, April/2009.

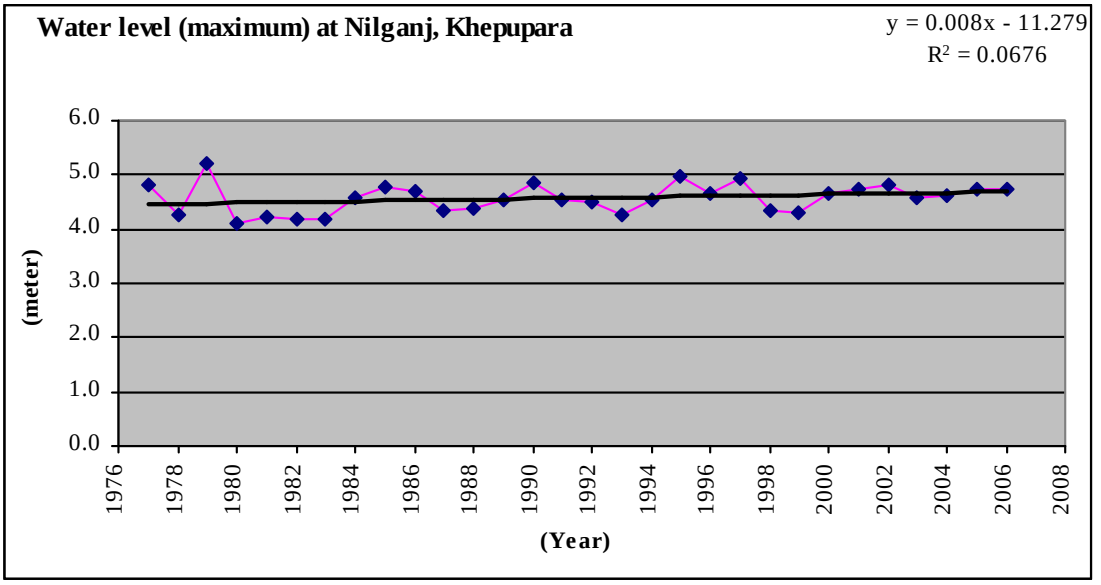
Figure 17-28:Changes in Sea Level and Salinity Intrusion are shown graphically below:

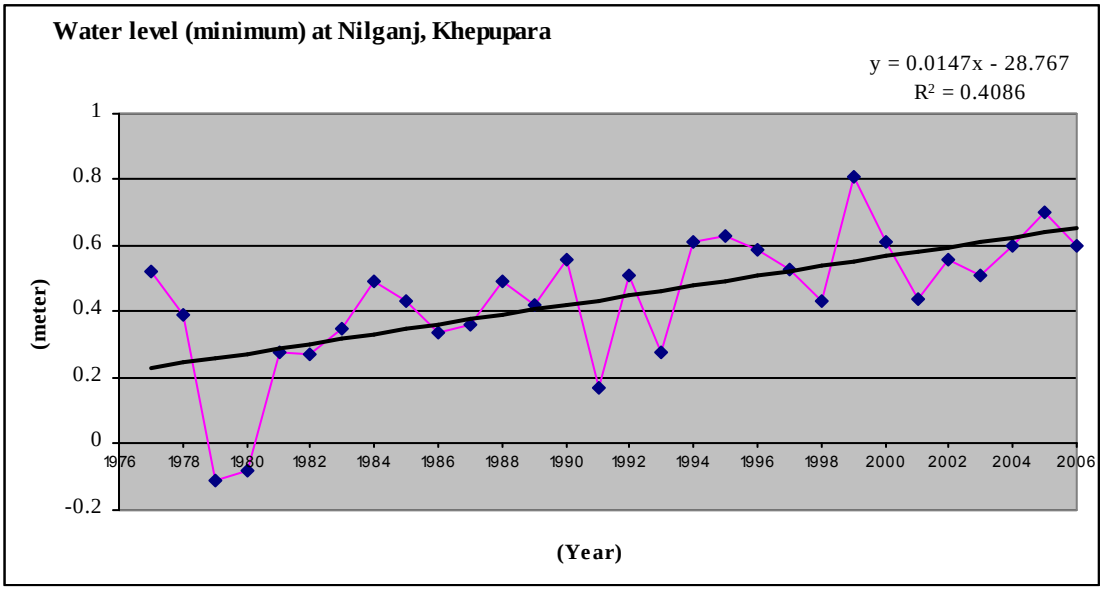


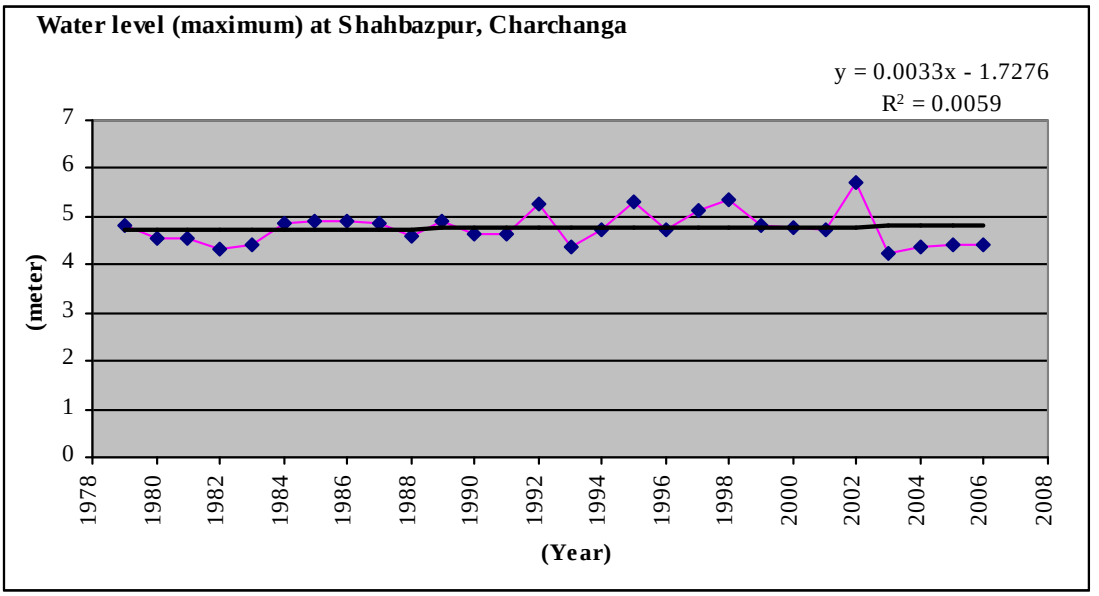

Water level (maximum) at Sital khal, Sandwip
y = 0.037x - 66.393
R² = 0.4946
(meter)
(Year)

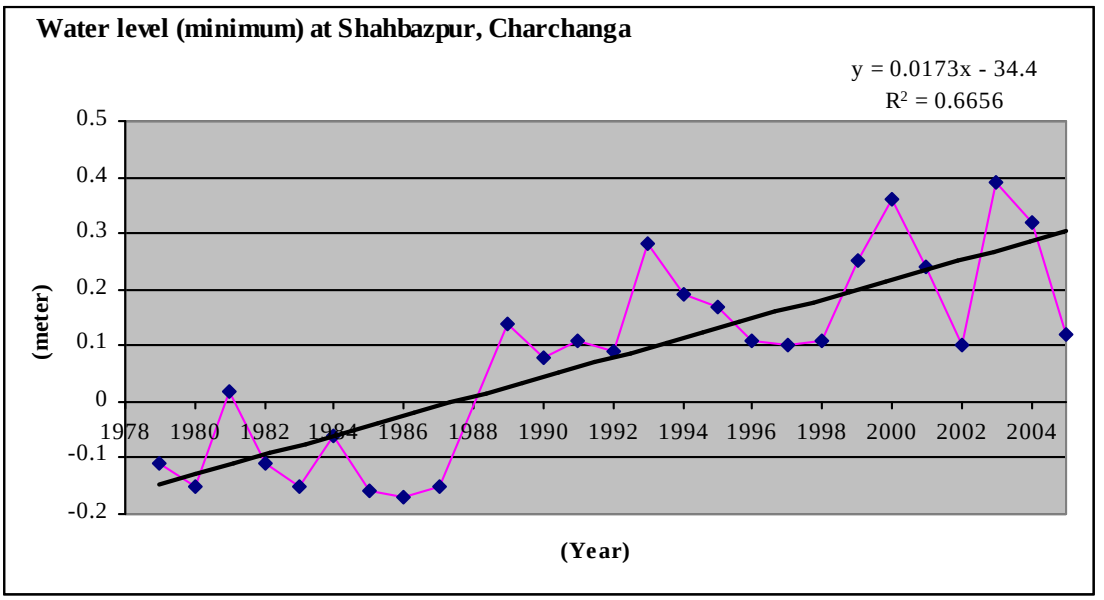

Water level (minimum) at Golachipa river, Patuakhali
y = 0.0119x - 22.969
R² = 0.1033
(meter)
(Year)

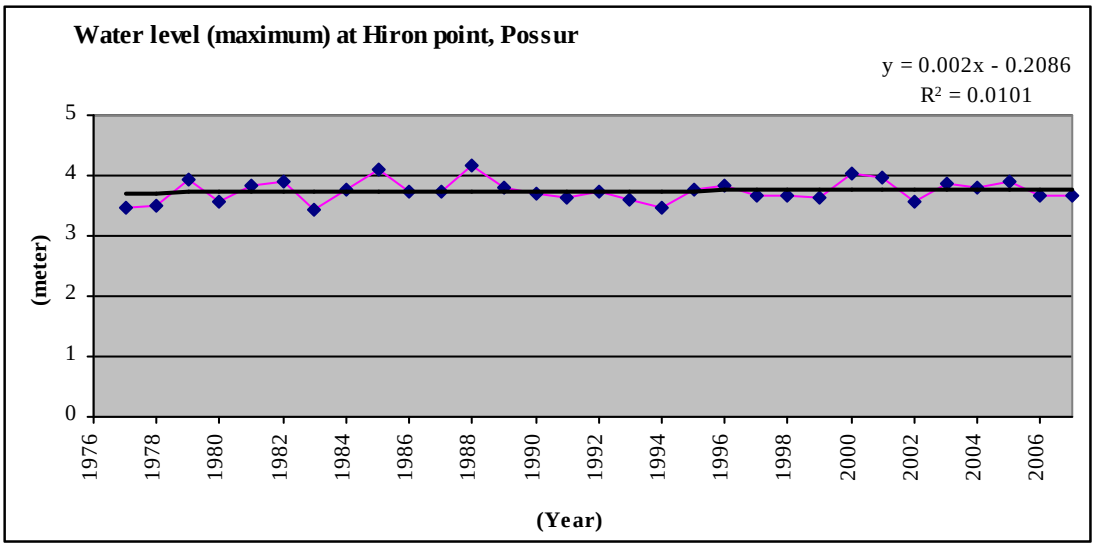

Water level (minimum) at Sital khal, Sandwip
y = 0.0046x - 9.0761
R² = 0.0222
(meter)
(Year)

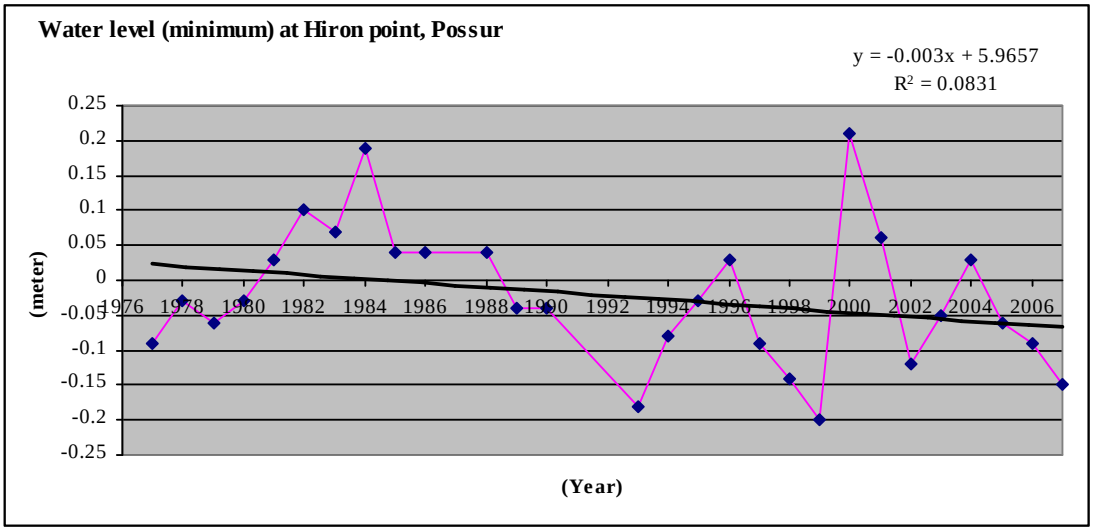

Water level (maximum) at Nilganj, Khepupara
y = 0.008x - 11.279
R² = 0.0676
6.0
5.0
4.0
3.0
2.0
1.0
0.0
(meter)
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
(Year)

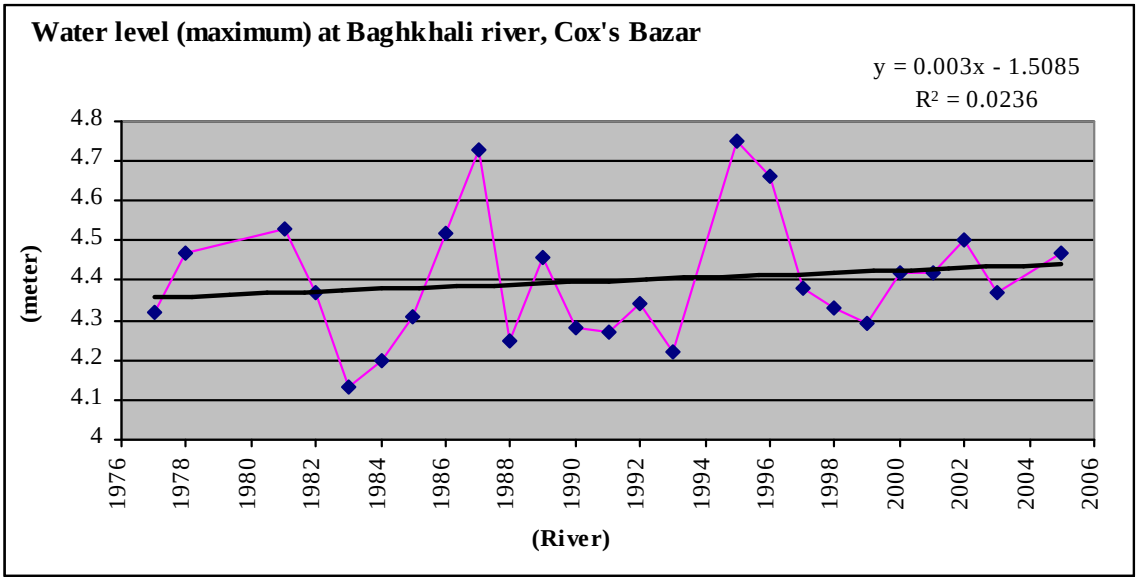

Water level (minimum) at Nilganj, Khepupara
y = 0.0147x - 28.767
R² = 0.4086
1
0.8
0.6
0.4
0.2
0
-0.2
(meter)
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
(Year)

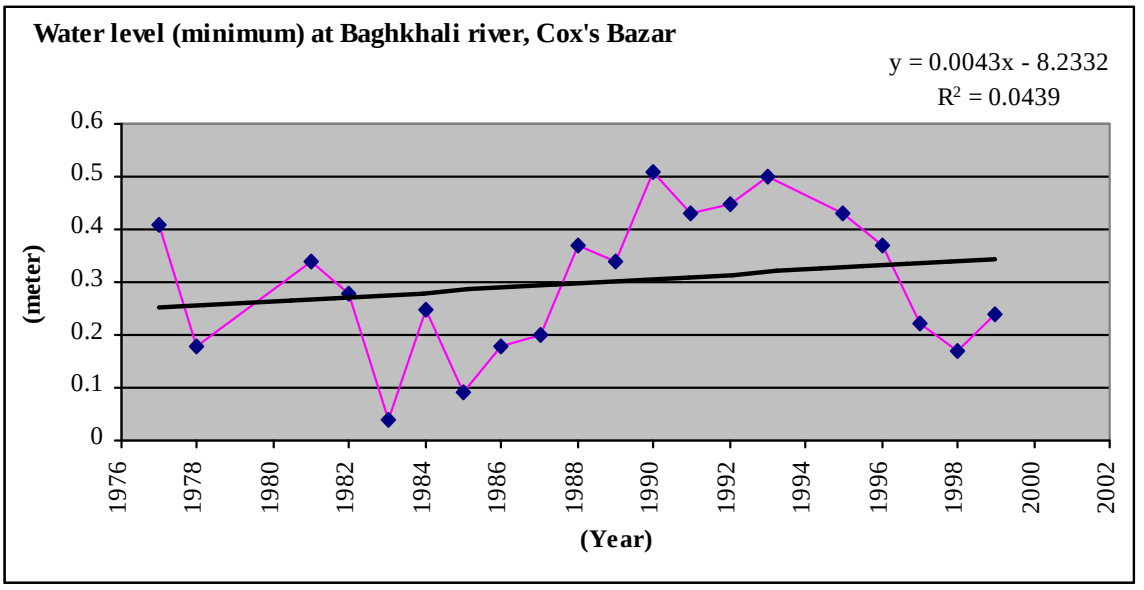

Water level (maximum) at Shahbazpur, Charchanga
y = 0.0033x - 1.7276
R² = 0.0059
7
6
5
4
3
2
1
0
(meter)
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
(Year)


Water level (minimum) at Shahbazpur, Charchanga
y = 0.0173x - 34.4
R² = 0.6656
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
(meter)
1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004
(Year)


Water level (maximum) at Hiron point, Possur
y = 0.002x - 0.2086
R² = 0.0101
5
4
3
2
1
0
(meter)
1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006
(Year)


Water level (minimum) at Hiron point, Possur
y = -0.003x + 5.9657
R² = 0.0831
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
(meter)
1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006
(Year)





e) Estimation of Salt Affected Areas in the Coastal Region

Time series data/information on soil salinity level (Ec:ds/m) and areas of soil salinity of different coastal districts were collected from local offices of SRDI and DAE and discussion with farmers during field visits and FGDs at project sites. Data showed that salinity area significantly increased from 750,350 hectares in 1973 to 950,780 hectares in 2009 (3.02 to 136.48 % , average 26.71 % increase) with increased level of salinity (Ec: ds/m) during 1973-2009 period. The findings are shown below in Table-24:

Table 24: Estimation of Salt affected areas (in '000' ha) in Coastal Region

District	Year	Salinity Level*				Salinity increase over 4 decades		Remarks
		S_1	S_2	S_{3*}	S_4	Area (000'ha)	%	
Khulna	1973	3.90	92.54	13.95	9.80	21.39	17.80	Batiaghata, Dacope, Dumuria, Koyra, Digholia, Paikgacha
	2000	29.04	38.32	59.49	19.61			
	2009	24.64	26.88	47.78	30.57			
Bagerhat	1973	8.30	77.08	3.60	0	48.03	53.98	Chitalmari,

District	Year	Salinity Level*				Salinity increase over 4 decades		Remarks
		S_1	S_2	S_{3*}	S_4	Area (000'ha)	%	
	2000	35.66	42.56	41.23	6.74			Fakirhat, Kachua, Mongla, Rampal
	2009	32.33	42.48	52.96	9.24			
Satkhira	1973	26.50	85.60	34.50	10.90	4.76	3.02	Asasuni, Debhatta, Kaliganj, Shyamnagar
	2000	29.03	39.01	60.55	22.01			
	2009	31.00	32.96	69.72	28.58			
Pirojpur	1973	20.40	1.90	0.00	0.00	13.53	60.67	Bhandaria, Mathbaria, Nazirpur
	2000	22.93	6.05	2.43	0.00			
	2009	23.11	9.94	2.78	0.00			
Barisal	1973	0.00	0.00	0.00	0.00	0	-	Agailjhara, Ujirpur
	2000	2.35	2.70	0.00	0.00			
	2009	8.12	2.54	0.70	0.00			
Bhola	1973	9.18	30.81	0.00	0.00	54.58	136.48	Burhanuddin, Charfession, Monpura, Lalmohan
	2000	32.44	33.70	26.13	5.27			
	2009	42.11	28.84	20.62	3.00			
Paltuakhali	1973	68.50	46.60	0.00	0.00	43.28	37.60	Galachipa, Kalapara, Sadar, Dashmina
	2000	40.11	43.62	46.10	9.52			
	2009	57.73	39.90	44.98	15.77			
Barguna	1973	96.39	7.20	0.00	0.00	-2.67	-2.58	Amtali, Patharghata, Sadar
	2000	37.22	30.77	33.47	3.77			
	2009	32.11	30.90	32.60	5.31			
Noakhali	1973	6.30	39.90	1.80	0.00	4.52	9.42	Hatiya, Sudharam (Sadar)
	2000	13.04	16.93	15.83	7.75			
	2009	15.36	13.33	22.21	1.62			
Cox's Bazar	1973	7.20	16.20	17.30	14.00	1.65	3.02	Chakoria, Maheshkhali, Teknaf
	2000	2.83	11.08	35.55	10.50			
	2009	2.81	13.63	33.84	6.07			
Grand Total	**1973**	**246.67**	**397.83**	**71.15**	**34.7**			
	2000	**244.65**	**264,74**	**320.78**	**85.17**	**189.07**	**26.71**	**Above mentioned Upazilas**
% Increase	**2009**	**269.32**	**241.4**	**339.9**	**100.16**			

* S_1 *= 2.0 – 4.0 ds/m,* S_2 *= 4.1 – 8.0 ds/m,* S_3 *= 8.1 – 16.0 ds/m,* S_4 *= >16.0 ds/m*

f) Estimation of water-logged areas in Coastal Region

Time series data/information on water-logged areas of different coastal districts under the project were collected from local offices of SRDI and DAE and discussion with farmers during field visits and FGDs at project sites. Data showed that water-logged areas have significantly increased to 147,917.00 ha in 2008-09 compared to 61,929.00 ha in 1975-76 due to tidal surges, tidal flooding, sea level rise, faulty sluice gates etc. during last 30 years. The survey/FGDs findings are shown below in Table-25:

District	Upazila	Water-logged areas (in ha)		Remarks
		1975-76	2008-2009	
Bagerhat	Bagerhat Sader	320.00	907.00	-High rainfall & floods -Seasonal Submergence -Tidal surge - Drainage congestion - Faulty sluice gate -Heavy clay -Gher areas
	Fakirhat	-	160.00	
	Mollahat	1224.00	2,370.00	
	Rampal	502.00	14,825.00	
	Morrelganj	3,000.00	7,000.00	
	Sharankhola	39.00	100.00	
	Chitalmari	78.00	4,200.00	
	Mongla	8,000	10,925.00	
	Total	**13,163.00**	**40,487.00**	
Khulna	Dacope	1,500.00	5,500.00	-Seasonal rainfall & floods -Seasonal Submergence -Tidal surge -Drainage congestion -Heavy clay
	Rupsa	-	100.00	
	Dumuria	860.00	2,600.00	
	Paikgacha	-	510.00	
	Terekhada	1200.00	5,500.00	
	Digholia	-	300.00	
	Batiaghata	660.00	1,000.00	
	Koyra	5,000.00	11,000.00	
	Total	**9,220.00**	**26,510.00**	
Satkhira	Satkhira Sadar	700.00	2,000.00	-Seasonal Submergence -Tidal surge -Drainage congestion -Faulty sluice gate -Heavy clay -Shrimp gher areas
	Tala	500.00	2,500.00	
	Shymnagar	765.00	1,500.00	
	Kalaroa	-	880.00	
	Ashassuni	960.00	1,505.00	
	Kaliganj	856.00	1,200.00	
	Maheskhali	05.00	200.00	
	Chakaria	100.00	4,500.00	
	Total	**3,886.00**	**14,285.00**	
Pirojpur	Pirojpur Sadar	200.00	1,750.00	-Seasonal Submergence -Tidal surge -Drainage congestion -Faulty sluice gate
	Nazirpur	1,000.00	2,500.00	
	Bhandaria	-	50.00	
	Nesarabad	500.00	600.00	
	Mathbaria	-	60.00	
	Zianagar	-	1,030.00	
	Total	**1,700**	**5,990.00**	
Patuakhali	Dumki	300.00	450.00	-Seasonal Submergence -Tidal flooding -Drainage congestion -Faulty sluice gate -Heavy clay
	Baufal	1,000.00	1,500.00	
	Galachipa	6,000.00	7,500.00	
	Kalapara	300.00	500.00	
	Total	**7,600.00**	**9,950.00**	
Barguna	Barguna Sadar	-	340.00	-Seasonal Submergence -Tidal flooding -Drainage congestion -Faulty sluice gate -Heavy clay
	Patharghata		100.00	
	Betagi		70.00	
	Amtali		1,225.00	
			2,635.00	
Barisal	Barisal Sadar	-	250.00	-Seasonal Submergence -Tidal flooding -Drainage congestion -Faulty sluice gate -Heavy clay
	Gournadi		750.00	
	Ujirpur		5,800.00	
	Babuganj		1,250.00	
	Banaripara		515.00	
	Agailjhara		75.00	
		4,000.00	**8,640.00**	

District	Upazila	Water-logged areas (in ha)		Remarks
		1975-76	2008-2009	
Bhola	Bhola Sadar	-	2,500.00	-Seasonal Submergence -Tidal flooding -Drainage congestion -Faulty sluice gate -Heavy clay
	Charfassion		3,000.00	
		2,000.00	**5,500.00**	
Cox's bazar	Cox's bazaar Sadar	50.00	250.00	-Seasonal Submergence -Tidal flooding -Drainage congestion -Faulty sluice gate -Heavy clay
	Maheskhali	10.00	200.00	
	Chakaria	100.00	4,500.00	
	Ramu	-	150.00	
		160.00	**5,100.00**	
Noakhali	Subarnachar	400.00	700.00	-Seasonal Submergence -Tidal flooding -Drainage congestion -Faulty sluice gate -Heavy clay
	Senbagh	4,500.00	6,500.00	
	Chatkhil	5,600.00	6,900.00	
	Sunaimuri	7,000.00	10,000.00	
	Kabirhat	2,700.00	4,720.00	
		20,200.00	**28,820.00**	
Grand Total		**61,929.00**	**147,917.00**	All 10 (ten) coastal districts

g) Estimation of drought prone, flood prone, river bank erosion prone and tidal surge areas in Coastal Region

The present situation of drought prone, flood prone, river bank erosion prone and tidal surge areas were estimated by collecting upazila wise related detailed data/information under the project from local offices of SRDI and DAE and discussion with farmers during field visits and FGDs at project sites and finally evaluated/estimated the changes of vulnerable areas in the context of climate change. Utilization of land in crop agriculture and changes in crops/cropping patterns in the coastal districts were found that the average cropping intensity has not so significantly increased during 1975-76 to 2005-06 compared to Flood Plain Agriculture. The main reasons are: expansion of water-logged areas, tidal surged areas, shrimp culture, poultry farm and brick field. The survey findings of vulnerable areas based on average situations of last 3 years (2006-2008) are shown/summarized below in Table-26:

Table 26: A summary Table on drought prone, flood prone, river bank erosion prone and tidal surge areas based on FGDs/Workshop in different regions/districts

District	Drought prone area (in ha)	Flood prone area (in ha)	River bank erosion prone area (in ha)	Tidal surge area (in ha)
Khulna	7,945.00	-	68,047.00	16,791.00
Bagerhat	2,747.00	27,762.00	940.00	34,645.00
Satkhira	17,360.00	5,535.00	5,960.00	2,450.00
Barisal	3,070.00	12,400.00	2,627.00	10,475.00
Pirojpur	1,495.00	4,900.00	950.00	11,550.00
Barguna	14,975.00	10,843.00	1,265.00	8,812.00
Patuakhali	34,153.00	17,200.00	1,460.00	21,325.00
Bhola	9,025.00	21,485.00	9,010.00	15,285.00
Cox;s bazaar	20,120.00	9,810.00	3,710.00	2,490.00
Noakhali	41,395.00	4,430.00	1,355.00	6,765.00
Total	**152,285.00**	**114,365.00**	**95,324.00**	**130,588.00**

Source: FGDs/Workshops at district/regional level organized by BCAS

Upazila-wise present situation (average of last 3 years) of drought prone, flood prone, river bank erosion prone and tidal surge areas of all project sites were estimated by collecting related information/data from local offices of SRDI and DAE and discussion with farmers during field visits and FGDs/workshops at different project sites and shown in the following table (Table 27).

Table 27: Estimation of drought prone, flood prone, river bank erosion prone and tidal surge areas (in ha) in the Coastal Region during 2006-2008 (average of 3 years)

District	Upazila	Drought prone area (in ha) including coastal char lands	Flood prone area (in ha)	River bank erosion prone area (in ha)	Tidal surge area (in ha)
Khulna	Dacope	1,400.00	-	67,410.00	5,336.00
	Rupsa	20.00	-	-	210.00
	Paikgacha	340.00	-	-	-
	Fultala	-	-	-	-
	Batiaghata	125.00	-	100.00	-
	Koyra	5,980.00	-	237.00	11,200.00
	Dumuria	-	-	-	-
	Digholia	80.00	-	300.00	45.00
	Terokhada	-	-	-	-
		7,945.00		**68,047.00**	**16,791.00**
Bagerhat	Bagerhat Sadar	912.00	767.00	80.00	-
	Fakirhat	235.00	-	-	105.00
	Morrelganj	100.00	10,000.00	500.00	15,000.00
	Sharankhola	-	-	310.00	-
	Rampal	-	-	-	-
	Kachua	600.00	-	-	7,800.00
	Mollahat	-	-	50.00	140.00
	Chitalmari	800.00	4,290.00	-	-
	Mongla	100.00	12,705.00	-	11,600.00
		2,747.00	**27,762.00**	**940.00**	**34,645.00**
Satkhira	Satkhira Sadar	2,500.00	-	-	-
	Kaliganj	9,415.00	-	-	-
	Shyamnagar	-	-	3,360.00	-
	Kalaroa	1,200.00	500.00	-	-
	Tala	2,500.00	2,200.00	-	-
	Debhata	-	-	-	-
	Assasuni	1,745.00	2,835.00	2,600.00	2,450.00
		17,360.00	**5,535.00**	**5,960.00**	**2,450.00**
Barisal	Barisal Sadar	195.00	1,800.00	45.00	1,550.00
	Muladi	-	-	530.00	-
	Gournadi	250.00	850.00	325.00	6,700.00
	Agailjhara	-	740.00	-	-
	Ujirpur	2,045.00	2,560.00	690.00	740.00
	Babuganj	380.00	650.00	590.00	810.00
	Banaripara	-	5,800.00	37.00	675.00
	Hizla	200.00	-	410.00	-
		3,070.00	**12,400.00**	**2,627.00**	**10,475.00**
Pirojpur	Pirojpur Sadar	-	-	-	1,750.00

District	Upazila	Drought prone area (in ha) including coastal char lands	Flood prone area (in ha)	River bank erosion prone area (in ha)	Tidal surge area (in ha)
	Nazirpur	970.00	300.00	200.00	4,500.00
	Bhandaria	-	-	-	-
	Mathbaria	-	-	-	-
	Zianagar	525.00	4,600.00	750.00	5,300.00
		1,495.00	**4,900.00**	**950.00**	**11,550.00**
Barguna	Barguna Sadar	8,550.00	-	10.00	12.00
	Patharghata	3,745.00	935.00	245.00	4,550.00
	Betagi	91.00	9,330.00	115.00	100.00
	Bamna	254.00	68.00	120.00	250.00
	Amtali	2,335.00	510.00	775.00	3,900.00
		14,975.00	**10,843.00**	**1,265.00**	**8,812.00**
Patuakhali	Patuakhali Sadar	6,340.00	-	200.00	525.00
	Dashmina	2,400.00	4,600.00	200.00	9,600.00
	Galachipa	18,500.00	9,200.00	50.00	7,000.00
	Mirzaganj	250.00	1,050.00	210.00	-
	Baufal	3,813.00	1,850.00	700.00	3,600.00
	Dumki	850.00	-	150.00	-
	Kalapara	2,000.00	500.00	-	600.00
		34,153.00	**17,200.00**	**1,460.00**	**21,325.00**
Bhola	Bhola Sadar	5,000.00	8,500.00	2,500.00	3,000.00
	Tazumuddin	-	1,335.00	905.00	1,410.00
	Charfassion	-	8,200.00	2,300.00	6,850.00
	Daulatkhan	1,500.00	2,000.00	2,000.00	2,000.00
	Monpura	-	-	280.00	-
	Borhanuddin	1,025.00	1,450.00	575.00	1,600.00
	Lalmohan	1,500.00	-	450.00	425.00
		9,025.00	**21,485.00**	**9,010.00**	**15,285.00**
Cox's bazaar	Cox's bazaar (S)	1,830.00	2,300.00	560.00	850.00
	Kutubdia	-	-	-	1,000.00
	Ukhiya	3,000.00	-	-	-
	Maheskhali	50.00	30.00	-	150.00
	Pekua	290.00	1,200.00	-	-
	Ramu	300.00	230.00	100.00	-
	Chakaria	13,000.00	4,500.00	3,050.00	250.00
	Teknaf	1,650.00	1,550.00	-	240.00
		20,120.00	**9,810.00**	**3,710.00**	**2,490.00**
Noakhali	Subarnachar	9,000.00	-	-	400.00
	Senbagh	-	-	-	-
	Companiganj	16,745.00	4,330.00	855.00	1,180.00
	Chatkhil	-	-	-	-
	Sunaimuri	50.00	-	-	-
	Kabirhat	600.00	100.00	-	185.00
	Hatiya	15,000.00	-	500.00	5,000.00
		41,395.00	**4,430.00**	**1,355.00**	**6,765.00**
Grand Total		**152,285.00**	**114,365.00**	**95,324.00**	**130,588.00**

Source: FGDs/Workshops at district/regional level organized by BCAS

h) Changes in crops/cropping patterns and Conversion of agricultural land into other purposes in the Coastal Region

Time series data/information on changes of crops/cropping patterns and conversion of agricultural lands into other purposes in different coastal districts under the project were collected from local offices of SRDI and DAE and discussion with farmers during field visits and FGDs at project sites and evaluated/estimated the changes of crops/cropping patterns due to continuous cropping in the context of climate change. Data showed that style of crop agriculture have significantly changed due to modernization of agriculture and good agricultural lands are converted into non-crop agriculture systems in the context of climate change during 1975-76 to 2007-08 period. Utilization of land in crop agriculture and changes in crops/cropping patterns in the coastal districts were evaluated and found that the average cropping intensity has not so significantly increased during 1975-76 to 2005-06 compared to Flood Plain Agriculture. The main reasons of conversion of agricultural land into non-crop agriculture/other purposes are: expansion of water-logged areas, expansion of shrimp culture, poultry farm, high market price of fish and poultry and brick field. The findings are shown/summarized below in Table-28:

Table 28: Changes in crops/cropping pattern and Conversion of agricultural land into other purposes (1975-76 to 2005-06) in hectares in the Coastal Region

Agricultural land use	Cox's Bazar		Pirojpur		Barisal	
	LU (1975-76)	Land use (2005-06)	LU (1975-76)	Land use (2005-06)	LU (1975-76)	Land use (2005-06)
Paddy (local varieties)	16560	2025	94859	68918	112473	80748
Paddy (HYV)	21273	107369	7591	47467	25464	78956
Vegetables (Summer)	878	2131	827	2585	2165	3590
Vegetables (Winter)	2116	3552	1807	4490	2312	4990
Pulses	201	2899	3258	8901	20290	21024
Wheat	02	-	5	10	303	522
Sugarcane	220	368	192	459	710	658
Jute	-	-	426		3570	2323
Brick field	8	520	4	83	21	319
Poultry	9	180	5	233	10	635
- Fish/shrimp culture	7500	48105	30	3986	249	542
Gardening/forestry	8968	8491	35	1550	35	193
Industries	15	225	-	4800	2720	3564
Housing	3015	21644	14	45	2630	4354
Others	350	18373	263	868	245	600

Source : DAE, District Office and SRDI

Changes in cropping pattern and Conversion of agricultural land for other purposes (1975-76 to 2005-06) in hectares in the Coastal Region **(Contd.)**

Agricultural land use	Noakhali		Patuakhali		Barguna District	
	LU (2000-01)	Land use (2005-06)	LU (1975-76)	Land use (2005-06)	LU (1975-76)	Land use (2005-06)
Paddy (local varieties)	123400	115424	116500	106423	70000	75200
Paddy (HYV)	10833	98291	14400	58385	30000	22000
Vegetables (Summer)	790	2173	10487	1290	880	1600
Vegetables (Winter)	1190	4166	775	4330	1700	4000
Pulses	12690	14174	40150	69929	30000	31000
Wheat	0	58	x	24	100	5
Sugarcane	80	151	69	67	293	148
Jute	1150	20	65	38	20	10

Agricultural land use	Noakhali		Patuakhali		Barguna District	
	LU (2000-01)	Land use (2005-06)	LU (1975-76)	Land use (2005-06)	LU (1975-76)	Land use (2005-06)
Brick field	4	127	x	50	-	-
Poultry	0	15	x	35	-	-
- Fish/shrimp culture	0	1468	101.5	4360	-	-
Gardening/forestry	8080	20153	4685	11030	-	-
Industries	0	15	01	25	-	-
Housing	12840	19579	5330	8697	-	-
Others	0	0	2657	7467	-	-

Changes in cropping pattern and Conversion of agricultural land into other purposes (1975-76 to 2005-06) in hectares in the Coastal Region **(Contd.)**

Agricultural land use	Khulna		Bagerhat		Satkhira		Bhola	
	LU (1975-76)	Land use (2005-06	LU (1975-76)	Land use (2005-06	LU (1975-76)	Land use (2005-06	LU (1975-76)	Land use (2005-06)
Paddy (local varieties)	54000	55615	78597	78050	107350	6570	146970	168735
Paddy (HYV)	190	95260		54389	8200	131957	6150	118860
Vegetables (Summer)	130	3714	13205	2230	1456	5719	875	2435
Vegetables (Winter)	235	5338	673	3596	1849	8429	3200	8812
Pulses	827	1191	1165	7068	3970	3467	42180	41847
Wheat	10	132	5541	227	698.5	1818	620	3414
Sugarcane	153	853	35	1721	219.5	2001	2048	397
Jute	15	478.5	1860	302	4266	6706	515	60
Brick field	2	35	585	17	1	110	0	130.5
Poultry	10	295.5	0.25	31.5	0	37		52
- Fish/shrimp culture	510	52950	10	64653	2500	56167	13	3227
Gardening/forestry	350	4425	2150	3510	1530	841	0	1853
Industries		225	1800	8	0	15		0
Housing	1500	12169		3193	4070	16611	0	40
Others	54000	55615	3982	770	15075	7390		280

Table 29: A Summary Table on Changes of Land Use in fish/shrimp culyure, poultry and brick field during 1975-76 to 2006-07

District	Fish/shrimp culture (in ha)		Poultry (in ha)		Brick field (in ha)		Remarks/reasons of changes
	1975-76	2006-07	1975-76	2006-07	1975-76	2006-07	
Khulna	500.00	52,950.00	10.00	320.00	2.00	35.00	Tidal surge, water-logging
Bagerhat	20.00	61,960.00	2.00	40.00	5.00	15.00	Tidal surge, water-logging
Satkhira	5,000.00	60,000.00	-	30.00	1.00	20.00	Tidal surge, water-logging
Cox's bazar	7,500.00	48,105.00	9.00	180.00	8.00	520.00	Tidal surge, water-logging
Noakhali	500.00	2,670.00	-	75.00	10.00	75.00	Water-logging
Barisal	250.00	542.00	10.00	635.00	21.00	319.00	Water-logging
Patuakhali	101.00	4,360.00	-	35.00	-	50.00	Water-logging

Source: DAE & SRDI data base, 2007 and Survey/FGDs conducted, 2008-09

h) Changes in Fertility Status due to Cultivation Practices in the context of Climate Change during 1975-76 to 2005-06

Time series data/information on changes of soil fertility level in agricultural lands and conversion of agricultural lands into other purposes in different coastal districts under the project were collected from local offices of SRDI and DAE and discussion with farmers during field visits and FGDs at project sites and evaluated/estimated the changes of soil fertility and soil quality. Changes in fertility status due to intensive cultivation in the context of climate change are shown in Table 30 . Long-term data showed that there is an increasing trend of pH found in most sites due to increase of salinity. The organic matter content has been increased in most low lying sites except Bhola, Cox's bazaar, Khulna and Satkhira of intensively cultivated areas. The salinity level (Ec:ds/m) of all project sites has greatly increased due to long-term impacts of climate change. The salinity level has increased almost double(at Sharankhola of Bagerhat, Dumuria of Khulna and Shyamnagar of Satkhira district. The availability of phosphorus, potassium, sulphur, zinc and boron in all sites has significantly decreased. But there is some indications of sulpher build up in Bhola, Pirojpur and Noakhali. However, changes in nutrient status showed a significant depletion supporting the over all degradation of land quality and soil fertility due to continuous cropping in the context of climate change.

Major Changes in fertility level

- Degradation of land quality
- Salinity level (Ec : ds/m) increased – almost double at Sharankhola, Dumuria & Shamnagar
- Depletion of Nutrients
- Availability of P decreased (3.9 – 61.0%)
- Availability of K decreased (3.6 – 54.3%)
- Availability of S decreased (14.8 – 28.0%)
- Availability of Zn decreased (5.8 – 64.7%)
- Availability of B decreased (3.7 – 125.0%)

Comments: Increased salinity level and depletion of plant nutrients (P, K, S, Zn & B) indicating degradation of land quality.

Table 30 : Changes in Fertility Status due to Cultivation Practices in the context of Climate Change during 1975-76 to 2005-06

District/Upazila Soil Series	pH	SOM (%)	Salinity (Ec)	N (%)	P (ug/g)	K (me%)	S (ug/g)	Zn (ug/g)	B (ug/g)
1.Babuganj, Barisal **Sara Series**									
Year:1975-76	5.9-8.0	1.4	0.93	0.02	14.0	0.56	43.0	2.1	0.84
Year:2005-06	5.5-8.2	2.31	1.18	0.13	4.6	0.54	36.6	0.73	0.60
Difference	**-1.0**	**+0.91**	**+0.25**	**+0.11**	**-3.4**	**-0.02**	**-6.4**	**-1.37**	**-0.24**
2. Charfasion,Bhola **Ramgati Series**									
Year:1975-76	4.5-7.2	2.60	1.26	0.05	8.40	0.49	55.0	1.6	0.93
Year:2005-06	5.7-8.3	2.56	2.80	0.09	4.55	0.39	171.2	0.19	0.71
Difference	**+1.15**	**-0.04**	**+1.54**	**+0.04**	**-3.85**	**-0.10**	**+116.2**	**-0.97**	**-0.22**
3. Amtali, Barguna **Barisal Series**									
Year:1975-76	5.2-7.4	1.4	5.6	0.03	16.5	0.81	130.0	5.5	2.10

District/Upazila Soil Series	pH	SOM (%)	Salinity (Ec)	N (%)	P (ug/g)	K (me%)	S (ug/g)	Zn (ug/g)	B (ug/g)
Year:2005-06	5.4-7.1	1.5	7.7	0.06	15.6	0.37	119.0	4.6	1.25
Difference	**-0.05**	**+0.1**	**+2.1**	**+0.03**	**-0.9**	**-0.44**	**-21.0**	**-0.9**	**-0.85**
4. Patuakhali Sadar **Jhalkati Series**									
Year:1975-76	3.9-8.0	1.93	0.32-9.9	0.09	6.80	0.47	155.0	2.47	1.19
Year:2005-06	4.0-8.2	1.62	0.8-9.9	0.10	4.91	0.24	134.3	0.87	0.66
Difference	**+0.15**	**-0.31**	**+0.24**	**+0.01**	**-1.89**	**-0.23**	**-20.7**	**-1.60**	**-0.53**
5. Bhandaria,Pirojpur **Jhalkati Series**									
Year:1975-76	4.9-6.4	1.69	2.80	0.08	12.6	0.41	150	1.20	0.54
Year:2005-06	5.9-7.4	2.43	0.53	0.06	8.5	0.10	196	0.83	0.64
Difference	**+1.0**	**+0.74**	**+2.27**	**+0.02**	**-4.1**	**-0.31**	**+46.0**	**-0.37**	**+0.10**
6. Senbag, Noakhali **Homna Series**									
Year:1975-76	5.5-7.2	1.12	0.31	0.08	7.60	0.18	15.0	0.80	0.52
Year:2005-06	4.9-7.3	1.09	0.43	0.06	3.33	0.12	24.17	0.52	0.36
Difference	**+0.25**	**-0.03**	**+0.12**	**+0.02**	**-4.27**	**-0.06**	**+9.17**	**-0.28**	**-0.16**
7. Kutubdia, Cox's bazar **Chakaria Series**									
Year:1975-76	4.2-5.1	2.6	0.8-10	0.16	4.2	0.30	140.0	1.70	0.38
Year:2005-06	4.5-5.5	2.4	0.9-10.6	0.14	3.2	0.25	120.0	1.60	0.28
Difference	**+0.35**	**-0.2**	**+0.7**	**-0.02**	**-1.0**	**-0.05**	**-20.0**	**-0.10**	**-0.10**
8. Sharankhola, Bagerhat **Bajoa Series**									
Year:1975-76	5.0-8.1	3.0	3.1-12.5	0.39	4.36	0.60	265.0	0.93	1.18
Year:2005-06	5.5-7.9	2.6	4.0-22.0	0.30	3.58	0.50	280.4	0.54	0.81
Difference	**+0.30**	**-0.4**	**+5.5**	**-0.09**	**-0.78**	**-0.10**	**+15.4**	**-0.39**	**-0.37**
9. Dumuria, Khulna **Gopalpur Series**									
Year:1975-76	3.9-8.81	3.25	0.8-24.0	0.50	8.12	0.38	71.45	3.15	0.91
Year:2005-06	4.5-8.2	2.56	0.7-64.0	0.12	7.8	0.16	51.0	2.58	0.40
Difference	**-**	**-0.69**	**+19.95**	**-0.38**	**-0.32**	**-0.22**	**-20.45**	**-0.57**	**-0.51**
10. Shyamnagar, Satkhira **Bajoa Series**									
Year:1975-76	2.8-8.3	4.2	5.5-18.9	0.26	16.4	0.92	211.2	0.99	1.82
Year:2005-06	3.8-7.2	3.48	7.2-42.5	0.15	13.7	0.80	197.2	0.96	1.57
Difference	**-0.05**	**-0.72**	**+12.65**	**-0.11**	**-2.7**	**-0.12**	**-14.0**	**-0.03**	**-0.25**

Source: SRDI data base, 2007-08

4.3.2 Long-term Impacts of Vulnerable Factors on Crop Production in Study Areas

a) Estimation of Crop Loss/Yield Reduction Through FGDs

BCAS Study Team visited 10(ten) study areas(Cox's bazaar, Satkhira, Khulna, Bagerhat, Patuakhali, Barguna, Pirojpur, Barisal, Bhola and Noakhali districts) for assessing/evaluating the long-term impacts of climatic vulnerable risk factors affecting the crop production in the study locations at farmers' level. Focus Group Discussion (FGD) was arranged in each district inviting members from DAE/District level officers, local NARS Scientists, all Upazila Agril. Officers/AEOs with some selected SAAOs and NGOs/farmers to bring/collect Upazila-wise information/data as per questionnaire. A summary Table 31-40 have been prepared by compiling the Upazila-wise information/data of vulnerable factors affecting crop production under each district.

Table 31: Long-term impacts of different climatic risks/vulnerable factors on crop production at Cox's bazaar district

Crop	Climatic risks/vulnerable factors	Severity of vulnerable factors (very severe, severe, moderate or low)*	Crop loss/yield reduction (%)	Remarks
T.Aman	Drought, flash flood Drought,flash flood Flash flood, drought Hill erosion/sand deposits Drought, salinity Drought,flood, salinity Drought,tidal flood Tidal surge	Severe Severe Moderate Moderate Moderate Moderate Moderate Moderate	40-60 ,, 20-40 ,, ,, ,, ,, ,,	Cox's bazaar(S): 4,000 ha(drought/flood) Chakaria : 17,000 ha (drought/flood) Pekua : 1,500 ha (flash flood) Ramu : 5,000 ha (flash flood/erosion) Ukhia : 3,000 ha (drought, salinity) Teknaf : 3,500 ha (drought, flood) Maheskhali : 500 ha (drought, salinity) Kutubdia : 1,000 ha (tidal surge)
Wheat	Temperature variation Late winter/short cold period	Severe Severe	40-60 ,,	Due to temperature variation and late winter/short cold period, the farmers usually do not cultivate wheat.
Maize	Drought Rainfall variation High wind	Severe Severe Severe	40-60 ,, ,,	Severe drought/rainfall variation and high wind causing 40-60% yield reduction in maize crop. Maize can not be profitably grown.
Potato	Temperature variation Late winter/short cold period Clayey soils Salinity	Severe Severe Severe Moderate	40-60 ,, ,, 20-40	Short winter/short cold period, clayey soils, salinity and temperature variation, the cultivation of diamond/cardinal variety of potato is not possible. Only local variety (var. Dohazari) of potatoes can be cultivated (average yield : 10-12 t/ha) in some locations.
Pulse crops (cowpea)	Temperature variation Late winter/short cold period Clayey soils Salinity	Severe Severe Severe Moderate	40-60 ,, ,, 20-40	Farmers usually do not cultivate pulse crops except cowpea under zero tillage.
Oilseed crops (mustard, ground nut)	Temperature variation Late winter/short cold period Clayey soils Salinity	Severe Severe Severe Moderate	40-60 ,, ,, 20-40	Farmers usually do not cultivate oilseed crops except mustard and ground nut in some locations.
Spice crops (chilli, onion, garlic)	Salinity Pests and diseases Soil wetness	Severe Moderate Moderate	40-60 20-40 ,,	Severe salinity in drier months causing 40-60% yield reduction in onion and garlic crop in about 2,400 hectares. Usually the farmers do not cultivate onion and garlic due to salinity.
Jute Sugarcane	Temperature variation High rainfall High wind	Severe Severe Severe	40-60 ,, ,,	Farmers usually do not cultivate jute and sugarcane due to unfavourable climatic conditions.
Fruit crops (papaya,	Salinity High wind	Severe Moderate	50-60 ,,	Due to stormy wind and severe/ moderate salinity in drier months

Crop	Climatic risks/vulnerable factors	Severity of vulnerable factors (very severe, severe, moderate or low)*	Crop loss/yield reduction (%)	Remarks
water banana, water melon, mango)	Excessive rainfall Pests and diseases	Moderate Moderate	,, ,,	and pests & diseases in monsoon period, the cultivation of fruit crops is affected.
Irrigated crops HYV boro	Cold wave Drought Cyclone/tidal surge Iron toxicity Salinity Pests and diseases	Moderate Moderate Moderate Low Moderate Moderate	20-40 ,, ,, ,, ,, ,,	The mentioned environmental risk factors causing 20-40% yield reduction in HYV boro crop in about 25,000 hectares.
T.Aus	Hot wave Submergence Salinity Iron toxicity	Moderate Severe Moderate Moderate	20-40 ,, ,, ,,	The mentioned environmental risk factors causing 20-40% yield reduction in HYV T.Aus crop in about 20,000 hectares.
T.Aman	Low sunshine Tidal surge Erratic rainfall/drought Salinity Iron toxicity	Moderate Moderate Moderate Moderate Low	20-40 ,, ,, ,, ,,	The mentioned environmental risk factors causing 20-40% yield reduction in HYV T.Aman crop in about 30,000 hectares.

* Very severe= > 60% yield loss, Severe= 40-60% yield loss, Moderate=20-40% yield loss and Low=< 20% yield loss

Table 32: Long-term impacts of different climatic risks/vulnerable factors on crop production at Patuakhali district

Crop	Climatic risks/vulnerable factors	Severity of vulnerable factors (very severe, severe, moderate or low)*	Crop loss/yield reduction (%)	Remarks
T.Aman	Drought, water-logging Drought, tidal flood Tidal flood, drought Tidal flood, drought Drought, flood Drought Drought, salinity, flood	Moderate Moderate Moderate Moderate Moderate Moderate Moderate	20-40 ,, ,, ,, ,, ,, ,,	Dumki : 2,000 ha (drought/water-logging) Baufal : 10,000 ha (floods, drought) Dashmina : 15,000 ha (tidal flood, drought) Galachipa : 30,000 ha (tidal flood, drought) Mirzaganj : 2,500 ha (drought, flood) Patuakhali(s) : 6,500 ha (erratic rainfall, drought) Kalapara : 10,200 ha (drought, salinity, flood)
Wheat	Temperature variation Late winter/short cold period	Severe Severe	40-60 ,,	Due to temperature variation and late winter/short cold period, the farmers can not cultivate wheat.
Maize	Drought Rainfall variation High wind	Severe Severe Severe	40-60 ,, ,,	Severe drought/rainfall variation and high wind causing 40-60% yield reduction in maize crop. Maize can not be profitably cultivated here.
Potato	Temperature variation Late winter/short cold period	Severe Severe	40-60 ,,	Short winter/short cold period, clayey soils, salinity and temperature variation, the

Crop	Climatic risks/vulnerable factors	Severity of vulnerable factors (very severe, severe, moderate or low)*	Crop loss/yield reduction (%)	Remarks
	Clayey soils Salinity	Severe Moderate	,, 20-40	cultivation of diamond/cardinal variety of potato is not possible. Only local variety (var. Dohazari) of potatoes can be cultivated in 11,500 ha (average yield : 10-12 t/ha) in some locations.
Pulse crops (khesari, mung bean, soybean, cowpea)	Heavy rain/excess moisture Drought Pests and diseases	Moderate Moderate Moderate	20-40 ,, ,,	Due to mentioned environmental risk factors, cultivation of pulse crops is affected in about 75,400 hectares.
Oilseed crops (mustard, ground nut)	Temperature variation Late winter/short cold period Clayey soils Salinity	Severe Severe Severe Moderate Moderate	40-60 ,, ,, 20-40 ,,	Farmers usually do not cultivate oilseed crops except mustard and ground nut in some locations (about 10,500 ha).
Spice crops (chilli, onion, garlic)	Salinity Pests and diseases Soil wetness	Severe Moderate Moderate	40-60 20-40 ,,	Severe salinity in drier months causing 40-60% yield reduction in chilli, onion and garlic crop in about 14,500 hectares. Usually the farmers do not cultivate onion and garlic due to salinity.
Jute Sugarcane	Temperature variation High rainfall High wind	Severe Severe Severe	40-60 ,, ,,	Farmers usually do not cultivate jute and sugarcane due to unfavourable climatic conditions.

* Very severe= > 60% yield loss, Severe= 40-60% yield loss, Moderate=20-40% yield loss and Low=< 20% yield loss

Table 33: Long-term impacts of different climatic risks/vulnerable factors on crop production at Barguna district

Crop	Climatic risks/vulnerable factors	Severity of vulnerable factors (very severe, severe, moderate or low)*	Crop loss/yield reduction (%)	Remarks
T.Aman	Drought Flood, drought Drought, flood Drought, flood Drought, tidal flood	Moderate Moderate Moderate Moderate Moderate	20-40 20-40 ,, ,, ,,	Barguna(S) : 8,000 ha (drought) Betagi : 7,500 ha (flood, drought) Pathorghata : 4,000 ha (drought, flood) Bamna : 1,000 ha (drought, flood) Amtali : 7,000 ha (drought, tidal flood)
Wheat	Temperature variation Late winter/short cold period	Severe Severe	40-60 ,,	Due to temperature variation and late winter/short cold period, the farmers can not cultivate wheat.
Maize	Drought Rainfall variation High wind	Severe Severe Severe	40-60 ,, ,,	Severe drought/rainfall variation and high wind causing 40-60% yield reduction in maize crop.

Crop	Climatic risks/vulnerable factors	Severity of vulnerable factors (very severe, severe, moderate or low)*	Crop loss/yield reduction (%)	Remarks
				Maize can not be profitably grown here.
Potato	Temperature variation Late winter/short cold period Clayey soils Pests and diseases	Severe Severe Severe Moderate Moderate	40-60 ,, ,, 20-40 ,,	Short winter/short cold period, clayey soils, salinity and temperature variation, the cultivation of diamond/cardinal variety of potato is not possible. Only local variety (var. Dohazari) of potatoes can be cultivated in 2,800 ha (average yield : 10-12 t/ha) in some locations.
Pulse crops (khesari, mung bean, soybean, cowpea)	Heavy rain/excess moisture Drought Pests and diseases	Moderate Moderate Moderate	20-40 ,, ,,	Due to mentioned environmental risk factors, cultivation of pulse crops is affected in about 33,700 hectares.
Oilseed crops (mustard, sesame, ground nut)	Temperature variation Late winter/short cold period Clayey soils Salinity	Severe Severe Severe Moderate Moderate	40-60 ,, ,, ,, ,,	Farmers usually do not cultivate oilseed crops except mustard, sesame and ground nut in some locations (about 2,850 ha).
Spice crops (chilli, onion, garlic)	Moisture stress Salinity Hot wave Pests and diseases	Moderate Moderate Moderate Moderate	20-40 ,, ,, ,,	Farmers usually do not cultivate spice crops except chilli and some onion in some locations (about 2,000 ha).
Jute Sugarcane	Temperature variation High rainfall High wind	Severe Severe Severe	>60 ,, ,,	Farmers usually do not cultivate jute and sugarcane due to unfavourable climatic conditions. Some farmers cultivate some chewing varieties of sugarcane.
Fruit crops (papaya, banana, water melon, mango)	Salinity High wind Excessive rainfall Pests and diseases	Severe Moderate Moderate Moderate	.40-60 ,, ,, ,,	Due to stormy wind and severe/ moderate salinity in drier months and pests & diseases in monsoon period, the cultivation of fruit crops is severely affected. Water melon is cultivated in some locations (650 ha).
Irrigated crops HYV boro	Lack of irrigation water Late harvest of T.Aman Drought High temperature Salinity Pests and diseases	Severe Moderate Moderate Moderate Moderate Moderate	20-40 ,, ,, ,, ,, ,,	The mentioned environmental risk factors causing 20-40% yield reduction in HYV boro crop in about 500 hectares.
T.Aus	Drought Salinity Pests and diseases	Moderate Severe Moderate	20-40 ,, ,,	The mentioned environmental risk factors causing 20-40% yield reduction in HYV T.Aus crop in about 30,000 hectares.
T.Aman	Low sunshine Drought Tidal flood Pests and diseases	Moderate Moderate Moderate	20-40 ,, ,,	The mentioned environmental risk factors causing 20-40% yield reduction in HYV T.Aman crop in about 60,000 hectares.

* Very severe= > 60% yield loss, Severe= 40-60% yield loss, Moderate=20-40% yield loss and Low=< 20% yield loss

Table 34: Long-term impacts of different climatic risks/vulnerable factors on crop production at Pirojpur district

Crop	Climatic risks/vulnerable factors	Severity of vulnerable factors (very severe, severe, moderate or low)*	Crop loss/yield reduction (%)	Remarks
T.Aman	Water-logging, floods Water stagnancy Tidal surge/salinity Drought, flood Tidal flood, drought Flood Water-logging	Moderate Moderate Moderate Moderate Moderate Moderate Moderate	20-40 ,, ,, ,, ,, ,, ,,	Pirojpur(S) : 2,000 ha (floods) Bhandaria : 500 ha (water-logging) Kawkhali : 5,000 ha (tidal surge) Nazirpur : 2,000 ha (drought, flood) Zianagar : 5,500 ha (flood, drought) Nesarabad : 5,000 ha (floods) Mathbaria : 5,000 ha (water-logging)
Wheat	Temperature variation Late winter/short cold period	Severe Severe	>60 ,,	Due to temperature variation and late winter/short cold period, the farmers can not cultivate wheat.
Maize	Drought Rainfall variation High wind	Severe Severe Severe	>60 ,, ,,	Severe drought/rainfall variation and high wind causing 40-60% yield reduction in maize crop. Maize can not be profitably grown here.
Potato	Temperature variation Late winter/short cold period Clayey soils Pests and diseases	Severe Severe Severe Moderate Moderate	40-60 ,, ,, ,, ,,	Short winter/short cold period, clayey soils, salinity and temperature variation, the cultivation of diamond/cardinal variety of potato is not possible. Only local variety (var. Dohazari) of potatoes can be cultivated (average yield : 10-12 t/ha) in some locations (under zero tillage).
Pulse crops (khesari, mung bean)	Heavy rain/excess moisture Drought Salinity Pests and diseases	Moderate Moderate Moderate	20-40 ,, ,,	Due to mentioned environmental risk factors, cultivation of pulse crops is affected in about 8,800 hectares.
Oilseed crops (mustard, sesame, ground nut)	Temperature variation Late winter/short cold period Clayey soils Salinity	Severe Severe Severe Moderate Moderate	40-60 ,, ,, ,, ,,	Farmers usually do not cultivate oilseed crops except mustard, sesame and ground nut in some locations (about 200 ha).
Spice crops (chilli, onion, garlic)	Floods Temperature variation Pests and diseases	Moderate Moderate Moderate	20-40 ,, ,,	Farmers usually do not cultivate spice crops except chilli and some onion in some locations (about 1,200 ha).
Jute Sugarcane	Temperature variation High rainfall High wind	Severe Severe Severe	>60 ,, ,,	Farmers usually do not cultivate jute and sugarcane due to unfavourable climatic conditions. Some farmers cultivate some chewing varieties of sugarcane.
Fruit crops (papaya, banana, water melon,	Salinity High wind Excessive rainfall Pests and diseases	Severe Moderate Moderate Moderate	.40-60 ,, ,, ,,	Due to stormy wind and severe/ moderate salinity in drier months and pests & diseases in monsoon period, the cultivation of fruit crops is severely affected. Water melon is cultivated in some locations (4,400

Crop	Climatic risks/vulnerable factors	Severity of vulnerable factors (very severe, severe, moderate or low)*	Crop loss/yield reduction (%)	Remarks
mango)				ha).
Irrigated crops HYV boro	Late harvest of T.Aman High temperature Drought Salinity Pests and diseases	Moderate Moderate Moderate Moderate Moderate	20-40 ,, ,, ,, ,,	The mentioned environmental risk factors causing 20-40% yield reduction in HYV boro crop in about 17,000 hectares.
T.Aus	Drought Salinity Tidal surge Flash flood Pests and diseases	Moderate Moderate Moderate	20-40 ,, ,,	The mentioned environmental risk factors causing 20-40% yield reduction in HYV T.Aus crop in about 23,000 hectares.
T.Aman	Low sunshine Drought Water stagnancy Tidal surge Pests and diseases	Moderate Moderate Moderate Moderate Moderate	20-40 ,, ,, ,, ,,	The mentioned environmental risk factors causing 20-40% yield reduction in HYV T.Aman crop in about 30,000 hectares.

* Very severe= > 60% yield loss, Severe= 40-60% yield loss, Moderate=20-40% yield loss and Low=< 20% yield loss

Table 35: Long-term impacts of different climatic risks/vulnerable factors on crop production at Barisal district

Crop	Climatic risks/vulnerable factors	Severity of vulnerable factors (very severe, severe, moderate or low)*	Crop loss/yield reduction (%)	Remarks
T.Aman	Excess rainfall/floods Erratic rain/drought Erratic rain/drought Water-logging Water-logging Water-logging Water-logging Floods Drought Drought	Moderate Moderate Moderate Moderate Moderate Moderate Moderate Moderate Moderate Moderate	20-40 ,, ,, ,, ,, ,, ,, ,, ,, ,,	Barisal(S) : 16,500 ha (floods) Hizla : 1,200 ha (erratic rainfall/drought) Bakerganj : 10,000 ha (erratic rainfall/drought) Babuganj : 10,000 ha (water stagnancy) Banaripara : 4,000 ha (excessive rain/floods) Wazirpur : 7,000 ha (excessive rain/floods) Agailjhara : 800 ha (excess rainfall) Gournadi : 1,250 ha (excessive rain/floods) Muladi : 500 ha (drought) Mehendiganj : 6,500 ha (drought)
Wheat	Temperature variation Late winter/short cold period	Severe Severe	40-60 ,,	Due to temperature variation and late winter/short cold period, the farmers can not cultivate wheat profitably.
Maize	Drought Rainfall variation High wind	Severe Severe Severe	30-40 ,, ,,	Severe drought/rainfall variation and high wind causing 30-40% yield reduction in maize crop. Maize can not be profitably grown here.
Potato	Temperature variation	Severe	30-40	Short winter/short cold period,

Crop	Climatic risks/vulnerable factors	Severity of vulnerable factors (very severe, severe, moderate or low)*	Crop loss/yield reduction (%)	Remarks
	Late winter/short cold period Clayey soils Pests and diseases	Severe Severe Moderate Moderate	,, ,, ,, ,,	clayey soils, salinity and temperature variation, the cultivation of diamant/ cardinal variety of potato can not be profitably grown. Average yield of potato: 12-15 t/ha) in some locations .
Pulse crops (khesari, mung bean)	Heavy rain/excess moisture Soil wetness Drought Salinity Pests and diseases	Moderate Moderate Moderate	20-40 ,, ,,	Due to mentioned environmental risk factors, cultivation of pulse crops is affected in about 21,000 hectares.
Oilseed crops (mustard, sesame, ground nut)	Temperature variation Late winter/short cold period Clayey soils Salinity	Severe Severe Severe Moderate Moderate	40-60 ,, ,, ,, ,,	Farmers usually do not cultivate oilseed crops except mustard, sesame and ground nut in some locations (about 2,800 ha).
Spice crops (chilli, onion, garlic)	Early rainfall Temperature variation Pests and diseases	Moderate Moderate Moderate	20-40 ,, ,,	Farmers usually do not cultivate spice crops except chilli and some onion in some locations (about 4,500 ha).
Jute Sugarcane	Temperature variation High rainfall High wind	Severe Severe Severe	>60 ,, ,,	Farmers usually do not cultivate jute and sugarcane due to unfavourable climatic conditions. Some farmers cultivate some chewing varieties of sugarcane.
Fruit crops (papaya, banana, water melon, amra)	Salinity High wind Excessive rainfall Pests and diseases	Severe Moderate Moderate Moderate	.40-60 ,, ,, ,,	Due to stormy wind and severe/moderate salinity in drier months and pests & diseases in monsoon period, the cultivation of fruit crops is severely affected. Water melon and amra is cultivated in some locations (150 ha).
Irrigated crops HYV boro	Higher temperature Cool temperature Cyclone Pests and diseases	Moderate Moderate Moderate Moderate	20-40 ,, ,, ,,	The mentioned environmental risk factors causing 20-40% yield reduction in HYV boro crop in about 17,000 hectares.
T.Aus	Rainfall variation Drought Salinity Tidal surge/submergence Pests and diseases	Moderate Moderate Moderate	20-40 ,, ,,	The mentioned environmental risk factors causing 20-40% yield reduction in HYV T.Aus crop in about 23,500 hectares.
T.Aman	Floods/water stagnancy Drought Changed timing of rainfall Pests and diseases	Moderate Moderate Moderate Moderate	20-40 ,, ,, ,,	The mentioned environmental risk factors causing 20-40% yield reduction in HYV T.Aman crop in about 27,000 hectares.

* Very severe= > 60% yield loss, Severe= 40-60% yield loss, Moderate=20-40% yield loss and Low=< 20% yield loss

Table 36: Long-term impacts of different climatic risks/vulnerable factors on crop production at Noakhali district

Crop	Climatic risks/vulnerable factors	Severity of vulnerable factors (very severe, severe, moderate or low)*	Crop loss/yield reduction (%)	Remarks
T.Aman	Drought, water-logging Drought, tidal flooding Water-logging Water-logging Drought, tidal flooding Water-logging Water-logging, drought	Moderate Moderate Moderate Moderate Moderate Moderate Moderate	20-40 ,, ,, ,, ,, ,, ,, ,,	Subarnachar: 10,000 ha (drought,water-logging) Hatiya : 15,000 ha (drought, flood) Senbag : 6,500 ha (water-logging) Chatkhil : 6,000 ha (water stagnancy) Companyganj :7,000 ha (drought/floods) Begumganj : 450 ha (water-logging) Sunaimuri : 10,000 ha (stagnant water) Kabirhat: 5,000 ha (water-logging)
Wheat	Temperature variation Late winter/short cold period	Severe Severe	40-60 ,,	Due to temperature variation and late winter/short cold period, the farmers can not grow wheat profitably.
Maize	Drought Rainfall variation High wind	Severe Severe Severe	40-60 ,, ,,	Severe drought/rainfall variation and high wind causing 40-60% yield reduction in maize crop. Maize can not be profitably grown here.
Potato	Temperature variation Late winter/short cold period Clayey soils Pests and diseases	Severe Severe Severe Moderate Moderate	40-60 ,, ,, ,, ,,	Short winter/short cold period, clayey soils, salinity and temperature variation, the cultivation of diamond/cardinal variety of potato is not possible. Only local variety (var. Dohazari) of potatoes can be cultivated in 4,355 ha (average yield : 10-12 t/ha) in some locations (under zero tillage).
Pulse crops (khesari, mung bean, soybean, cowpea)	Heavy rain/excess moisture Soil wetness Drought Salinity Pests and diseases	Moderate Moderate Moderate	20-40 ,, ,,	Due to mentioned environmental risk factors, cultivation of pulse crops is affected in about 28,700 hectares.
Oilseed crops (mustard, sesame, ground nut)	Temperature variation Late winter/short cold period Clayey soils Salinity	Severe Severe Severe Moderate Moderate	40-60 ,, ,, ,, ,,	Farmers usually do not cultivate oilseed crops except mustard, sesame and ground nut in some locations (about 17,900 ha).

Crop	Climatic risks/vulnerable factors	Severity of vulnerable factors (very severe, severe, moderate or low)*	Crop loss/yield reduction (%)	Remarks
Spice crops (chilli, onion, garlic)	Early rainfall Temperature variation Pests and diseases	Moderate Moderate Moderate	20-40 ,, ,,	Farmers usually do not cultivate spice crops except chilli and some onion in some locations (about 3,500 ha).
Jute Sugarcane	Temperature variation High rainfall High wind	Severe Severe Severe	>60 ,, ,,	Farmers usually do not cultivate jute and sugar-cane due to unfavourable climatic conditions. Some farmers cultivate some chewing varieties of sugarcane.
Fruit crops (papaya, banana, water melon, amra)	Salinity High wind Excessive rainfall Pests and diseases	Severe Moderate Moderate Moderate	.40-60 ,, ,, ,,	Due to stormy wind and severe/moderate salinity in drier months and pests & diseases in monsoon period, the cultivation of fruit crops is severely affected. Water melon and amra is cultivated in some locations (20 ha).
Irrigated crops HYV boro	Saline ground water Unavailability of surface water Salinity Pests and diseases	Severe Severe Moderate Moderate	20-40 ,, ,, ,,	The mentioned environmental risk factors causing 20-40% yield reduction in HYV boro crop.
T.Aus	Water stagnancy/floods Salinity Submergence Pests and diseases	Moderate Moderate Moderate	20-40 ,, ,,	The mentioned environmental risk factors causing 20-40% yield reduction in HYV T.Aus crop.
T.Aman	Floods/water stagnancy Drought, salinity Changed timing of rainfall Pests and diseases	Moderate Moderate Moderate Moderate	20-40 ,, ,, ,,	The mentioned environmental risk factors causing 20-40% yield reduction in HYV T.Aman crop.

* Very severe= > 60% yield loss, Severe= 40-60% yield loss, Moderate=20-40% yield loss and Low=< 20% yield loss

Table 37: Long-term impacts of different climatic risks/vulnerable factors on crop production at Satkhira district

Crop	Climatic risks/vulnerable factors	Severity of vulnerable factors (very severe, severe, moderate or low)*	Crop loss/yield reduction (%)	Remarks
T.Aman	Drought, water-logging Drought,water-logging Drought, water-logging Water-logging River erosion, salinity Drought, flood, erosion Drought	Moderate Moderate Moderate Moderate Moderate Moderate Moderate	20-40 20-40 20-40 20-40 20-40 20-40 20-40	Satkhira(S) : 4,500 ha (drought) Kalaroa : 2,500 ha (drought) Tala : 7,500 ha (erratic rainfall) Debhatta : 500 ha (water-logging) Shyamnagar : 3,000 ha (erosion) Assasuni :8,200 ha (drought,erosion) Kaliganj : 9,500 ha (drought)
Wheat	Temperature variation Late winter/short cold period	Severe Severe	40-60 ,,	Due to temperature variation and late winter/ short cold period, the farmers can not cultivate wheat.
Maize	Drought Rainfall variation High wind	Severe Severe Severe	40-60 ,, ,,	Severe drought/rainfall variation and high wind causing 40-60% yield reduction in maize crop. Maize can not be profitably grown here.
Potato	Temperature variation Late winter/short cold period Clayey soils Pests and diseases	Severe Severe Severe Moderate Moderate	40-60 ,, ,, ,, ,,	Short winter/short cold period, clayey soils, salinity and temperature variation, the cultivation of diamond/ cardinal variety of potato is not possible. Only local variety (var. Dohazari) of potatoes can be cultivated in 4,200 ha(average yield : 10-12 t/ha) in some locations (under zero tillage).
Pulse crops (khesari, mung bean, soybean, cowpea)	Heavy rain/excess moisture Soil wetness Drought Salinity, tidal surges Pests and diseases	Moderate Moderate Moderate	20-40 ,, ,,	Due to mentioned environmental risk factors, cultivation of pulse crops is affected in about 4,250 hectares.
Oilseed crops (mustard, sesame, ground nut)	Temperature variation Late winter/short cold period Clayey soils Salinity	Severe Severe Severe Moderate Moderate	40-60 ,, ,, ,, ,,	Farmers usually do not cultivate oilseed crops except mustard, sesame and ground nut in some locations (5,900 ha) .
Spice crops (chilli, onion, garlic)	Early rainfall Temperature variation Pests and diseases	Moderate Moderate Moderate	20-40 ,, ,,	Farmers usually do not cultivate spice crops except chilli and some onion in some locations (about 2,400 ha).
Jute Sugarcane	Temperature variation High rainfall High wind	Severe Severe Severe	>60 ,, ,,	Farmers usually do not cultivate jute and sugarcane due to unfavourable climatic conditions. Some farmers cultivate some chewing varieties of sugarcane.
Fruit crops (papaya, banana,	Salinity High wind Excessive rainfall	Severe Moderate Moderate	.40-60 ,, ,,	Due to stormy wind and severe/ moderate salinity in drier months and pests & diseases in monsoon

Crop	Climatic risks/vulnerable factors	Severity of vulnerable factors (very severe, severe, moderate or low)*	Crop loss/yield reduction (%)	Remarks
water melon)	Pests and diseases	Moderate	,,	period, the cultivation of fruit crops is severely affected. Water melon and amra is cultivated in some locations (800 ha).
Irrigated crops HYV boro	Saline ground water Unavailability of surface water Salinity Pests and diseases	Severe Severe Moderate Moderate	20-40 ,, ,, ,,	The mentioned environmental risk factors causing 20-40% yield reduction in the cultivation HYV boro crop.
T.Aus	Water stagnancy/floods Salinity Submergence Pests and diseases	Moderate Moderate Moderate	20-40 ,, ,,	The mentioned environmental risk factors causing 20-40% yield reduction in the cultivation of HYV T.Aus crop.
T.Aman	Floods/water stagnancy Drought Changed timing of rainfall Pests and diseases	Moderate Moderate Moderate Moderate	20-40 ,, ,, ,,	The mentioned environmental risk factors causing 20-40% yield reduction in the cultivation of HYV T.Aman crop.

* Very severe= > 60% yield loss, Severe= 40-60% yield loss, Moderate=20-40% yield loss and Low=< 20% yield loss

Table 38: Long-term impacts of different climatic risks/vulnerable factors on crop production at Khulna district

Crop	Climatic risks/vulnerable factors	Severity of vulnerable factors (very severe, severe, moderate or low)*	Crop loss/yield reduction (%)	Remarks
T.Aman	Water-logging,drought Water-logging, salinity Drought Water-logging,drought Water-logging Drought, water-logging Water-logging,drought Drought,water-logging	Moderate Moderate Moderate Moderate Moderate Moderate Moderate Moderate	20-40 20-40 20-40 20-40 20-40 20-40 20-40 20-40	Rupsa : 350 ha (water-logging) Dumuria : 500 ha (water-logging) Fultala : 1,000 ha (erratic rainfall) Digholia : 400 ha (water-logging) Terokhada : 5,300 ha (flood) Koyra : 15,000 ha (water-logging) Dacope : 6,000 ha (cyclone) Batiaghata : 300 ha (drought)
Wheat	Temperature variation Late winter/short cold period	Severe Severe	40-60 ,,	Due to temperature variation and late winter/short cold period, the farmers can not cultivate wheat.
Maize	Drought Rainfall variation High wind	Severe Severe Severe	40-60 ,, ,,	Severe drought/rainfall variation and high wind causing 40-60% yield reduction in maize crop. Maize can not be profitably grown here.
Potato	Temperature variation Late winter/short cold period Clayey soils	Severe Severe Severe Moderate	40-60 ,, ,, ,,	Short winter/short cold period, clayey soils, salinity and temperature variation, the cultivation of diamond/ cardinal

Crop	Climatic risks/vulnerable factors	Severity of vulnerable factors (very severe, severe, moderate or low)*	Crop loss/yield reduction (%)	Remarks
	Fogginess Pests and diseases	Moderate Moderate	,, ,,	variety of potato is not possible. Only local variety (var. Dohazari) of potatoes can be cultivated (average yield: 10-12 t/ha) in some locations (under zero tillage).
Pulse crops (khesari, mung bean, soybean, cowpea)	Heavy rain/excess moisture Soil wetness Drought Salinity Pests and diseases	Moderate Moderate Moderate	20-40 ,, ,,	Due to mentioned environmental risk factors, cultivation of pulse crops is affected in about 1,200 hectares in Rupsa, Batiaghata, Fultala and Digholia.
Oilseed crops (mustard, sesame, ground nut)	Temperature variation Late winter/short cold period Clayey soils Salinity	Severe Severe Severe Moderate Moderate	40-60 ,, ,, ,, ,,	Farmers usually do not cultivate oilseed crops except mustard, sesame and ground nut in some locations (about 5,700 ha) in Rupsa, Batiaghata, Fultala and Digholia.
Spice crops (chilli, onion, garlic)	Early rainfall Temperature variation Pests and diseases	Moderate Moderate Moderate	20-40 ,, ,,	Farmers usually do not cultivate spice crops except chilli and some onion in some locations (about 530 ha).
Jute Sugarcane	Temperature variation High rainfall High wind	Severe Severe Severe	>60 ,, ,,	Farmers usually do not cultivate jute and sugarcane due to unfavourable climatic conditions. Some farmers cultivate some chewing varieties of sugarcane.
Fruit crops (papaya, banana, amra, water melon)	Salinity High wind Excessive rainfall Pests and diseases	Severe Moderate Moderate Moderate	.40-60 ,, ,, ,,	Due to stormy wind and severe/ moderate salinity in drier months and pests & diseases in monsoon period, the cultivation of fruit crops is severely affected. Water melon and amra is cultivated in some locations (850 ha).
Irrigated crops HYV boro	Saline ground water Drought Salinity Pests and diseases	Severe Severe Severe Moderate	40-60 ,, ,, ,,	The mentioned environmental risk factors causing 40-60% yield reduction in the cultivation HYV boro crop.
T.Aus	Drought Salinity Submergence Pests and diseases	Moderate Moderate Moderate	20-40 ,, ,,	The mentioned environmental risk factors causing 20-40% yield reduction in the cultivation of HYV T.Aus crop.
T.Aman	Floods/water stagnancy Drought/salinity Erratic rainfall Pests and diseases	Moderate Moderate Moderate Moderate	20-40 ,, ,, ,,	The mentioned environmental risk factors causing 20-40% yield reduction in the cultivation of HYV T.Aman crop.

* *Very severe= > 60% yield loss, Severe= 40-60% yield loss, Moderate=20-40% yield loss and Low=< 20% yield loss*

Table 39: Long-term impacts of different climatic risks/vulnerable factors on crop production at Bagerhat district

Crop	Climatic risks/vulnerable factors	Severity of vulnerable factors (very severe, severe, moderate or low)*	Crop loss/yield reduction (%)	Remarks
T.Aman	Drought, water-logging River erosion Flood, water-logging Drought, water-logging Water-logging Water-logging Water-logging, flood Tidal flooding Water-logging	Moderate Severe Moderate Moderate Moderate Moderate Moderate Moderate Moderate	20-40 40-60 20-40 20-40 20-40 20-40 20-40 20-40 20-40	Bagerhat Sadar : 2,000 ha (drought) Sharankhola : 500 ha (river erosion) Mongla : 11,220 ha (flood) Fakirhat : 550 ha (drought) Rampal : 10,000 ha (water-logging) Morrelganj : 20,000 ha (flood) Chitalmari : 6,000 ha (flood) Kachua : 8,500 ha (tidal flood) Mollahat : 2,500 ha (water-logging)
Wheat	Temperature variation Late winter/short cold period	Severe Severe	40-60 ,,	Due to temperature variation and late winter/short cold period, the farmers can not cultivate wheat.
Maize	Drought Rainfall variation High wind	Severe Severe Severe	40-60 ,, ,,	Severe drought/rainfall variation and high wind causing 40-60% yield reduction in maize crop. Maize can not be profitably grown here.
Potato	Temperature variation Late winter/short cold period Clayey soils Fogginess Pests and diseases	Severe Severe Severe Moderate Moderate Moderate	40-60 ,, ,, ,, ,, ,,	Short winter/short cold period, clayey soils, salinity and temperature variation, the cultivation of diamond/ cardinal variety of potato is not possible. Only local variety (var. Dohazari) of potatoes can be cultivated (average yield : 10-12 t/ha) in some locations (under zero tillage).
Pulse crops (khesari, mung bean, soybean, cowpea)	Heavy rain/excess moisture Soil wetness Drought Salinity Pests and diseases	Moderate Moderate Moderate	20-40 ,, ,,	Due to mentioned environmental risk factors, cultivation of pulse crops is affected in about 5,500 hectares in Kachua, Bagerhat(S), Fakirhat and Morrelganj.
Oilseed crops (mustard, sesame, ground nut)	Temperature variation Late winter/short cold period Clayey soils Salinity	Severe Severe Severe Moderate Moderate	40-60 ,, ,, ,, ,,	Farmers usually do not cultivate oilseed crops except mustard, sesame and ground nut in some locations (about 1,400 ha) in Kachua, Bagerhat(S), Fakirhat and Morrelganj.
Spice crops (chilli, onion, garlic)	Early rainfall Temperature variation Pests and diseases	Moderate Moderate Moderate	20-40 ,, ,,	Farmers usually do not cultivate spice crops except chilli and some onion in some locations (about 1,400 ha).
Jute Sugarcane	Temperature variation High rainfall High wind	Severe Severe Severe	>60 ,, ,,	Farmers usually do not cultivate jute and sugarcane due to unfavourable climatic conditions. Some farmers cultivate some chewing varieties of sugarcane.

Crop	Climatic risks/vulnerable factors	Severity of vulnerable factors (very severe, severe, moderate or low)*	Crop loss/yield reduction (%)	Remarks
Fruit crops (papaya, banana, water melon)	Salinity High wind Excessive rainfall Pests and diseases	Severe Moderate Moderate Moderate	.40-60 ,, ,, ,,	Due to stormy wind and severe/ moderate salinity in drier months and pests & diseases in monsoon period, the cultivation of fruit crops is severely affected. Water melon and amra is cultivated in some locations (4,155 ha).
Irrigated crops HYV boro	Saline ground water Drought Salinity Pests and diseases	Severe Severe Severe Moderate	40-60 ,, ,, ,,	The mentioned environmental risk factors causing 40-60 % yield reduction in the cultivation HYV boro crop.
T.Aus	Drought Salinity Submergence Pests and diseases	Moderate Moderate Moderate	20-40 ,, ,,	The mentioned environmental risk factors causing 20-40% yield reduction in the cultivation of HYV T.Aus crop.
T.Aman	Floods/water stagnancy Drought/salinity Erratic rainfall Pests and diseases	Moderate Moderate Moderate Moderate	20-40 ,, ,, ,,	The mentioned environmental risk factors causing 20-40% yield reduction in the cultivation of HYV T.Aman crop.

* Very severe= > 60% yield loss, Severe= 40-60% yield loss, Moderate=20-40% yield loss and Low=< 20% yield loss

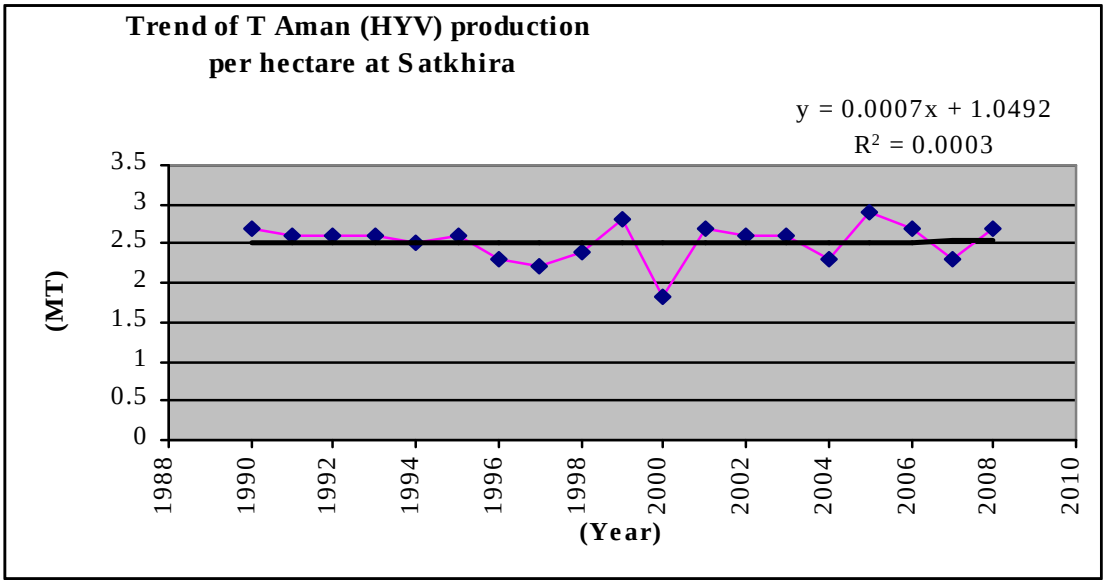
Table 40: Long-term impacts of different climatic risks/vulnerable factors on crop production at Bhola district

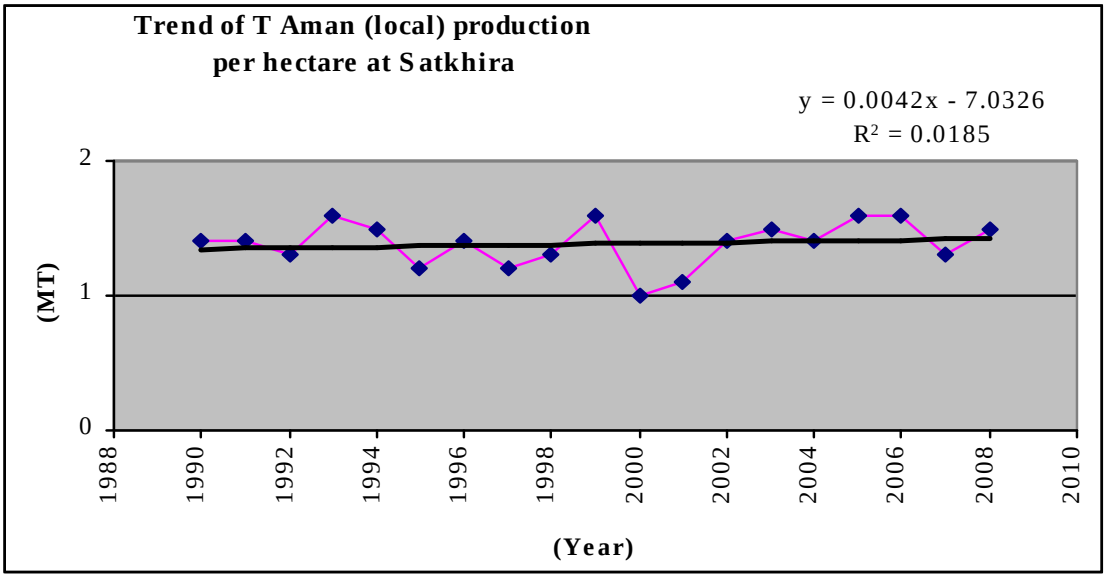
Crop	Climatic risks/vulnerable factors	Severity of vulnerable factors (very severe, severe, moderate or low)*	Crop loss/yield reduction (%)	Remarks
T.Aman	Drought, flood, erosion Drought,tidal surge Cyclone, river erosion Drought, flood, erosion Drought, flood Tidal flooding Tidal flooding, cyclone	Moderate Moderate Severe Moderate Moderate Moderate Moderate	20-40 20-40 40-60 20-40 20-40 20-40 20-40	Bhola (S): 12,000 ha(drought, flood) Lalmohan: 2,500 ha (drought, tidal surge) Monpura : 7,500 ha (cyclone, erosion) Daulatkhan : 5,500 ha (drought, flood) Borhanuddin : 2,000 ha (drought, flood) Tazumuddin : 2,500 ha (tidal flooding) Charfasion : 10,000 ha (flood, cyclone)
Wheat	Temperature variation Late winter/short cold period	Severe Severe	40-60 ,,	Due to temperature variation and late winter/ short cold period, the farmers can not cultivate wheat.
Maize	Drought Rainfall variation High wind	Severe Severe Severe	40-60 ,, ,,	Severe drought/rainfall variation and high wind causing 40-60% yield reduction in maize crop. Maize can not be profitably grown here.
Potato	Temperature variation	Severe	40-60	Short winter/short cold period,

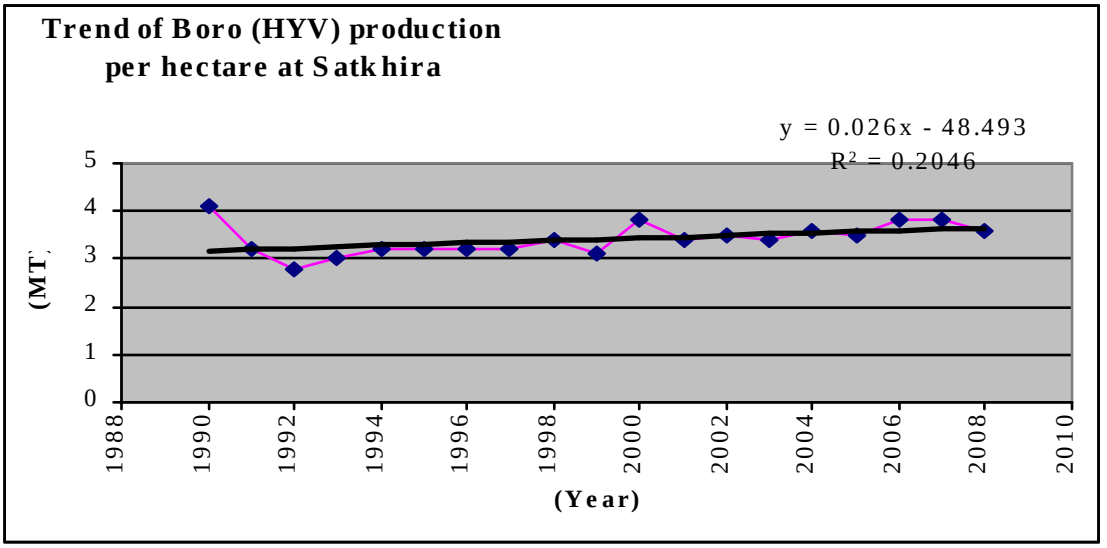
Crop	Climatic risks/vulnerable factors	Severity of vulnerable factors (very severe, severe, moderate or low)*	Crop loss/yield reduction (%)	Remarks
	Short cold period Pests and diseases	Moderate Moderate	20-40 20-40	clayey soils, salinity and temperature variation, the cultivation of diamant/ cardinal variety of potato is limited in 5,200 ha.
Pulse crops (khesari, mung bean, soybean, cowpea)	Erratic rainfall Soil wetness Drought Salinity Pests and diseases	Moderate Moderate Moderate	20-40 ,, ,,	Due to mentioned environmental risk factors, cultivation of pulse crops is affected in about 42,200 ha
Oilseed crops (mustard, sesame, ground nut)	Temperature variation Late winter/short cold period Clayey soils Salinity	Severe Severe Severe Moderate Moderate	40-60 ,, ,, ,, ,,	Farmers usually do not cultivate oilseed crops except mustard, sesame and ground nut in some locations (about 16,500 ha) in Bhola Sadar, Lalmohan, Daulatkhan and Borhanuddin.
Spice crops (chilli, onion, garlic)	Early rainfall Temperature variation Pests and diseases	Moderate Moderate Moderate	20-40 ,, ,,	Farmers usually do not cultivate spice crops except chilli and some onion in some locations (about 21,200 ha).
Jute Sugarcane	Temperature variation High rainfall High wind	Severe Severe Severe	>60 ,, ,,	Farmers usually do not cultivate jute and sugarcane due to unfavourable climatic conditions. Some farmers cultivate some chewing varieties of sugarcane.
Fruit crops (papaya, banana, water melon)	Salinity High wind Excessive rainfall Pests and diseases	Severe Moderate Moderate Moderate	.40-60 ,, ,, ,,	Due to stormy wind and severe/ moderate salinity in drier months and pests & diseases in monsoon period, the cultivation of fruit crops is severely affected. Water melon and amra is cultivated in some locations (4,000ha).
Irrigated crops HYV boro	Drought Cyclone Salinity Pests and diseases	Severe Severe Moderate Moderate	40-60 ,, ,, ,,	The mentioned environmental risk factors causing 40-60 % yield reduction in the cultivation HYV boro crop.
T.Aus	Drought Salinity Cyclone Pests and diseases	Moderate Moderate Moderate	20-40 ,, ,,	The mentioned environmental risk factors causing 20-40% yield reduction in the cultivation of HYV T.Aus crop.
T.Aman	Floods/water stagnancy Drought/salinity Cyclone Pests and diseases	Moderate Moderate Moderate Moderate	20-40 ,, ,, ,,	The mentioned environmental risk factors causing 20-40% yield reduction in the cultivation of HYV T.Aman crop.

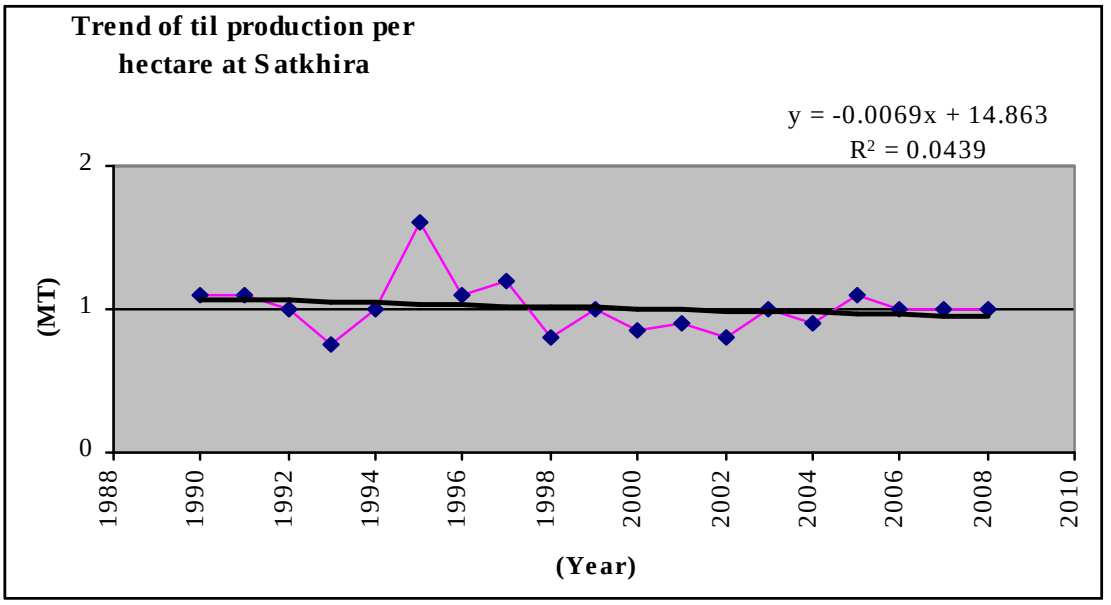
* Very severe= > 60% yield loss, Severe= 40-60% yield loss, Moderate=20-40% yield loss and Low=< 20% yield loss

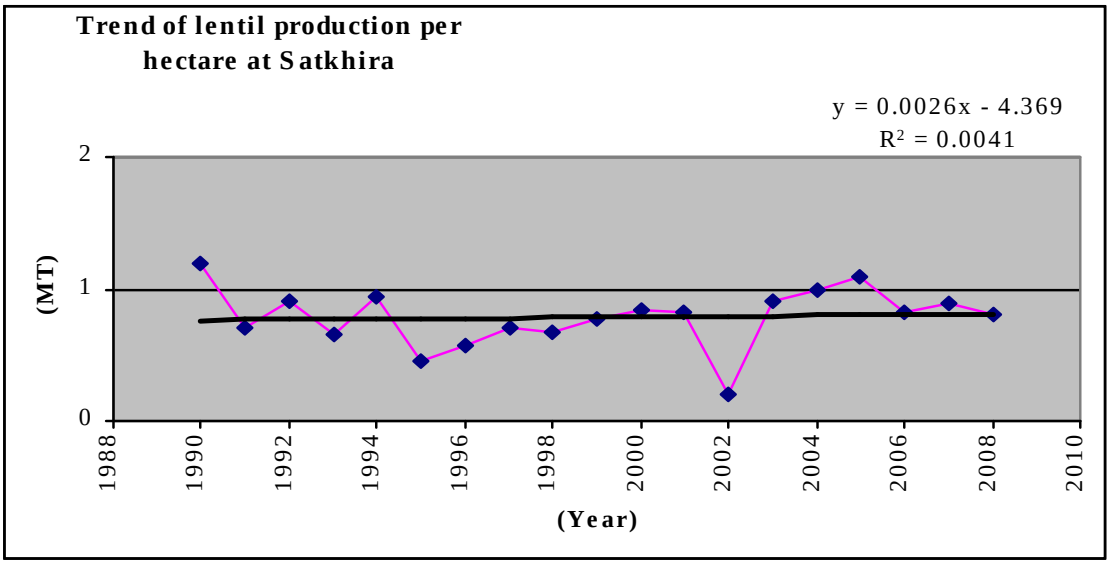
4.2 Trends of Crop Production(for example in Satkhira district) due to Climate Change are shown graphically below:Figure 29-38

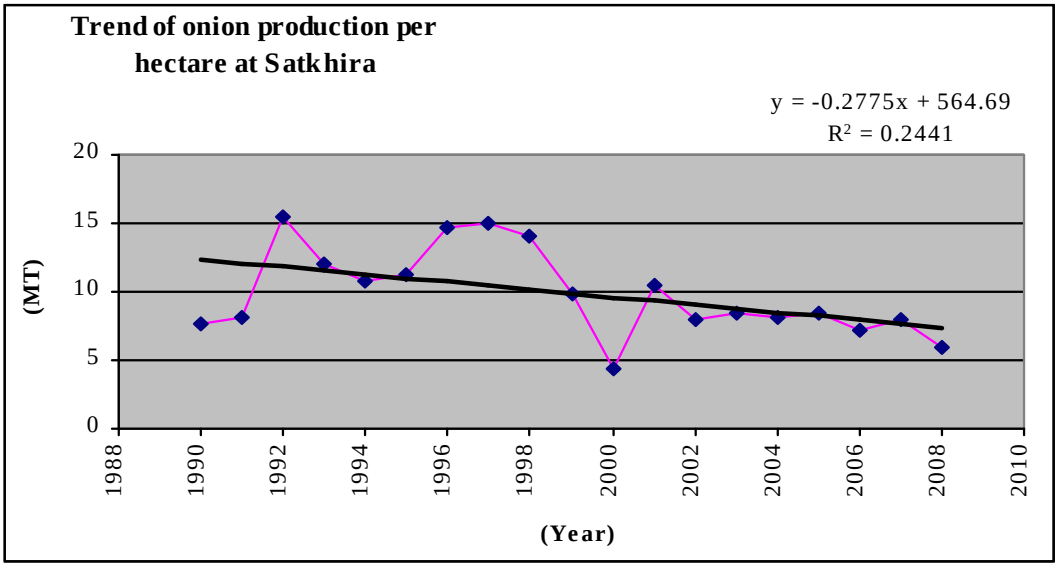


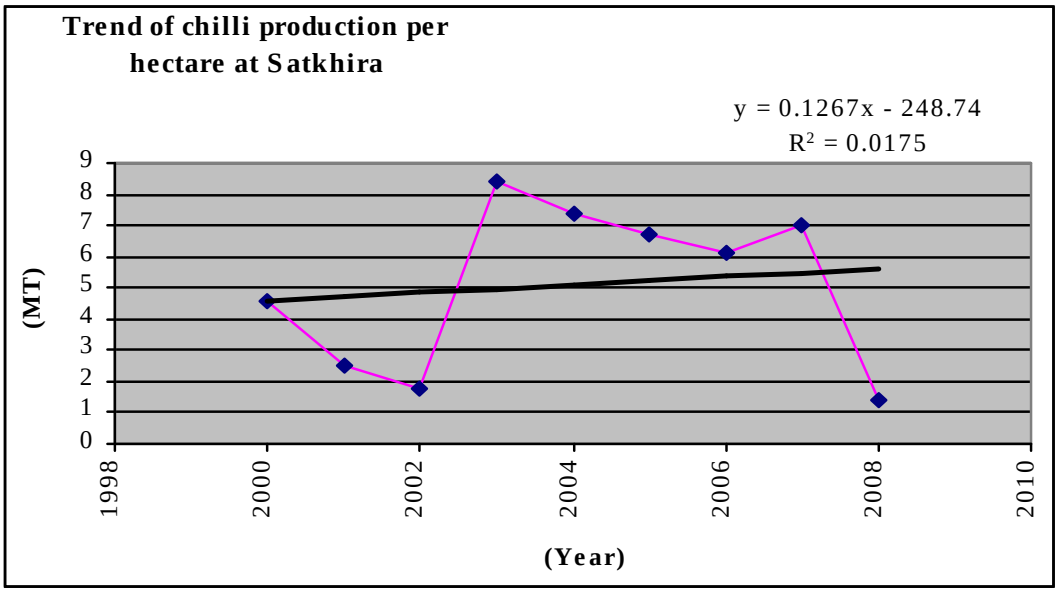


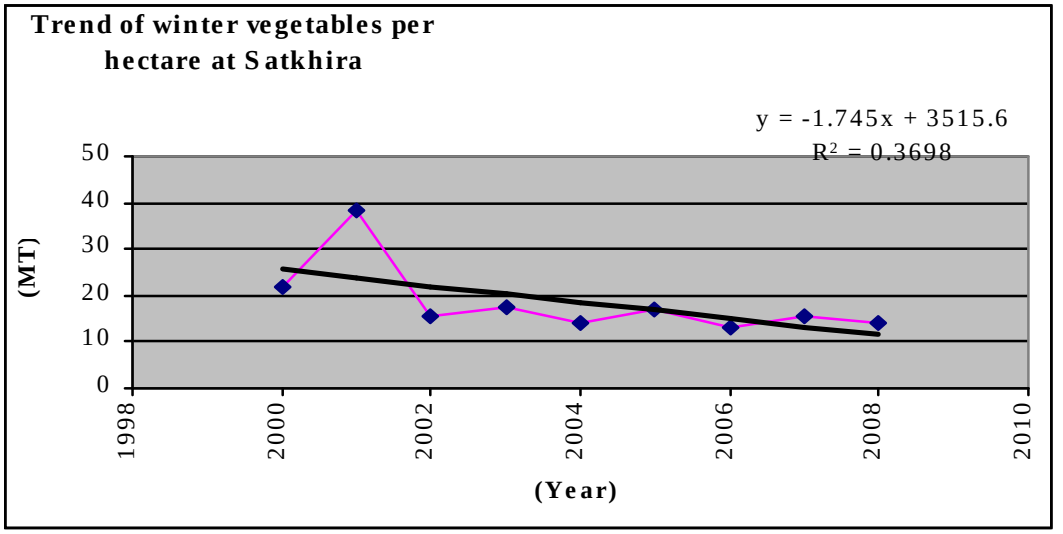



Trend of til production per hectare at Satkhira
y = -0.0069x + 14.863
R² = 0.0439
(MT)
(Year)


Trend of lentil production per hectare at Satkhira
y = 0.0026x - 4.369
R² = 0.0041
(MT)
(Year)


Trend of onion production per hectare at Satkhira
y = -0.2775x + 564.69
R² = 0.2441
(MT)
(Year)





i) Observations/Comments Based on Long-term Crop Productivity Data(10-15 years) in Satkhira district:

- T.Aman production (both local & HYV) showing a declining trend due to tidal surge, erratic rainfall, salinity and increased incidences of pests
- Boro production slightly increasing due to introduction of salt-tolerant varieties with improved management practices
- Production of wheat & potato is decreasing due to short winter, drought and salinity
- Lentil production is decreasing due to sensitive to salinity and drought
- Production trend of mustard and M.bean (moderately salt tolerant) is increasing
- Winter vegetables and spices (mainly onion and garlic) being affected by short winter, drought and salinity
- Area and production of chilli (moderately salt-tolerant) is increasing

ii) Observations/Comments Based on Long-term Crop Productivity Data (10-15 years) in Barisal district:

- T.Aman production (HYV) showing an increasing trend due to expansion

- Boro production increasing due to introduction of salt-tolerant varieties with improved management practices
- Production of wheat & potato is decreasing due to short winter, drought and salinity in some years
- Lentil production is decreasing due to sensitive to salinity and drought
- Production trend of mustard and M.bean (moderately salt tolerant) is increasing
- Winter vegetables and spices (mainly onion & garlic) being affected by short winter, drought and salinity
- Area and production of chilli (moderately salt-tolerant) is increasing

iii) Observations/Comments Based on Long-term Crop Productivity Data(10-15 years) in Bhola district:

- T.Aman and Boro production is being greatly affected by cyclone, flood, drought ,salinity and pests
- Production of wheat & potato is decreasing due to short winter, drought and salinity in some years
- Lentil production is decreasing due to sensitive to salinity and drought
- Production trend of mustard and M.bean (moderately salt tolerant) is increasing
- Winter vegetables and spices (mainly onion & garlic) being affected by short winter, drought and salinity
- Area and production of chilli (moderately salt-tolerant) is increasing

iv) Observations/Comments Based on Long-term Crop Productivity Data (10-15 years) in Cox's bazar district:

- T.Aman production being affected by drought, flash floods & sand deposits
- Boro production being affected by drought, salinity, iron toxicity
- Pulses & oil seed production being affected by temperature variation, short winter, salinity, pests & diseases
- Spice crops being affected by soil wetness, salinity, pests & diseases

v) Observations/Comments Based on Long-term Crop Productivity Data(10-15 years) in Noakhali district:

- T.Aman production being severely affected by excess rains, floods and water-logging.
- Boro production being affected by under ground water salinity, surface water salinity and scarcity of surface water.
- Production of wheat & potato is hampered temperature variation and short winter
- Pulses production(mainly khesari, mungbean) is being affected due to soil wetness and salinity.
- Production trend of oil seed crops (mustard) being affected by temperature variation and salinity.

4.3 Crop loss/yield reduction due to Climate Risk Factors

Crop losses and yield reductions were estimated based on field visits, survey, FGDs, case studies and discussion with local scientists, extension personnel and farmers in evaluating the severity of climate risk factors affecting crop production systems in the coastal districts following a standard criteria of checklist. During evaluation/estimation of

crop losses, major climatic risk factors were also identified. Estimation of crop loss/yield reduction has been summarized in the following table based on the local estimates, observations/experiences of last 5-10 years and long-term crop productivity (10-15 years) at different project sites:

Table 41: Crop loss/yield reduction due to climate risk factors

Crop	% yield reduction	District	Total areas (in ha) affected	Total yield loss '000' MT	Major Climatic Risks
T. Aman	40-60	Cox's Bazar	35,500	71.00	Drought,flash floods, salinity, erosion, tidal surges, pests & diseases
	20-40	Patuakhali	76,200	114.30	Drought, water-logging, tidal floods, pests and diseases
	20-40	Barguna	27,500	41.25	Drought, flood, pests & diseases
	20-40	Pirujpur	25,600	38.40	Flood, drought, tidal surge, pests
	20-40	Barisal	57,750	86.62	Flood, water-logging, drought, pests & diseases
	20-40	Noakhali	59,950	89.93	Drought, flood, water, logging, pests & diseases
	20-40	Satkhira	35,700	53.55	Drought, water-logging, erosion, pests
	20-40	Khulna	28,850	43.27	Cyclone, water-logging, salinity, pests
	20-40	Bagerhat	61,270	91.90	Drought, flood, river erosion, pests
	20-40	Bhola	42,000	63.00	Drought, tidal flood, cyclone, pests
Total			**450,320**	**693.22**	
T.Aus	20-40	All districts	75,000	112.50	Submergence, drought, salinity, Fe toxicity, river & ground water salinity, cyclone, pests & diseases
HYV Boro	20-40	All districts	150,000	300.00	Drought, salinity, Fe toxicity, river & ground water salinity, cyclone
Potato, Sweet Potato	40-60	All districts	28,055	140.25	Short winter, clayey soils, salinity, fogginess Average yield = 10-12 t/ha
Pulses (Khesari, M. bean)	20-40	- do -	201,850	60.55	Untimely rainfall, soil wetness, drought, salinity, Pests & diseases
Oilseed Crops (Mustard, sesame, G.nut)	20-40	- do -	63,750	19.12	Late/short winter, salinity, clayey soils, Pests & diseases
Spice Crops (Chilli, Onion, Garlic)	20-40	- do -	53,630	26.81	Early rainfall, soil wetness, salinity, pests and diseases.
Fruit crops (banana, papaya, water melon, amra, guava, amra etc)	20-40	-do-	10,625	53.12	Erratic rain, drought, high temperature, salinity, tidal flood, water-logging, pests & diseases and cyclone
Grand Total				**1,405.57**	

Source: FGDs at district level compiled data from concerned upazilas and DAE District Office, 2008-09

Estimates showed that the main reasons of yield reduction (20-40 % yield loss) in T.Aman crop are erratic rainfall, increased intensity and frequency of drought, increased salinity, tidal surges, floods, cyclone, use of local varieties, increased incidences of pests & diseases etc in the context of climate change. Total yield loss of T.Aman crop has been estimated to about 6.93 lakh ton per year in 450,320 hectares based on last 5-10 years climate change scenarios. Similarly, average yield level of HYV Boro is being affected (30-40 % yield loss) by high temperature (causing sterility) and increased salinity and that of T.Aus/Aus crop is being affected (20-40 % yield loss) by tidal surges. Vegetables, pulses, oilseed crops and fruit crops are being affected (20-40 % yield loss) by drought, increased salinity, soil wetness, excessive rainfall and water-logging and tidal surges in most coastal districts. From the study, total crop loss for major crops (viz. cereals, potato, pulses, oil seeds, vegetables, spices and fruit crops) due to different climate risks has been estimated to about 14.05 lakh tons per year based on last 5-10 years of climate change scenarios within the areas of ten project districts. But the people are to live with these climatic vulnerabilities and risks in the coastal region.

4.3.2 Farmers' Response on Crop Production Systems Through Household Survey

a) Assessing Farmers' Responses about Long-term Impacts of Climate Change on Crop Production Systems and Food Security

Long-term impacts of climate change on crop production systems, food security and livelihood of the study areas were evaluated through household survey as per programme shown below:

Table 42: Locations of Household survey

District	Selected Upazila	# HHs surveyed	DAE Field Staff in HHs survey	Climate vulnerabilities
Cox's bazaar	Cox's bazaar (S) Maheskhali Chakaria	60x3	Concerned SAAOs	-Soil salinity, tidal surges -Soil erosion, flash flood -Expansion of shrimp culture
Satkhira	Tala Shymnagar Assasuni	60x3	Concerned SAAOs	-Soil salinity, tidal surges -Tidal flood, water stagnancy -Expansion of shrimp culture
Khulna	Dumuria Batiaghata Terokhada	60x3	Concerned SAAOs	-Soil salinity, tidal surges -Ground water salinity -Expansion of shrimp culture
Bagerhat	Rampal Mollahat Sharankhola	60x3	Concerned SAAOs	-Soil salinity, tidal surges -Water stagnancy, cyclone -Expansion of shrimp culture
Barisal	Barisal Sadar Banaripara Ujirpur	60x3	Concerned SAAOs	-Soil salinity, tidal surges -Soil erosion, flash flood -Expansion of shrimp culture
Bhola	Charfashion Tajumuddin Borhanuddin	60x3	Concerned SAAOs	-Soil salinity, tidal surges -Water stagnancy, cyclone -Problems of communication
Pirojpur	Pirojpur Sadar	60x3	Concerned	-Soil salinity, tidal surges

	Nazirpur Nesarabad		SAAOs	-Water stagnancy, cyclone -Expansion of shrimp culture
Barguna	Barguna Sadar Amtali Betagi	60x3	Concerned SAAOs	-Soil salinity, tidal surges -Water stagnancy, cyclone -Expansion of shrimp culture
Patuakhali	Dumki Kalapara Galachipa	60x3	Concerned SAAOs	-Soil salinity, tidal surges -Water stagnancy, cyclone -Ground water salinity
Noakhali	Subarnachar Hatiya Senbag	60x3	Concerned SAAOs	-Soil salinity, tidal surges -River erosion, cyclone -Ground water salinity

Farmers' Responses about Long-term Impacts of Climate Change on Crop Production: During household survey, participants perceived that temperature has increased over the years and duration of winter has been shortened affecting the potential growing period of winter crops. Cultivation of wheat is being affected at grain filling stage due to high temperature and increased incidences of pests and diseases. Increased intensity of soil salinity was perceived by the farmers as white crust of salts on soil surface and crop burning during drier months in the coastal areas.

Presently, farmers are very concerned about climate change issues viz. erratic rainfall, temperature rise, short winter, intensity of drought, salinity, tidal surges, submergences, cyclone, tornadoes etc in crop production systems. Based on farmers' perception and farmers' response about climate change, problem rankings for major crops are shown in the following Tables.

b) Causes of Poverty and Food Insecurity

During household survey in the project sites, the following parameters were used to identify and measure the causes of poverty and food insecurity in surveyed HHs(180x10):

Low wage earning = 1, Inadequate income = 2, Landlessness = 3, Unemployment = 4, Number of disabled people in the family = 5, Household Head is widow or separated women = 6, Natural disaster = 7, Food grain deficit in the region = 8, High price of food grains = 9, Lack of access in market = 10, Multiple marriage = 11, Court Cases = 12, Diseases = 13, Cheating = 14, Drug addicted = 15, To be out of a job = 16, Lack of educational awareness = 17, low crop yield = 18, crop loss = 19, health and nutritional deficiency = 20, climatic hazards = 21, political crisis = 22, others (specify) = 23.

The findings of household survey in coastal districts have shown that the major causes of poverty are: natural disaster/impacts of climate change>lower crop productivity/crop loss due to climate risks>insufficient income>high price of daily food>poor marketing facilities. The detailed causes/factors that causing poverty in different districts are shown in a summary table (Table 43).

Table 43: Percentage Distribution of Households Surveyed for Assessing Causes of Poverty

Causes of Poverty	Study Area									
	Barisal	Bagerhat	Bhola	Borguna	Cox's Bazar	Khulna	Noakhali	Patuakhali	Pirojpur	Satkhira
Natural disaster	66.9	90.7	46.1	60.4	45.9	44.7	72.2	75.0	68.9	76.1
Impact of climate change	58.3	90.1	58.9	49.7	47.9	65.4	90.0	85.2	63.3	77.8
Insufficient income	46.9	60.5	28.9	53.1	44.3	36.3	59.4	56.3	57.2	52.8
Landless	-	-	-	19.8	33.0	-	30.5	-	-	-
Lack of job	21.7	22.1	-	24.3	33.5	21.2	28.9	-	30.5	-
Crop loss/damage	60.0	69.8	38.3	39.5	39.7	40.2	90.0	55.1	56.1	80.0
High price of daily food	35.4	62.2	16.7	-	-	18.4	41.7	39.2	-	37.8
Low market price of commodity	29.1	40.1	32.2	-	-	14.0	45.0	15.3	38.3	41.7
Lack of agricultural education/awarenes s	-	-	13.9	20.9	24.7	-	-	-	-	-
Low crop productivity	62.3	62.2	35.6	35.0	26.3	42.5	70.0	44.3	60.5	60.5
Low fertility of land	36.0	62.8	22.2	25.4	30.4	35.2	63.3	40.9	33.3	57.2
Lack of nutrition and health	-	-	-	-	-	-	-	12.5	27.8	34.4
Disease	20.0	27.3	17.2	40.1	23.2	25.7	-	33.5	30.0	37.8

ii) Local Perception on Climate Risks: Local perception of the impacts of climate hazards in coastal areas was assessed during FGDs and household survey. Participants stated that the current climate in this region is behaving differently than in the past on the following climate risk factors affecting crop production:

- Frequent drought
- Changes in seasonal rainfall pattern
- Seasonal rainfall
- Long dry spells
- Increase of soil salinity
- Increase of tidal surges

In addition, participants perceived that temperature has increased over the years and duration of winter has been shortened affecting the potential growing period of winter crops. Cultivation of wheat is being affected at grain filling stage due to high temperature and increased incidences of pests and diseases. Increased intensity of soil salinity was perceived by the farmers as white crust of salts on soil surface and crop burning during drier months in the coastal areas.

Presently, farmers are very concerned about climate change issues viz. erratic rainfall, temperature rise, short winter, intensity of drought, salinity, tidal surges, submergences, cyclone, tornadoes etc in crop production systems. Based on farmers' perception and farmers' response about climate change, problem rankings for major crops are shown in the following Table 44.

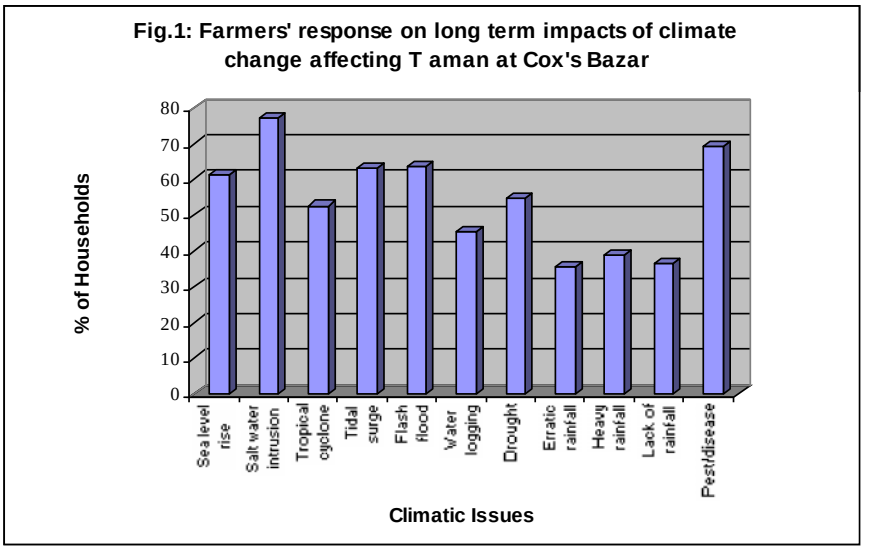
Table-44: Farmers' perception/response about climate related problems in the cultivation of different crops in the coastal region

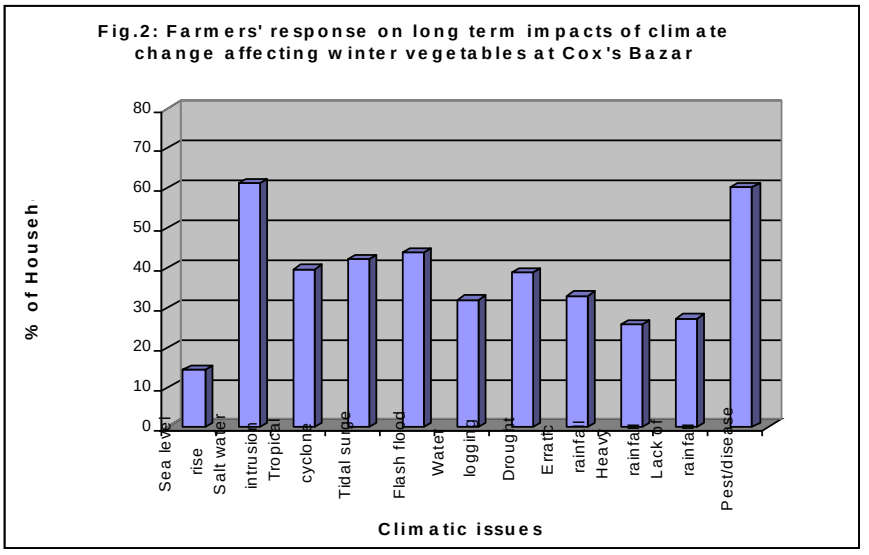
Crop	Vulnerability Ranking (1-4)*	% of farmers growing the crop	Total respondents	% farmers' response	Climate vulnerabilities
T.Aman	2-3	85	1,739	77 54 48.4 42 28	Pests and diseases Cyclone Water-logging Tidal flooding Salt water intrusion
T.Aus	3	50	1,739	50 27 24 22 20	Pests and diseases Cyclone Drought High temperature Salinity
HYV Boro	3	70	1,739	50 30 27 25 20	Pests and diseases Cyclone Drought High temperature Salinity
Wheat	1-2	40	1,739	70 60	Late/short winter Sterility due to high temp.
Oil seed crops(Mustard, Sesame, G.nut)	2-3	50	1,739	50 42 40 35	Late/short winter Salinity Pests and diseases Clayey soils
Potato, Sweet Potato	2-3	60	1,739	52 48 40	Late/short winter Heavy soils Salinity
W. Vegetables	2-3	70	1,739	53 32 30 25 20	Pests and diseases Drought Cyclone Erratic rainfall & heavy rain Tidal flooding
S. Vegetables	3-4	60	1,739	39 30 30 21 18	Pests and diseases Drought Salinity Cyclone Heavy rainfall
Pulses (Khesari, M.bean)	2-33	65	1,739	60 40 40	Soil wetness Salinity Pests and diseases
Water melon	3-4	30	1,739	50	Salinity, drought
Spice crops (Chilli, Onion, Garlic)	2-3	60	1,739	63 50 45	Early rainfall Soil wetness Pests and diseases

* Vulnerability Ranking: Very severe (1) = > 60 % yield loss, Severe(2) = 40-60 % yield loss, Moderate (3) = 20-40 % yield loss and Low (4) = < 20 % yield loss.

Farmers' responses on long-term impacts of climate change affecting crop production in vulnerable districts of Coastal Region are shown graphically below:

i) Farmers' response at Cox's Bazar District-Figure 39-41





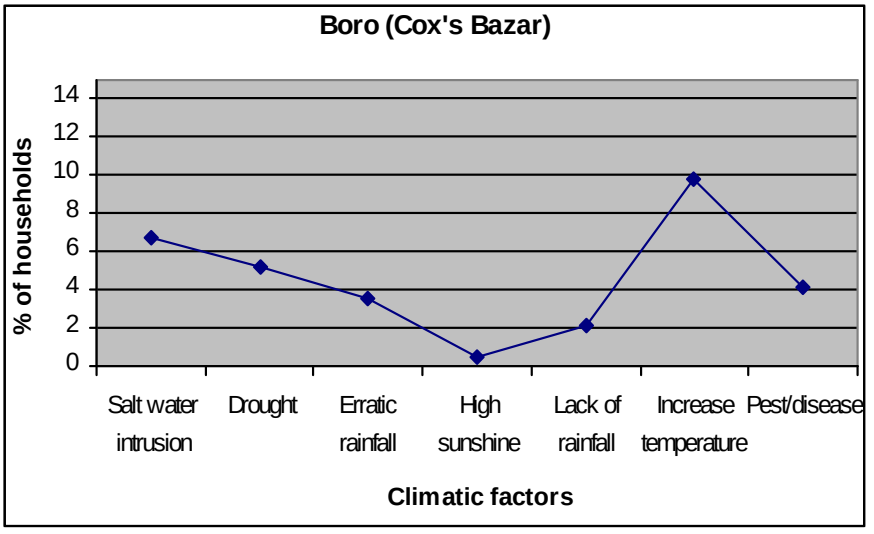
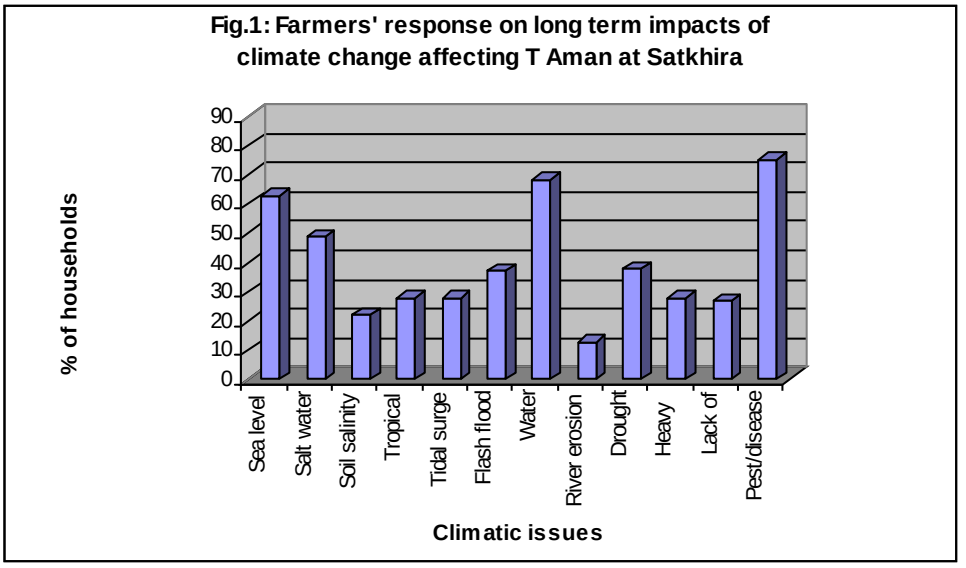
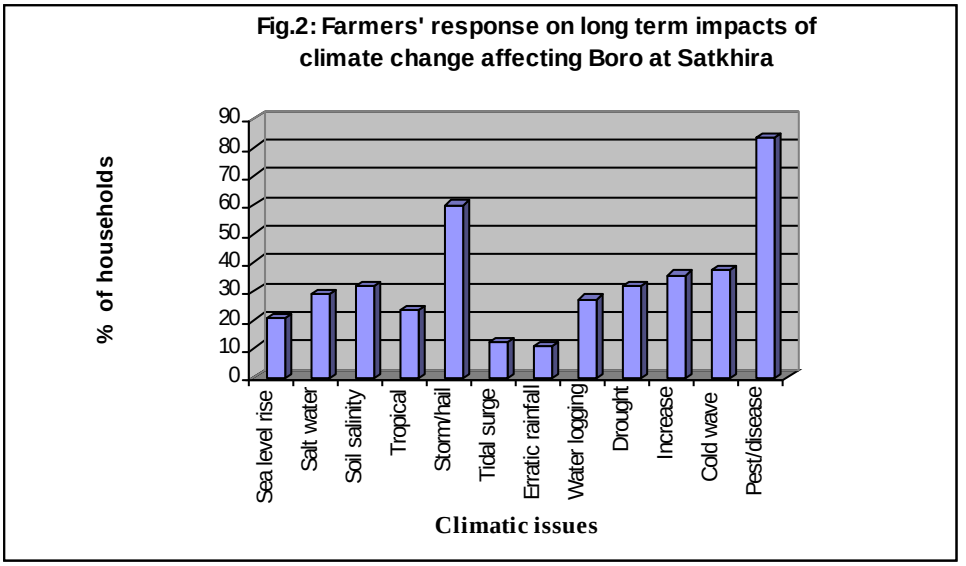
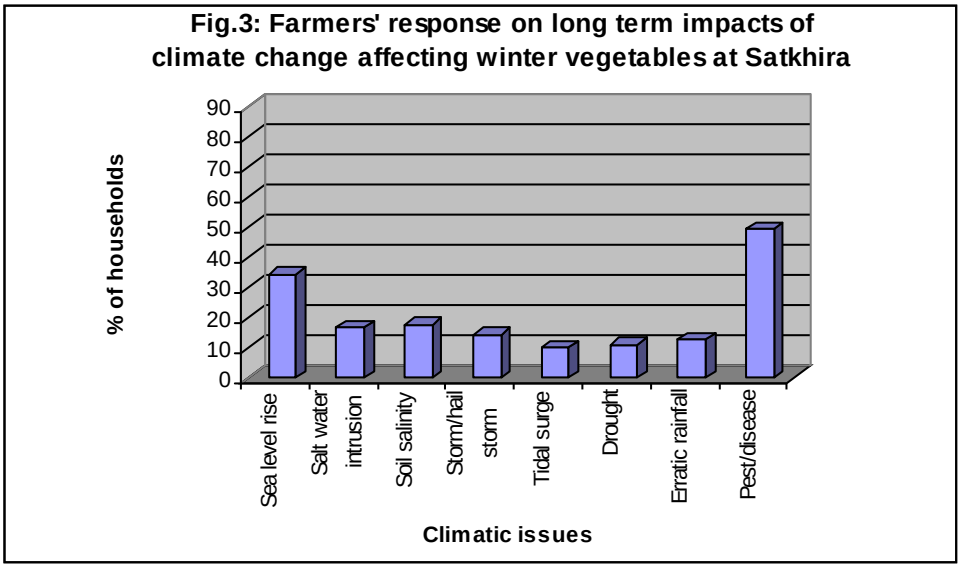


Figure 42-47: Farmers' response about impacts of climate change on crops (Satkhira)

ii) Farmers' response at Satkhira District







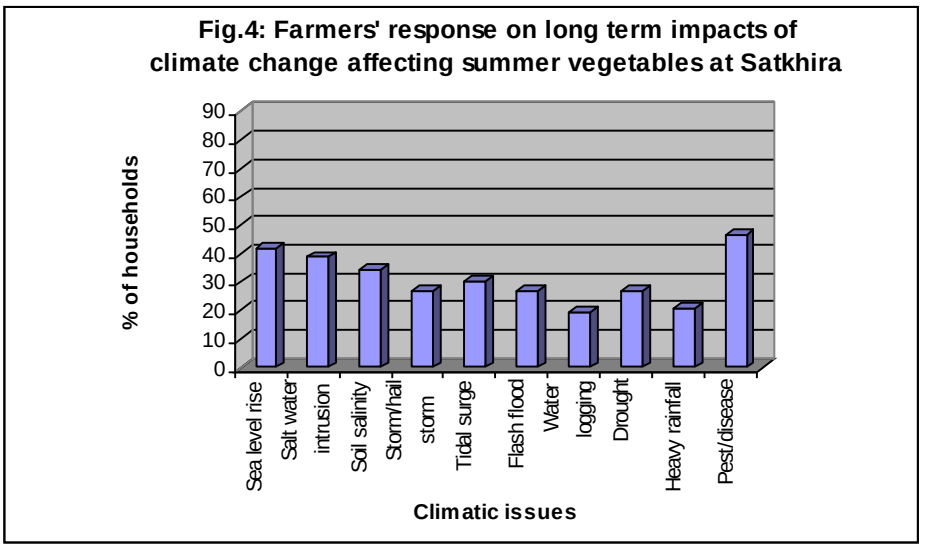


Fig.4: Farmers' response on long term impacts of climate change affecting summer vegetables at Satkhira
% of households
90
80
70
60
50
40
30
20
10
0
Sea level rise
Salt water intrusion
Soil salinity
Storm/hail storm
Tidal surge
Flash flood
Water logging
Drought
Heavy rainfall
Pest/disease
Climatic issues

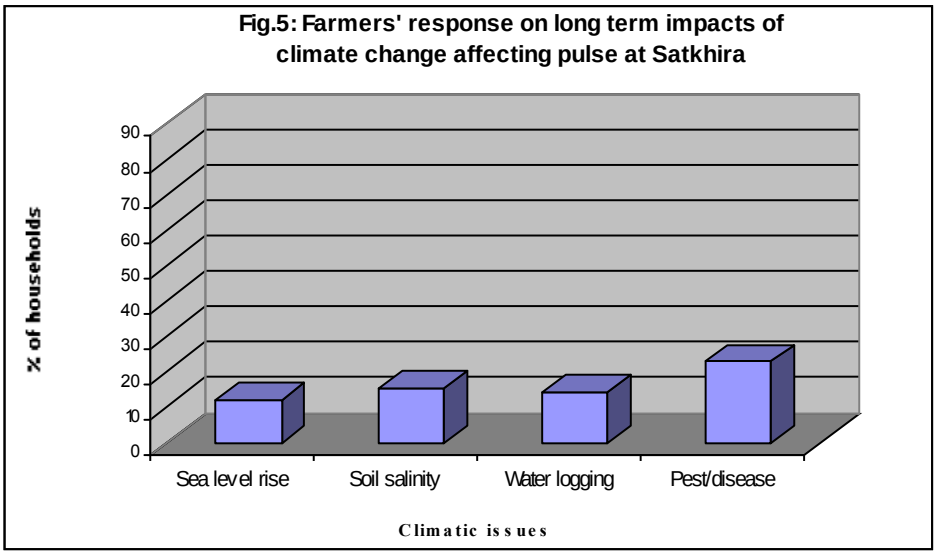


Fig.5: Farmers' response on long term impacts of climate change affecting pulse at Satkhira
% of households
90
80
70
60
50
40
30
20
10
0
Sea level rise
Soil salinity
Water logging
Pest/disease
Climatic issues

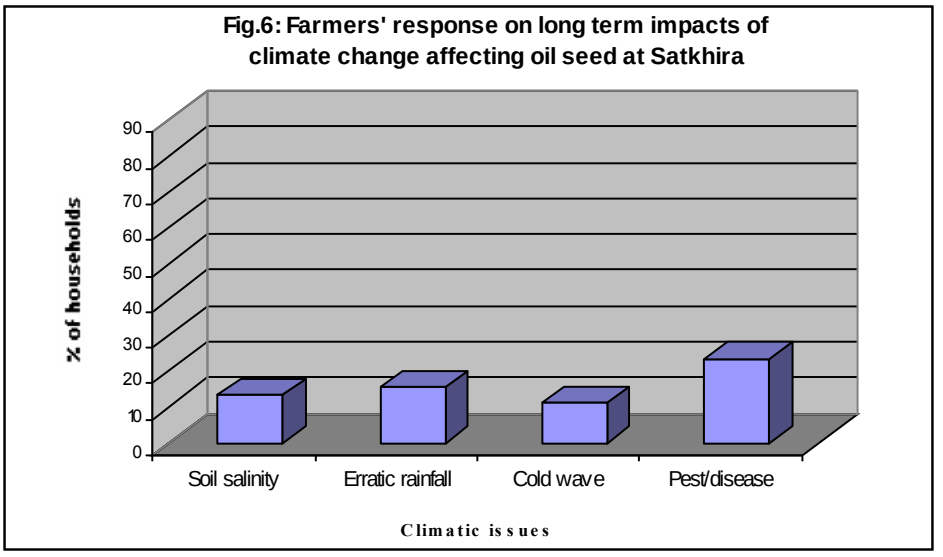
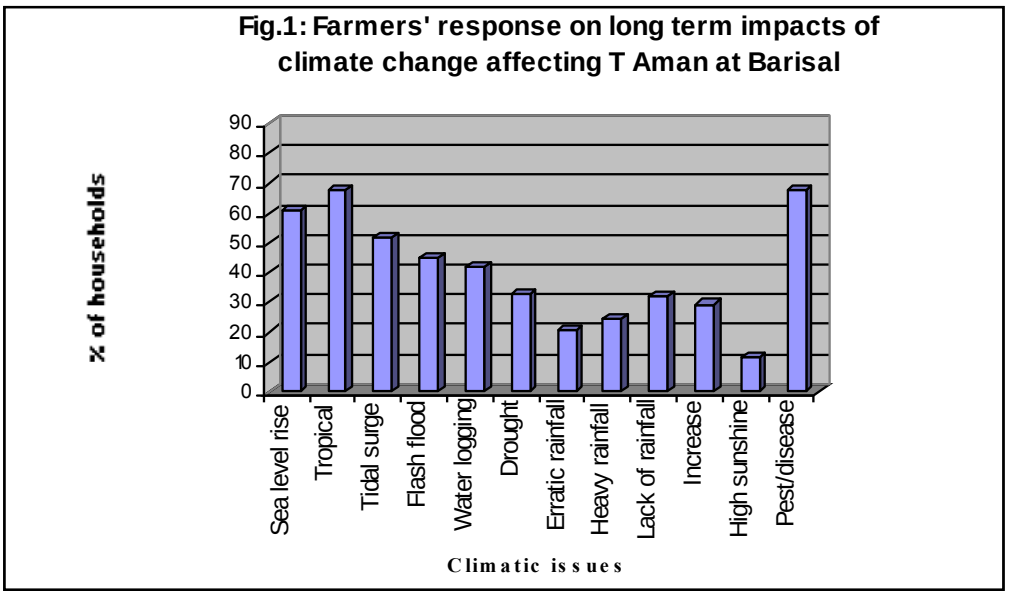
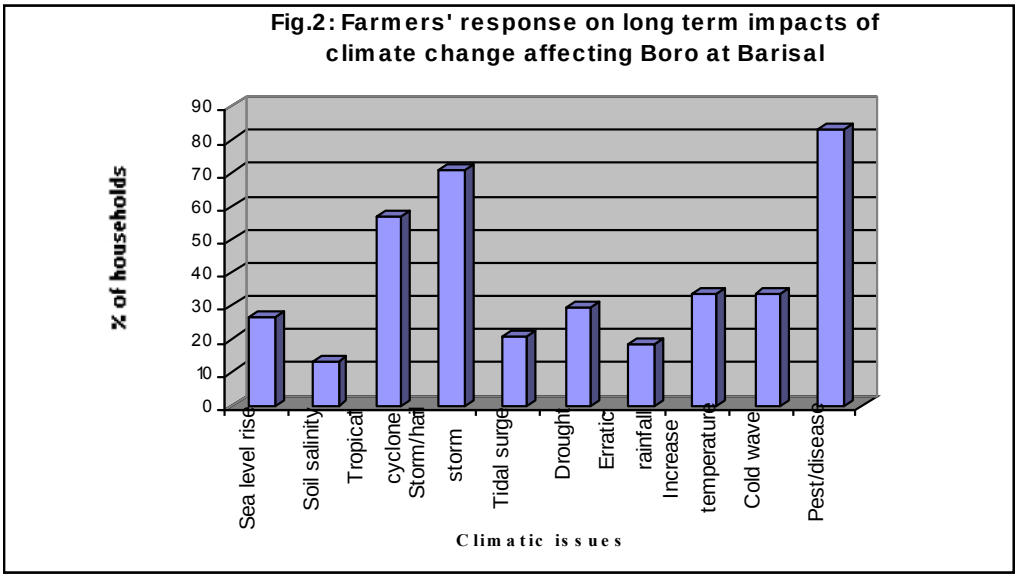
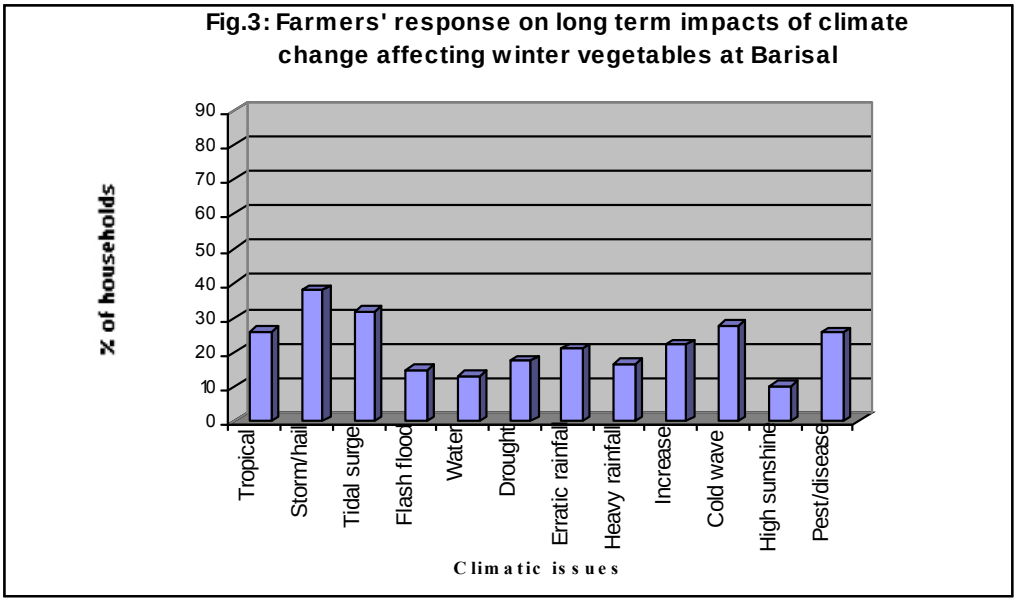


Fig.6: Farmers' response on long term impacts of climate change affecting oil seed at Satkhira
% of households
90
80
70
60
50
40
30
20
10
0
Soil salinity
Erratic rainfall
Cold wave
Pest/disease
Climatic issues

iii) Figure 48-53: Farmers' response at Barisal District







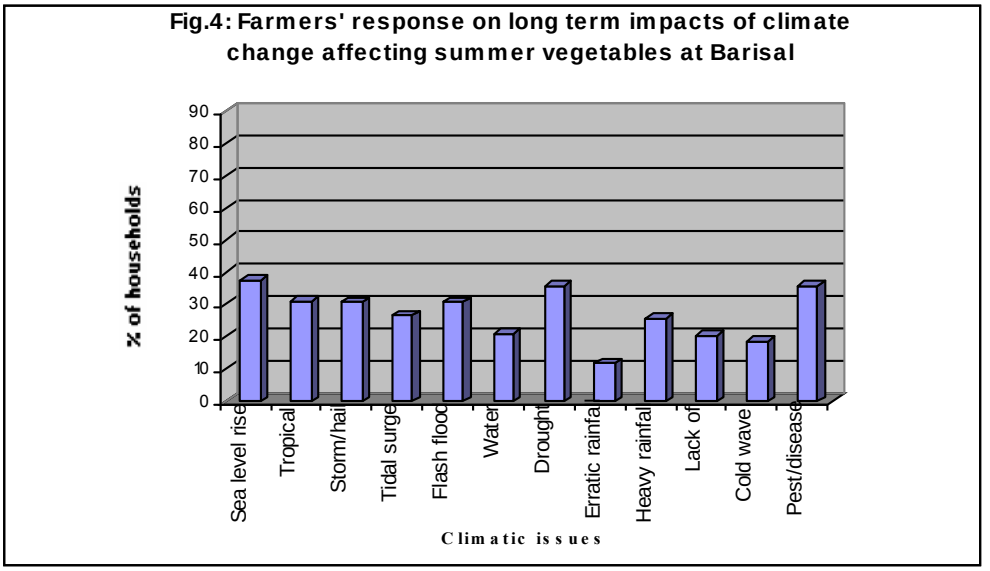


Fig.4: Farmers' response on long term impacts of climate change affecting summer vegetables at Barisal
% of households
90
80
70
60
50
40
30
20
10
0
Sea level rise
Tropical
Storm/hail
Tidal surge
Flash flood
Water
Drought
Erratic rainfa
Heavy rainfall
Lack of
Cold wave
Pest/disease
Climatic issues

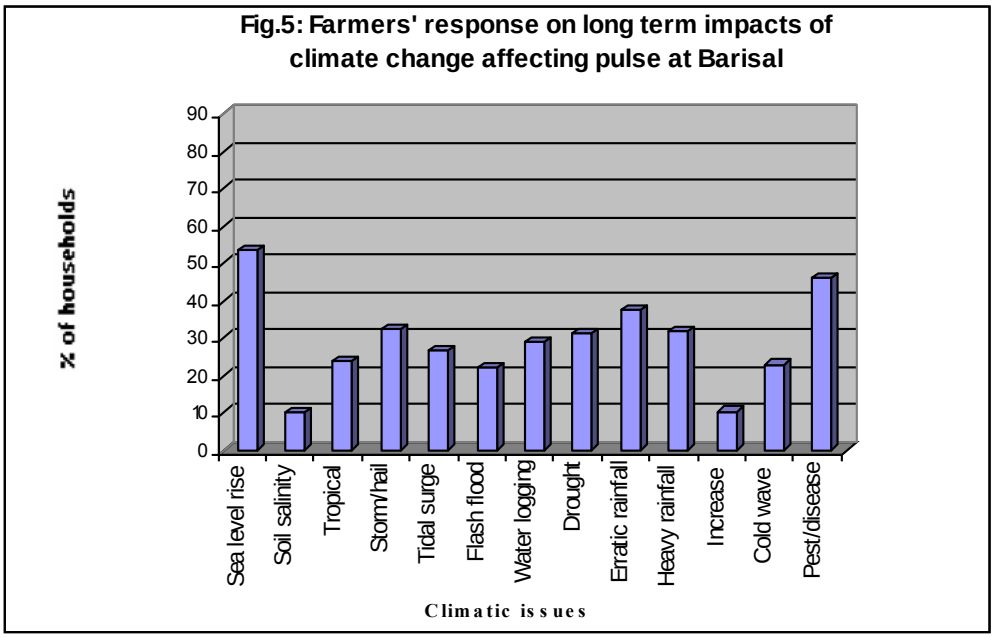


Fig.5: Farmers' response on long term impacts of climate change affecting pulse at Barisal
% of households
90
80
70
60
50
40
30
20
10
0
Sea level rise
Soil salinity
Tropical
Storm/hail
Tidal surge
Flash flood
Water logging
Drought
Erratic rainfall
Heavy rainfall
Increase
Cold wave
Pest/disease
Climatic issues

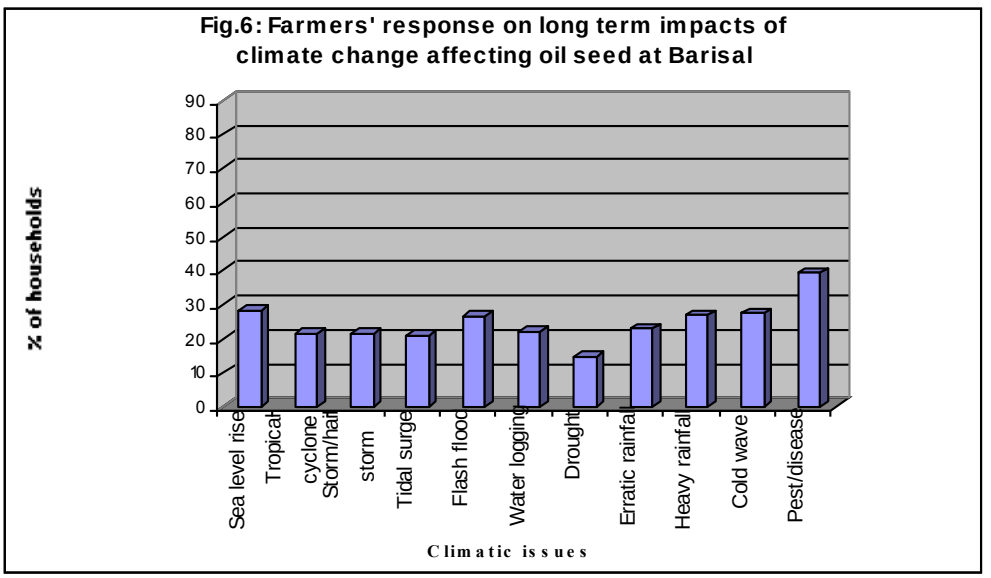
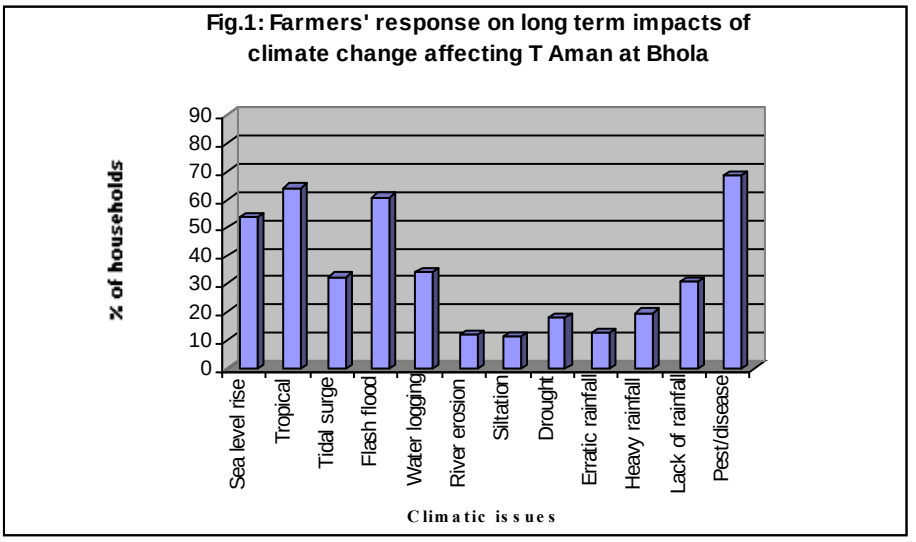
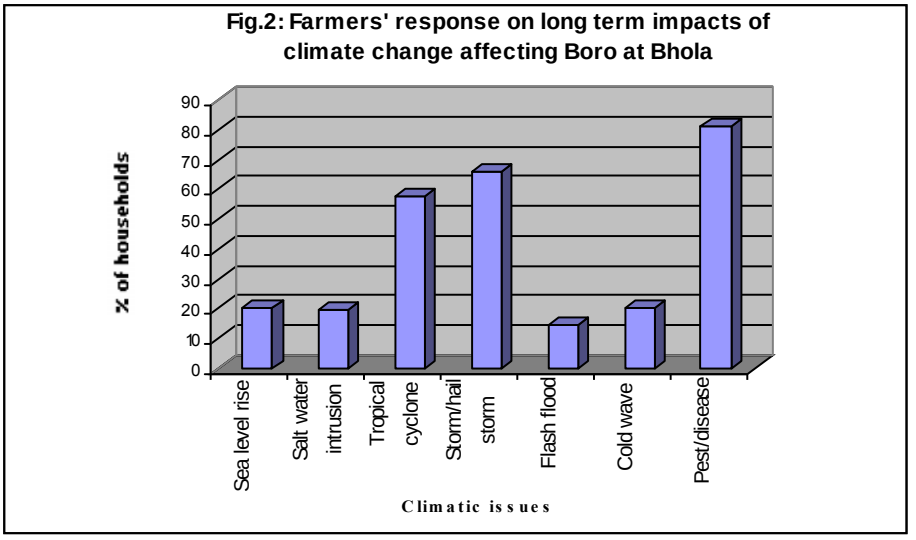
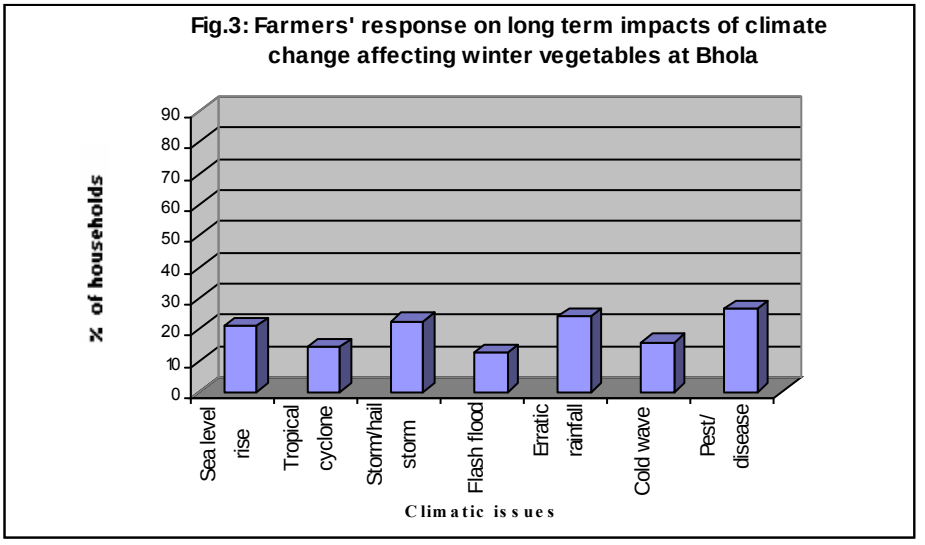


Fig.6: Farmers' response on long term impacts of climate change affecting oil seed at Barisal
% of households
90
80
70
60
50
40
30
20
10
0
Sea level rise
Tropical
cyclone
Storm/hail
storm
Tidal surge
Flash flood
Water logging
Drought
Erratic rainfa
Heavy rainfall
Cold wave
Pest/disease
Climatic issues

iv) Figure 54-59: Farmers' response at Bhola District







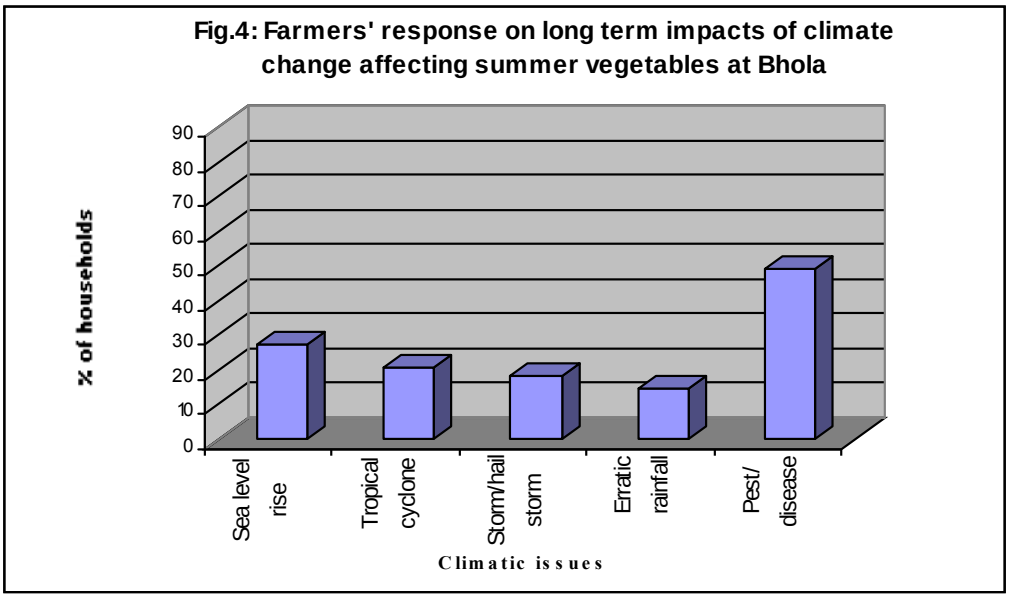


Fig.4: Farmers' response on long term impacts of climate change affecting summer vegetables at Bhola
% of households
90
80
70
60
50
40
30
20
10
0
Sea level rise
Tropical cyclone
Storm/hail storm
Erratic rainfall
Pest/ disease
Climatic issues

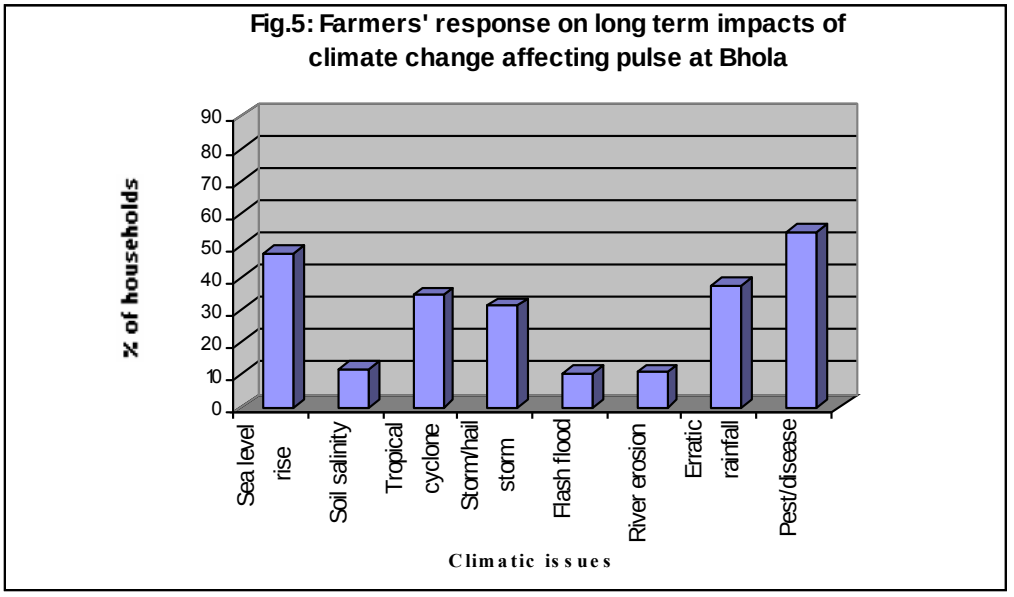


Fig.5: Farmers' response on long term impacts of climate change affecting pulse at Bhola
% of households
90
80
70
60
50
40
30
20
10
0
Sea level rise
Soil salinity
Tropical cyclone
Storm/hail storm
Flash flood
River erosion
Erratic rainfall
Pest/disease
Climatic issues

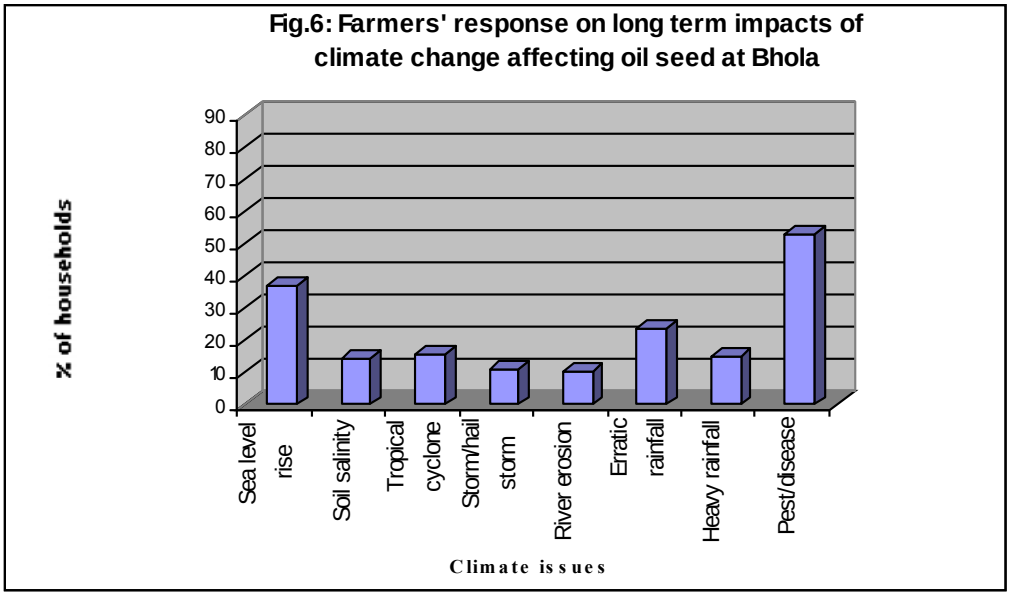
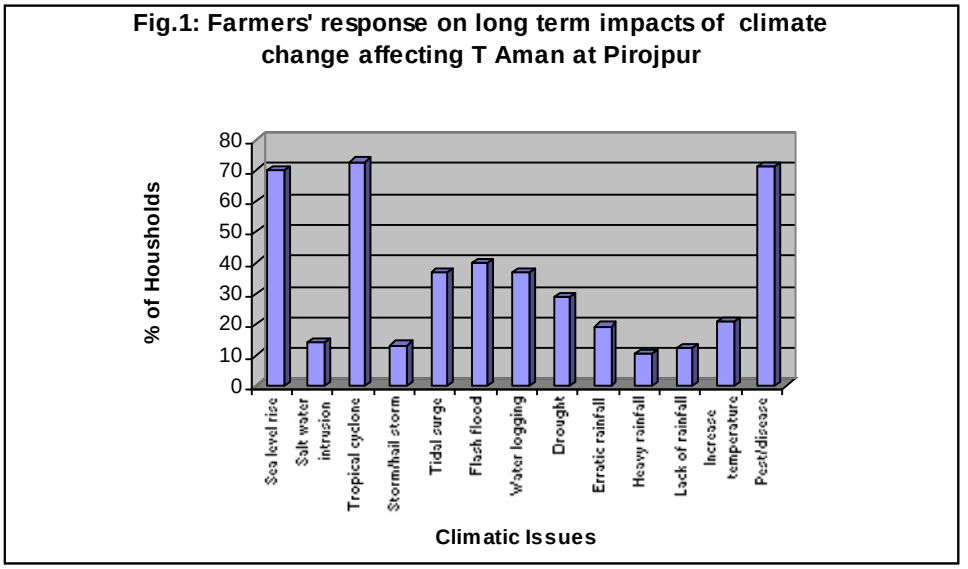
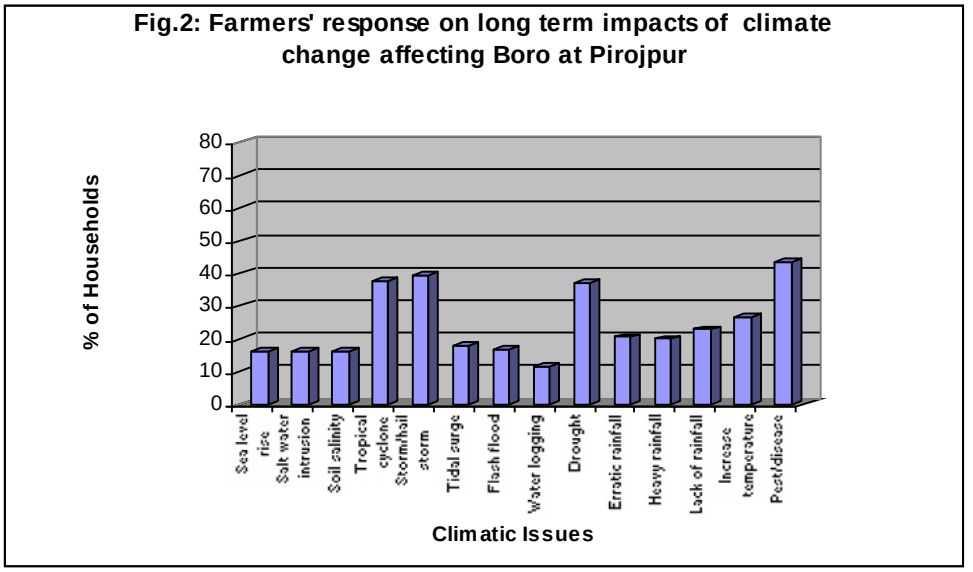


Fig.6: Farmers' response on long term impacts of climate change affecting oil seed at Bhola
% of households
90
80
70
60
50
40
30
20
10
0
Sea level rise
Soil salinity
Tropical cyclone
Storm/hail storm
River erosion
Erratic rainfall
Heavy rainfall
Pest/disease
Climate issues

v) Figure 60-65: Farmers' response Pirojpur District





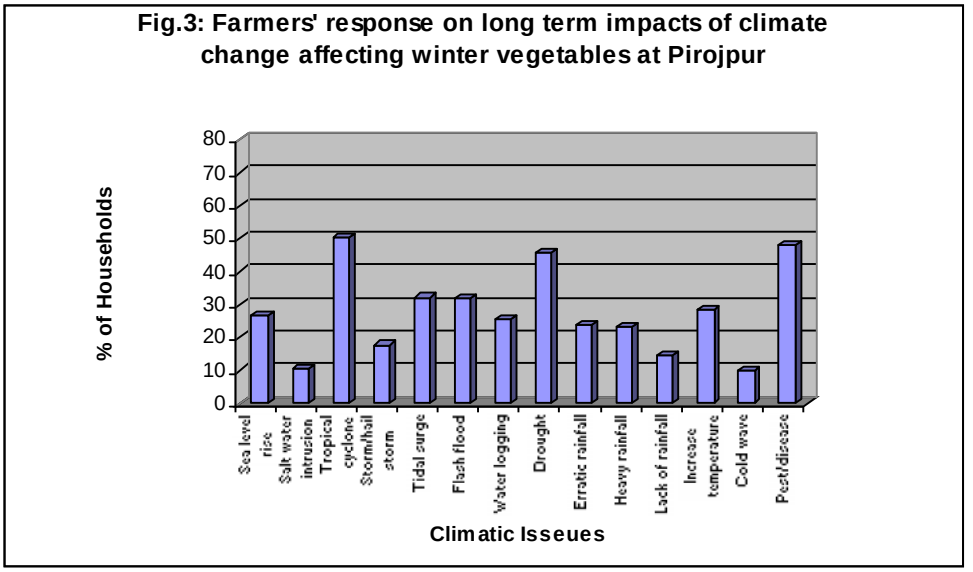


Fig.4: Farmers' response on long term impacts of climate change affecting summer vegetables at Pirojpur

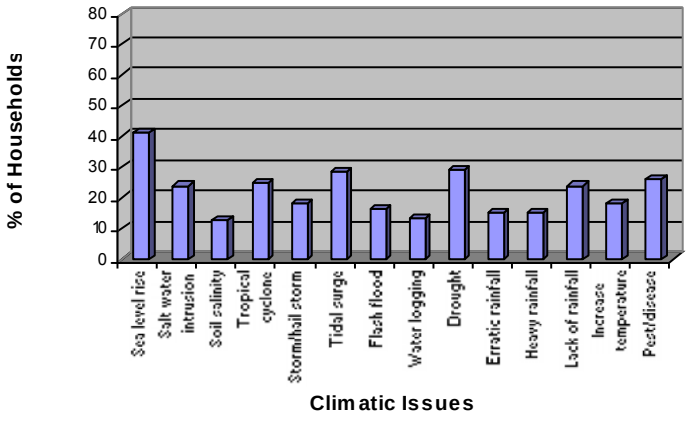


Fig.5: Farmers' response on long term impacts of climate change affecting pulse at Pirojpur

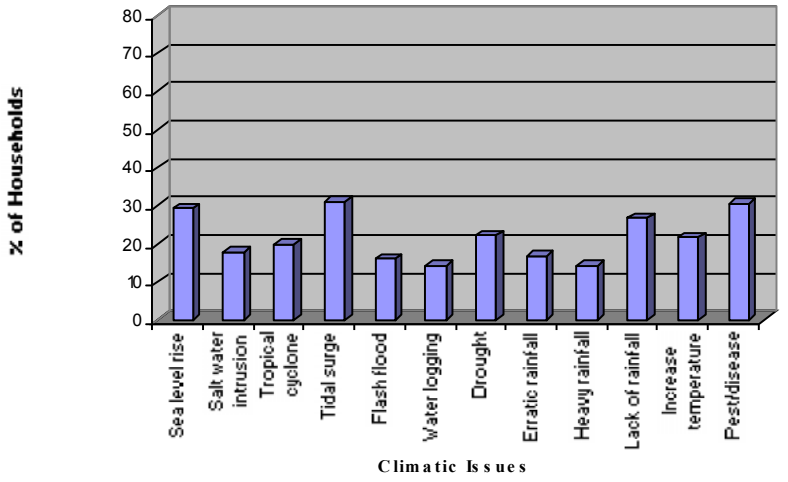
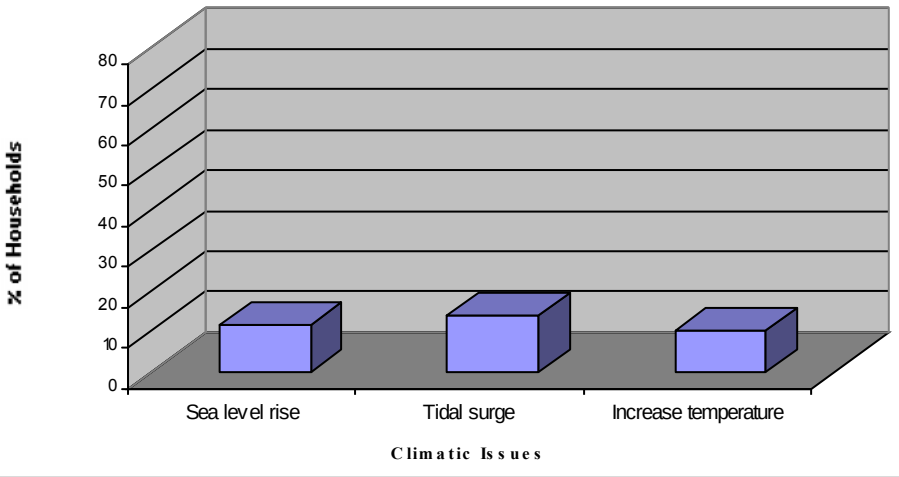
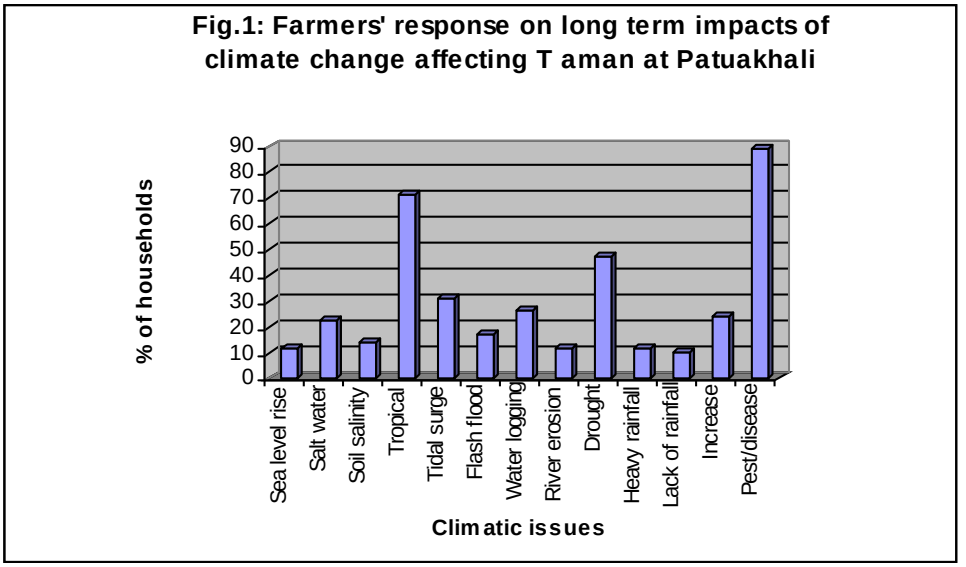
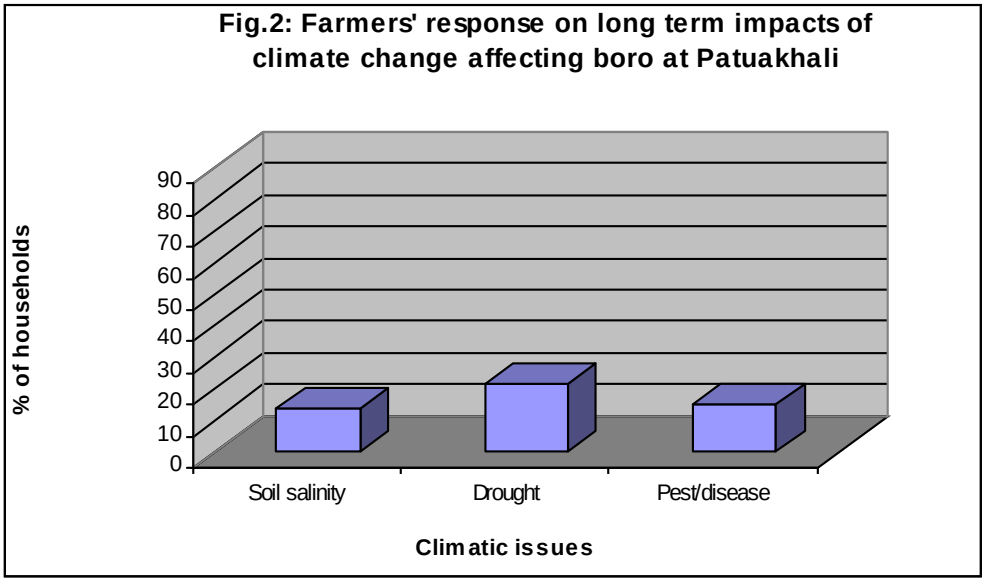


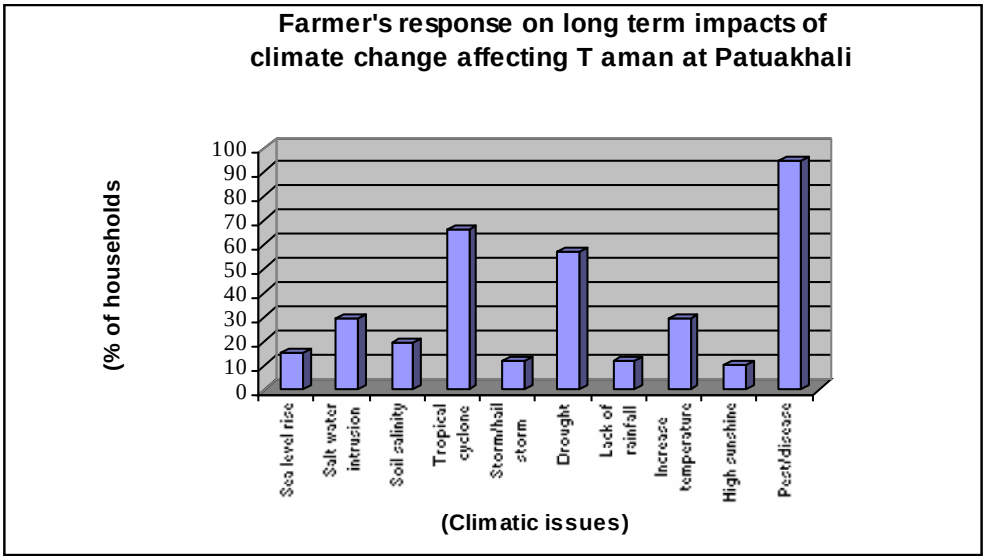
Fig.6: Farmers' response on long term impacts of climate change affecting oil seed at Pirojpur

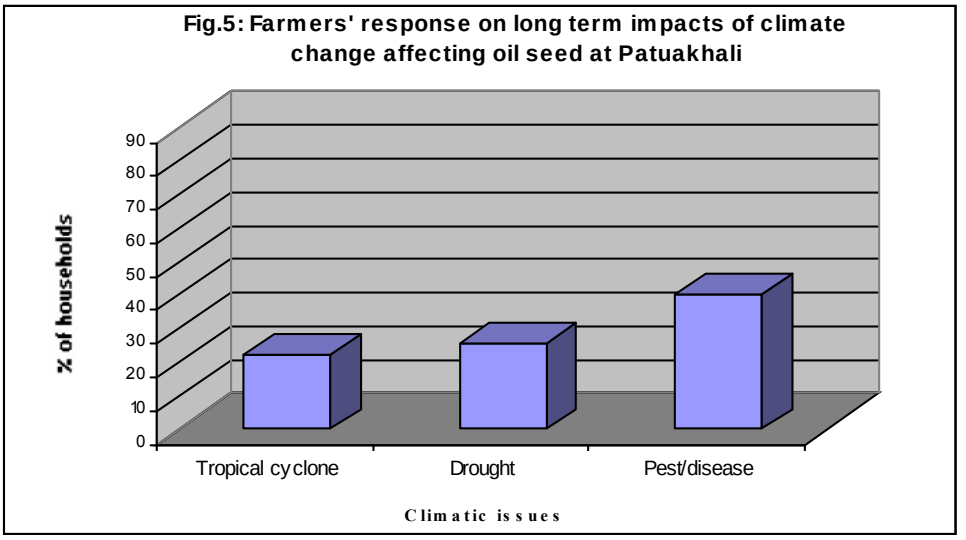


vi) Figure 66-70: Farmers' response Patuakhali District

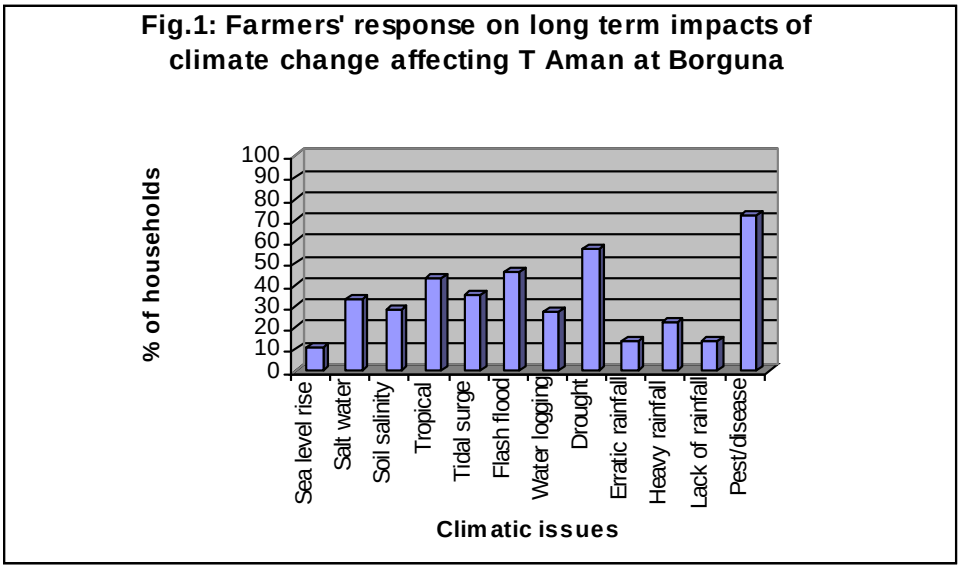


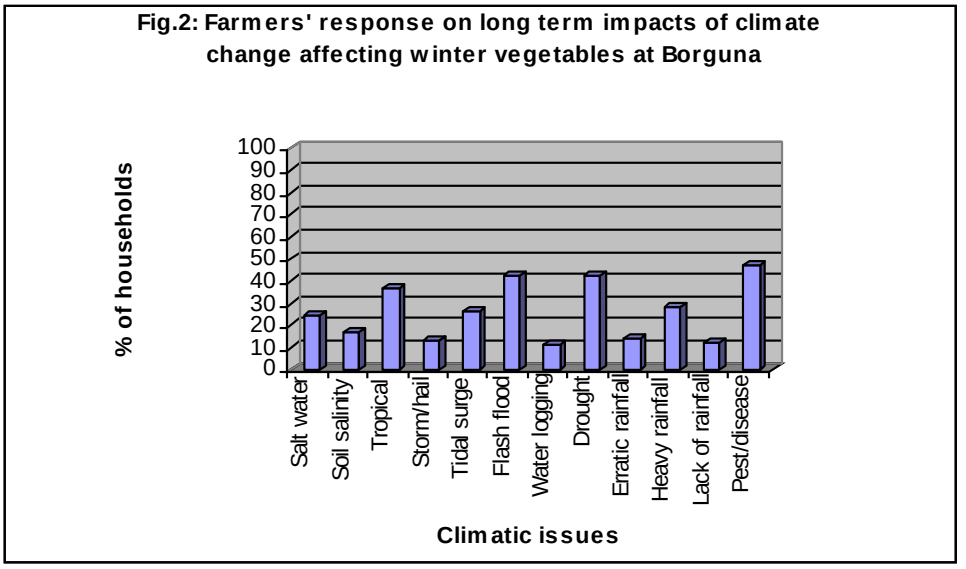






vii) Figure 71-75: Farmers' response Barguna District





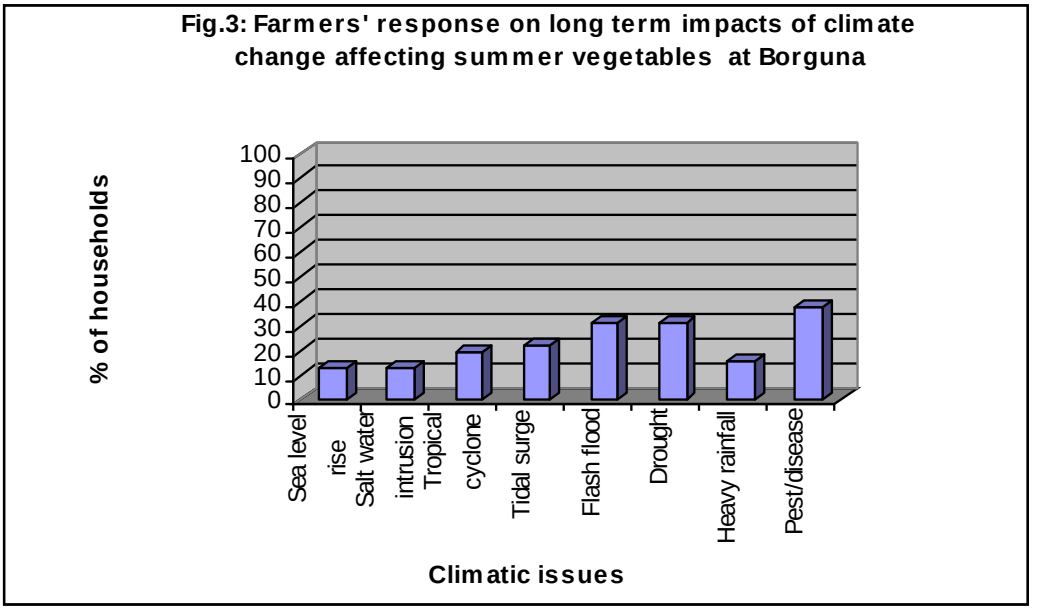


Fig.3: Farmers' response on long term impacts of climate change affecting summer vegetables at Borguna
% of households
100
90
80
70
60
50
40
30
20
10
0
Sea level rise
Salt water intrusion
Tropical cyclone
Tidal surge
Flash flood
Drought
Heavy rainfall
Pest/disease
Climatic issues

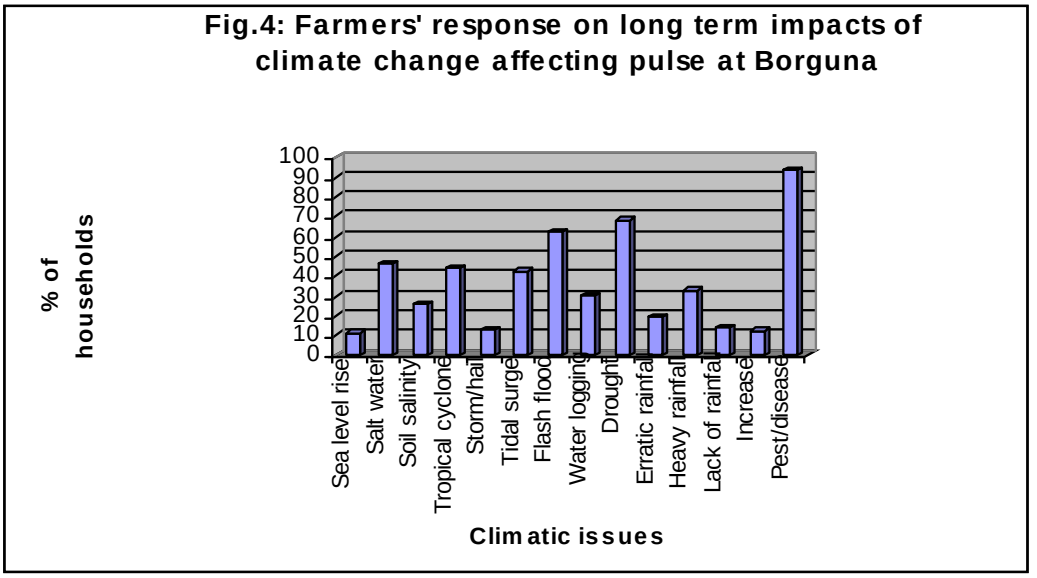


Fig.4: Farmers' response on long term impacts of climate change affecting pulse at Borguna
% of households
100
90
80
70
60
50
40
30
20
10
0
Sea level rise
Salt water
Soil salinity
Tropical cyclone
Storm/hail
Tidal surge
Flash flood
Water logging
Drought
Erratic rainfall
Heavy rainfall
Lack of rainfall
Increase
Pest/disease
Climatic issues

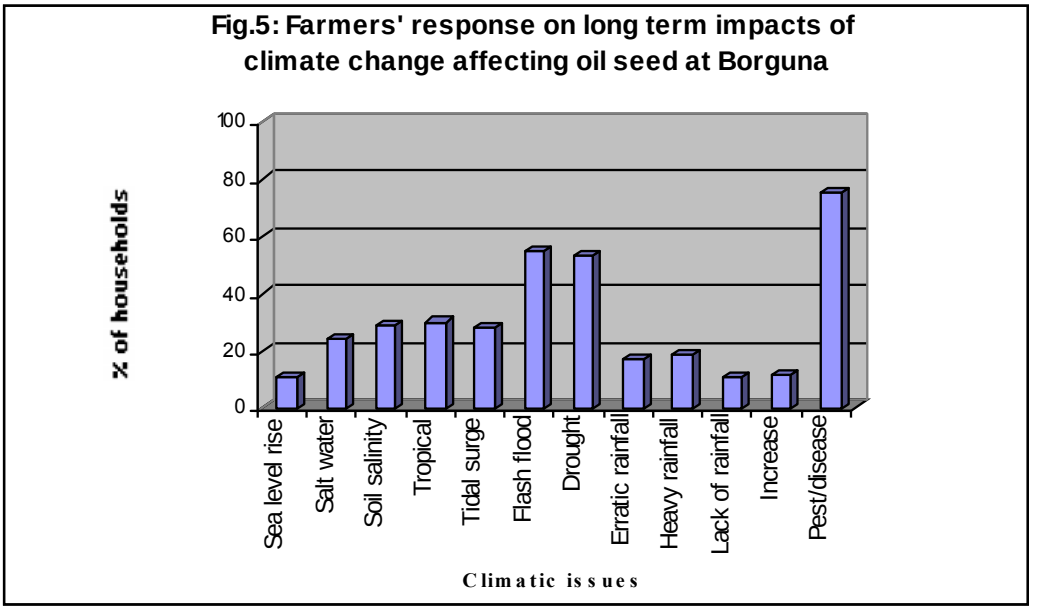
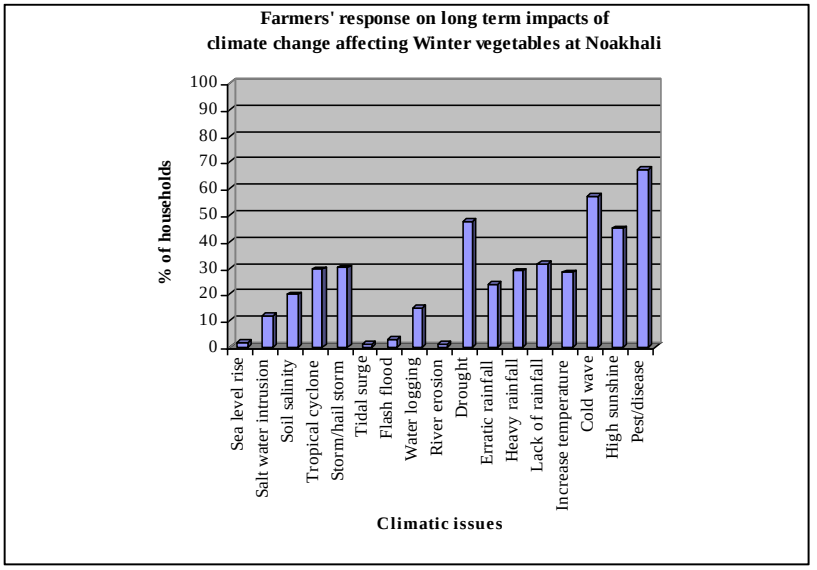
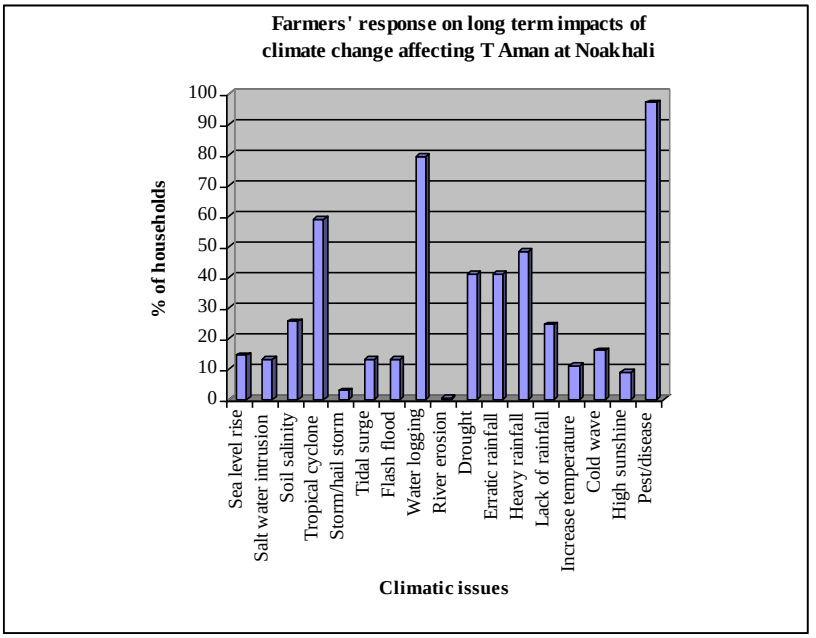
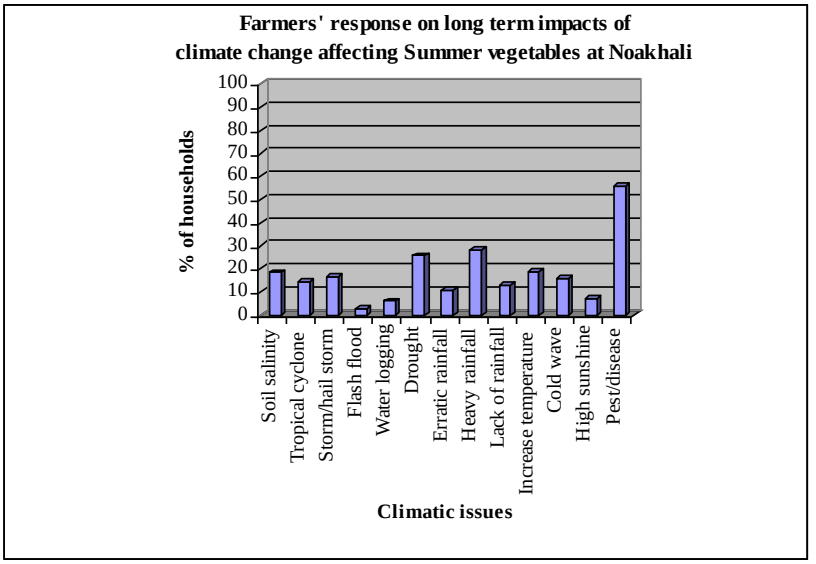


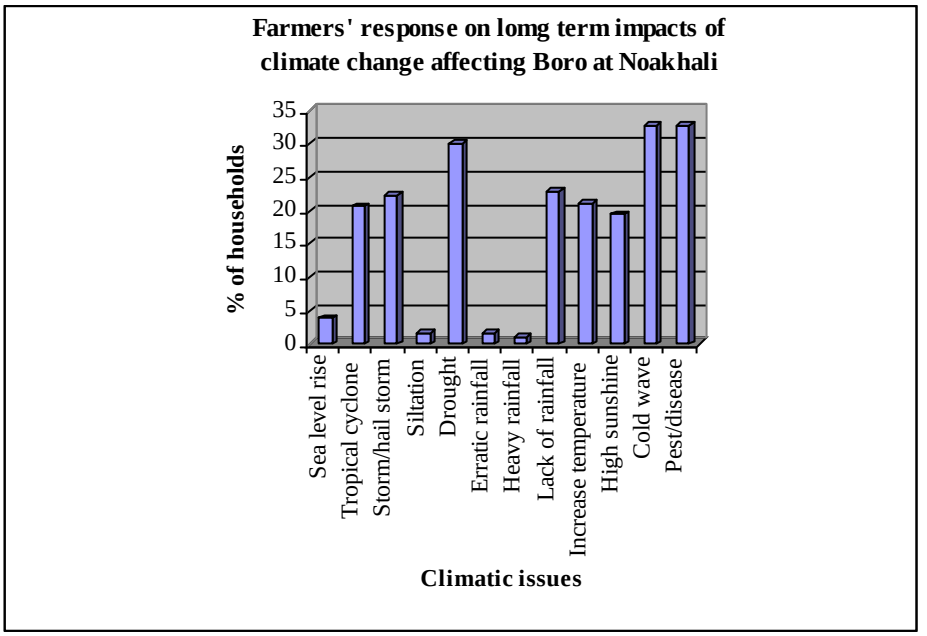
Fig.5: Farmers' response on long term impacts of climate change affecting oil seed at Borguna
% of households
100
80
60
40
20
0
Sea level rise
Salt water
Soil salinity
Tropical
Tidal surge
Flash flood
Drought
Erratic rainfall
Heavy rainfall
Lack of rainfall
Increase
Pest/disease
Climatic issues

viii) Figure 75-78: Farmers' response Noakhali District

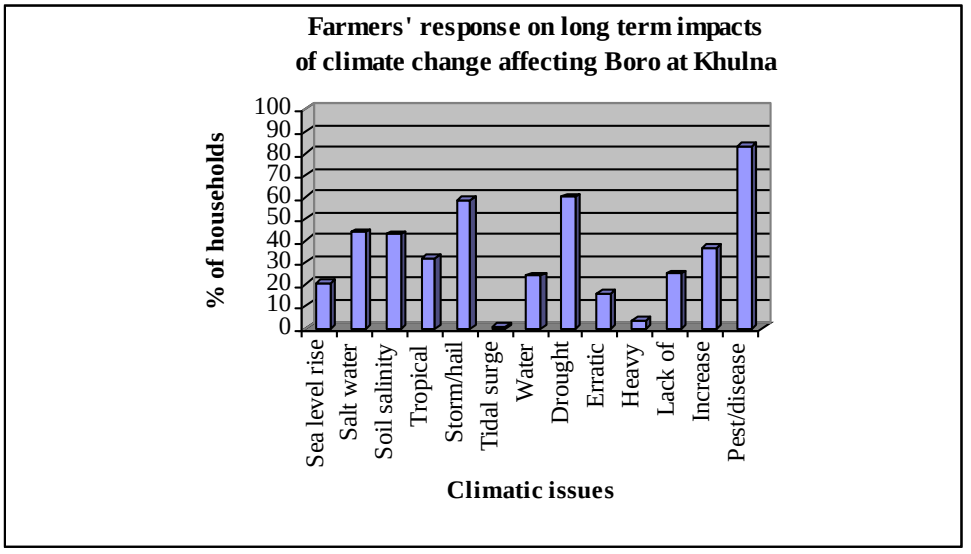


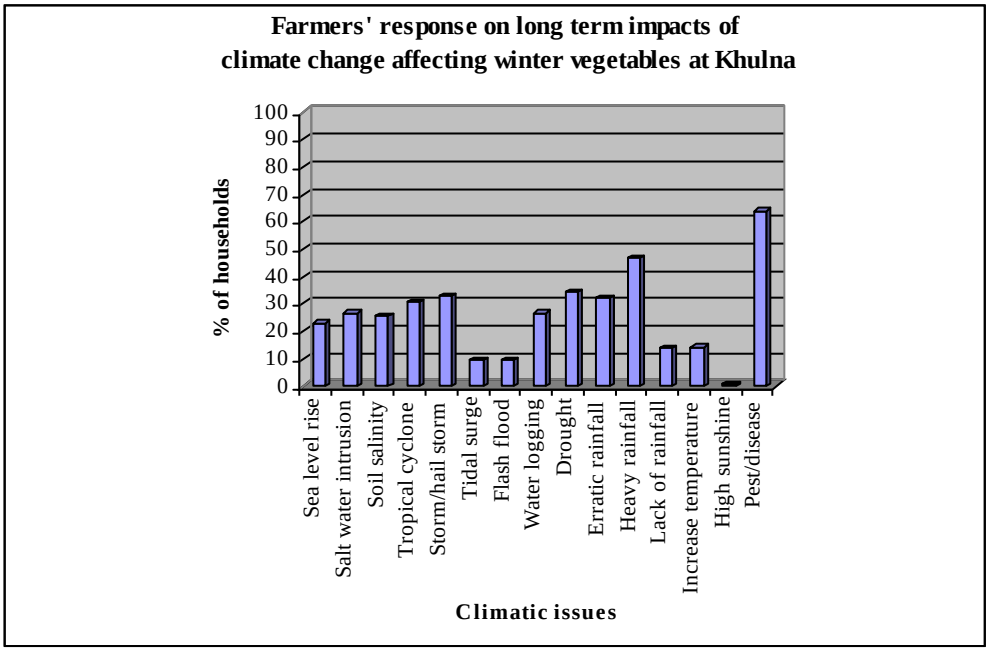


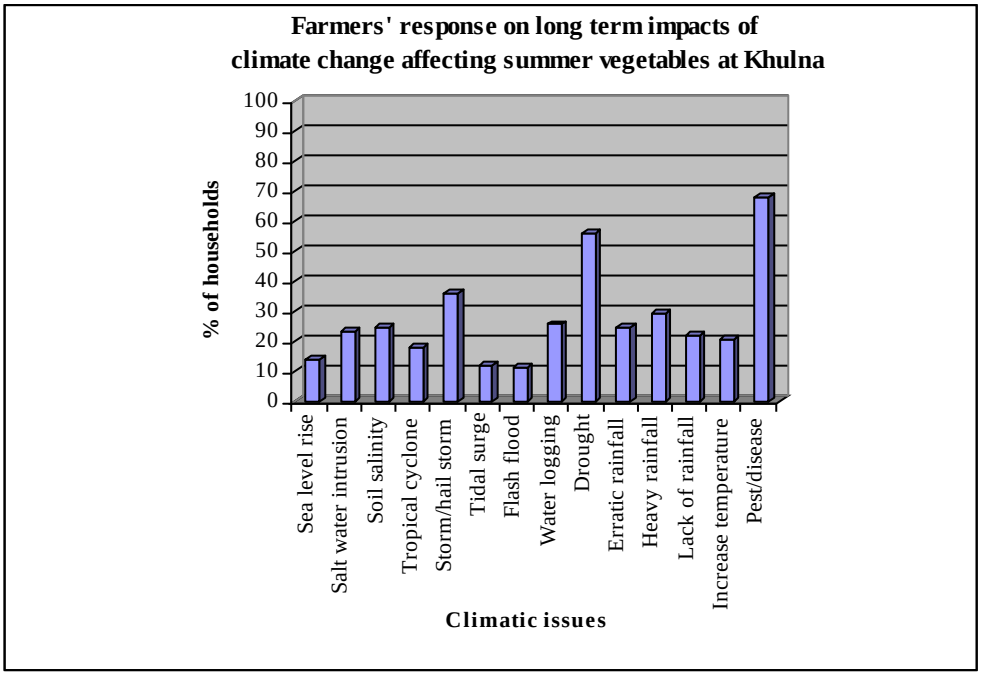




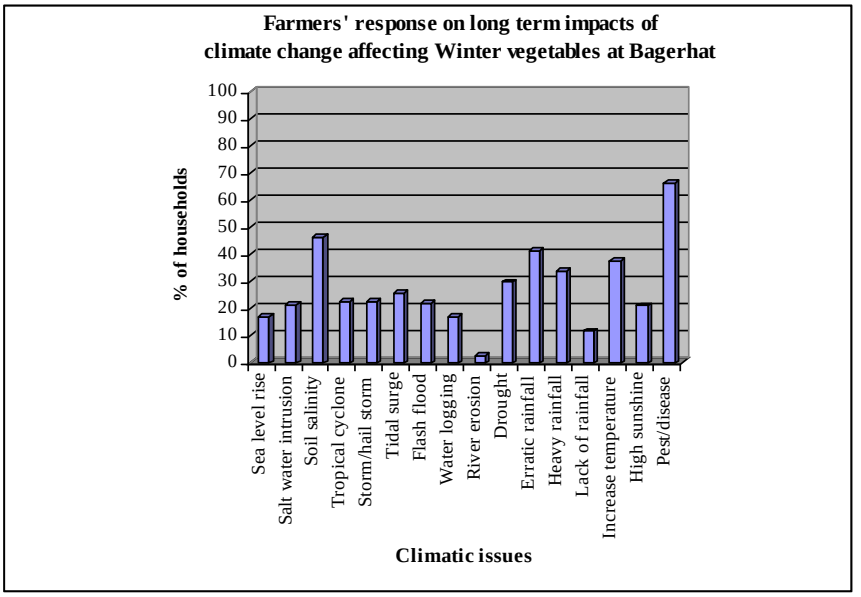
ix) Figure 79-80: Farmers' response at Khulna

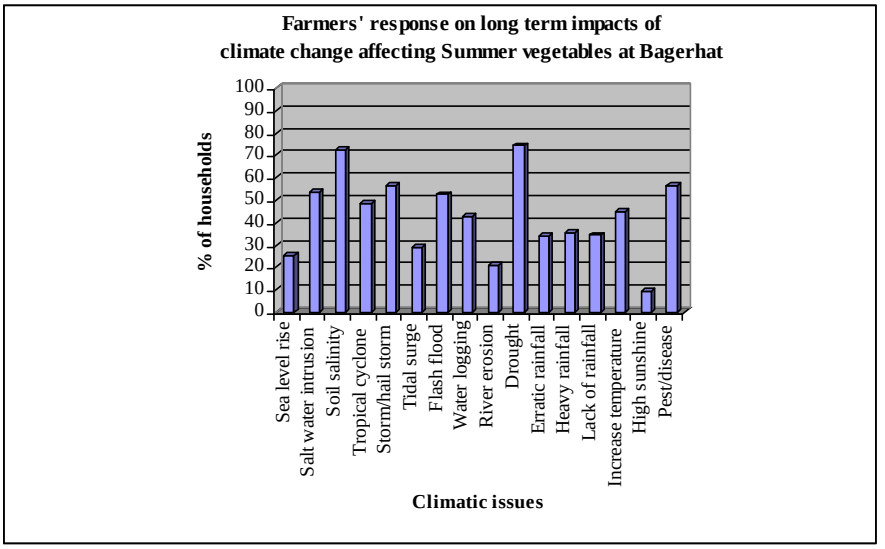


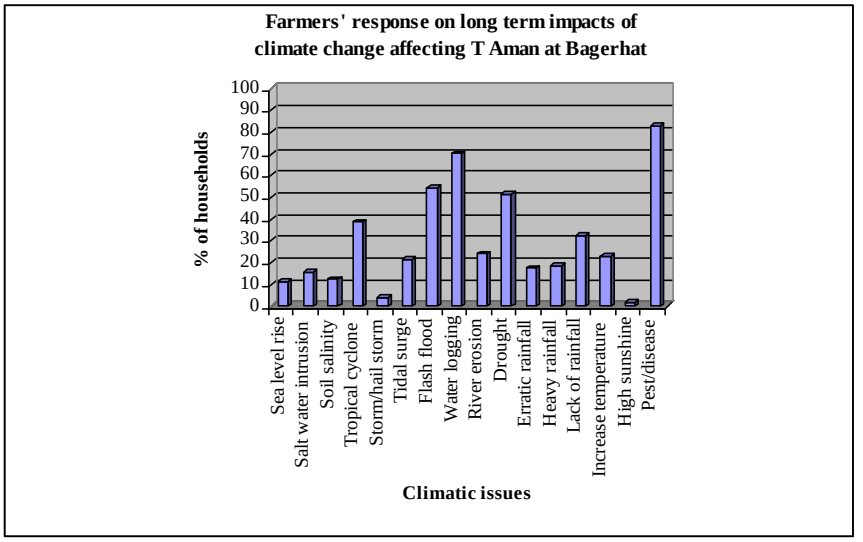




ix) Figure 81-83: Farmers' response at Bagerhat







c) ***F****armers' Opinion/Suggestions on the needs of GO/NGO Interventions to reduce the impacts of Climate Change for increased crop production*

Long-term impacts of climate change on crop production systems, food security and livelihood of the study areas were evaluated through household survey. In this connection, farmers' opinion/suggestions were evaluated through household survey in identifying the needs of GO/NGO interventions to reduce the long-term impacts of climate change for increasing crop production in the vulnerable coastal districts. Survey findings are summarized in the following Tables 43-44.

Farmers' Opinion/Suggestions on the needs of GO/NGO Interventions to reduce the impacts of Climate Change

Khulna district

i) Interventions in Dumuria are:

- Farmers' training/inputs>farmers' groups>innovative practices

ii) Interventions in Batighata are:

- Awareness>marketing>risk varieties/adaptation practices>farmers' training

iii) Interventions in Terokhada are:

- Risk varieties>inputs/training>adaptation practices

Bagerhat district

i) Interventions in Mollahat are:

- Awareness/farmers' training/risk varieties>marketing>adaptation practices>farmers' groups

ii) Interventions in Rampal are:

- Farmers' training/adaptation practices>risk varieties>adaptation practices>marketing

iii) Interventions in Sarankhola are:

- Awareness/farmers' training/innovative practices/risk varieties>marketing

Satkhira district

- Innovative practices/farmers' training>awareness>inputs>marketing/farmers' groups

Barisal district

i) Interventions in Barisal Sadar are:

- Innovative practices>awareness>marketing>farmers' training>risk varieties

ii) Interventions in Banaripara are:

- Farmers' training>marketing>farmers' groups>awareness>agro-processing

iii) Interventions in Ujirpur are:

- Farmers' training>risk varieties>awareness>marketing>farmers' groups

Barguna district

i) Interventions are:

- Risk varieties>marketing>farmers' training>innovative practices

Pirojpur district

Innovations are:

- Awareness>marketing>inputs>innovative practices

Patuakhali district

Interventions are:

- Farmers' training>innovative practices>risk varieties>marketing>inputs

Bhola district

i) Interventions in Charfasion are:

- Farmers' training>awareness/risk tolerant varieties>marketing>agro-processing>farmers' groups

ii) Interventions in Borhanuddin are:

- Innovative practices/farmers' training/inputs/risk tolerant varieties/marketing/agro-processing

iii) Interventions in Tajumuddin are:

- Farmers' training>farmers' groups>risk tolerant varieties>awareness>innovative practices

Cox's Bazar district

i) Interventions in Cox's bazar Sadar are:

- Farmers' training/risk tolerant varieties>awareness> farmers' groups>innovative practices>marketing

ii) Interventions in Chakaria are:

- Farmers' training>farmers' groups>risk tolerant varieties>awareness>inputs

iii) Interventions in Maheskhali are:

- Risk tolerant crop varieties>awareness>farmers' groups>marketing>innovative practices

Noakhali district

i) Interventions in Hatiya are:

- Awareness>marketing>risk tolerant varieties>farmers' training/farmers' groups>agro-processing>innovative practices

ii) Interventions in Senbagh are:

- Farmers' training>risk tolerant varieties>agro-processing>farmers' groups>innovative practices

iii) Interventions in Subarnachar are:

- Farmers' training> risk tolerant varieties> agro-processing> marketing> farmers' groups> innovative practices

Details of Household survey findings on Farmers' Opinion/Suggestions on the needs of GO/NGO Interventions to reduce the impacts of Climate Change for increased crop production have been shown in the following Tables 45-55.

Table 45: Farmers' opinion/suggestion on the needs of Govt./NGO interventions to reduce the Impacts of Climate Change for increased crop production at Khulna

Govt./Non govt. Initiatives	Farmers' Response (in Percentage)		
	Botiaghat	Dumuria	Terokhad
To use fallow land through local innovations/ adaptation practices	12.5	12.4	12.6
Training of farmers for increased sustainable agricultural production	12.4	13.5	12.5
To increase awareness among vulnerable farmers	12.8	11.2	12.3
To increase agro production by maximum utilization of production inputs	12.3	13.5	12.5
To produce and use of drought/salinity/flood adapted crop varieties	12.5	13.5	12.7
To give appropriate value of crops production/ marketing facilities of crops and promote agro-business	12.5	11.9	12.4
To develop marketing system and make agro net work	12.6	11.5	12.6
To increase agro production through farmers' community/groups	12.4	12.5	12.4
Total	**100.0**	**100.0**	**100.0**

Table 46: Farmers' opinion/suggestion on the needs of Govt./NGO interventions to reduce the Impacts of Climate Change for increased crop production at Bagerhat

Govt./Non govt. Initiatives	Farmers' Response (in Percentage)		
	Mollahat	Rampal	Sarankhola
To use fallow land through local innovations/ adaptation practices	12.4	13.0	13.0
Training of farmers for increased sustainable agricultural production	12.6	13.0	13.0
To increase awareness among vulnerable farmers	12.6	12.0	13.0
To increase agro production by maximum utilization of production inputs	12.5	12.5	12.8
To produce and use of drought/salinity/flood adapted crop varieties	12.6	12.6	12.8
To give appropriate value of crops production/ marketing facilities of crops and promote agro-business	12.5	12.5	11.8
To develop marketing system and make agro net work	12.4	12.3	11.8
To increase agro production through farmers' community/groups	12.4	12.1	11.8
Total	**100.0**	**100.0**	**100.0**

Table 47: Farmers' opinion/suggestion on the needs of Govt./NGO interventions to reduce the Impacts of Climate Change for increased crop production at Satkhira

Govt./Non govt. Initiatives	Farmers' Response (in Percentage)		
	Assasuni	Symnagar	Tala
To use fallow land through local innovations/ adaptation practices	15.0	11.9	5.2
Training of farmers for increased sustainable agricultural production	15.1	13.7	13.9
To increase awareness among vulnerable farmers	11.9	12.5	14.0
To increase agro production by maximum utilization of production inputs	11.5	12.6	14.2
To produce and use of drought/salinity/flood adapted crop varieties	11.6	12.3	14.1
To give appropriate value of crops production/ marketing facilities of crops and promote agro-business	11.7	12.6	13.8
To develop marketing system and make agro net work	11.9	12.3	10.7
To increase agro production through farmers' community/groups	11.3	12.1	14.1
Total	**100.0**	**100.0**	**100.0**

Table 48: Farmers' opinion/suggestion on the needs of Govt./NGO interventions to reduce the Impacts of Climate Change for increased crop production at Barisal

Govt./Non govt. Initiatives	Farmers' Response (in Percentage)		
	Banaripara	Barisal sadar	Uzirpur
To use fallow land through local innovations/ adaptation practices	9.1	15.5	11.4
Training of farmers for increased sustainable agricultural production	16.8	14.3	15.2
To increase awareness among vulnerable farmers	13.7	15.2	12.7
To increase agro production by maximum utilization of production inputs	10.6	13.2	11.9
To produce and use of drought/salinity/flood adapted crop varieties	9.1	11.7	14.2
To give appropriate value of crops production/ marketing facilities of crops and promote agro-business	15.3	14.6	12.7
To develop marketing system and make agro net work	10.6	7.6	9.5
To increase agro production through farmers' community/groups	14.8	7.9	12.4
Total	**100.0**	**100.0**	**100.0**

Table 49: Farmers' opinion/suggestion on the needs of Govt./NGO interventions to reduce the Impacts of Climate Change for increased crop production at Pirojpur

Govt./Non govt. Initiatives	Farmers' Response (in Percentage)		
	Nazirpur	Nesarabad	Pirojpur sadar
To use fallow land through local innovations/ adaptation practices	12.5	12.5	12.3
Training of farmers for increased sustainable agricultural production	12.4	12.2	12.5
To increase awareness among vulnerable farmers	12.5	12.8	12.7
To increase agro production by maximum utilization of production inputs	12.6	12.5	12.5
To produce and use of drought/salinity/flood adapted crop varieties	12.3	12.4	12.4
To give appropriate value of crops production/ marketing facilities of crops and promote agro-business	12.5	12.6	12.6
To develop marketing system and make agro net work	12.7	12.7	12.6
To increase agro production through farmers' community/groups	12.5	12.3	12.4
Total	**100.0**	**100.0**	**100.0**

Table 50: Farmers' opinion/suggestion on the needs of Govt./NGO interventions to reduce the Impacts of Climate Change for increased crop production at Borguna

Govt./Non govt. Initiatives	Farmers' Response (in Percentage)		
	Amtoli	Betagi	Borguna sadar
To use fallow land through local innovations/ adaptation practices	12.6	12.6	12.1
Training of farmers for increased sustainable agricultural production	13.1	13.1	12.2
To increase awareness among vulnerable farmers	12.6	12.1	12.5
To increase agro production by maximum utilization of production inputs	12.4	12.2	12.6
To produce and use of drought/salinity/flood adapted crop varieties	13.1	13.1	12.4
To give appropriate value of crops production/ marketing facilities of crops and promote agro-business	13.1	12.3	12.7
To develop marketing system and make agro net work	11.7	12.4	12.8
To increase agro production through farmers' community/groups	11.4	12.2	12.7
Total	**100.0**	**100.0**	**100.0**

Table 51: Farmers' opinion/suggestion on the needs of Govt./NGO interventions to reduce the Impacts of Climate Change for increased crop production at Bhola

Govt./Non govt. Initiatives	Farmers' Response (in Percentage)		
	Borhanuddin	Charfasion	Tojumuddin
To use fallow land through local innovations/ adaptation practices	12.5	9.1	9.9
Training of farmers for increased sustainable agricultural production	12.5	13.3	17.6
To increase awareness among vulnerable farmers	12.5	13.1	12.8
To increase agro production by maximum utilization of production inputs	12.5	12.7	8.3
To produce and use of drought/salinity/flood adapted crop varieties	12.5	13.1	16.6
To give appropriate value of crops production/ marketing facilities of crops and promote agro-business	12.5	12.9	8.7
To develop marketing system and make agro net work	12.5	13.0	8.6
To increase agro production through farmers' community/groups	12.5	12.8	17.5
Total	**100.0**	**100.0**	**100.0**

Table 52: **Farmers' response on causes of poverty and food insecurity during Household Survey at Cox's bazar**

Causes of Poverty	Farmers' response(in Percentage)		
	Cox's Bazar Sadar	Chakoria	Moheshkhali
Low wage earning	3.8	2.2	3.0
Insufficient income	9.4	13.7	6.1
Landless	2.8	10.5	8.8
Lack of job/unemployment	6.3	10.8	5.1
Disabled people	3.8	1.8	3.0
Widow/separated of household head	0.6	1.1	3.7
Natural disasters	11.9	10.0	7.7
Lack of crop	4.4	2.5	2.7
High price of daily food	4.4	1.8	6.7
Low market value	-	-	1.0
More marriage	-	-	0.3
Court Cases	7.2	1.4	0.3
Disease	4.1	10.4	1.0
Lack of educational awareness	5.6	5.1	5.4
Low productivity/production	2.8	4.0	10.4
Crop loss	7.8	5.1	8.4
Low fertility of land	6.9	5.1	7.7
Human Health & nutritional deficiency	2.8	4.0	5.4
Impact of climate change	12.5	9.0	9.4
Political crisis	1.0	-	0.3
Others	-	-	0.5
Total	**100.0**	**100.0**	**100.0**

Table 53: Farmers' opinion/suggestion on the needs of Govt./NGO interventions to reduce the Impacts of Climate Change for increased crop production at Noakhali

Govt./Non govt. Initiatives	Farmers' Response (in Percentage)		
	Hatia	Senbagh	Subarna char
To use fallow land through local innovations/ adaptation practices	9.5	10.4	6.0
Training of farmers for increased sustainable agricultural production	13.4	13.3	15.3
To increase awareness among vulnerable farmers	13.7	12.8	15.0
To increase agro production by maximum utilization of production inputs	9.4	11.5	8.8
To produce and use of drought/salinity/flood adapted crop varieties	13.5	13.2	15.3
To give appropriate value of crops production/ marketing facilities of crops and promote agro-business	13.4	13.1	15.2
To develop marketing system and make agro net work	13.6	12.7	13.0
To increase agro production through farmers' community/groups	13.5	13.0	11.4
Total	**100.0**	**100.0**	**100.0**

Table 54: Farmers' Opinion/suggestions on the needs of GO/NGO interventions to reduce the impacts of Climate Change for increased crop production at Cox's bazar

Farmers' Opinion on Future Initiatives Needs in the context of climate change	Farmers' Response (Percentage)		
	Cox's Bazar Sadar	Chakoria	Maheshkhali
To use fallow lands through local innovations/ adaptation practices	11.5	9.3	12.5
Training of farmers for increased sustainable agricultural production	15.8	17.6	9.6
To increase awareness among vulnerable farmers	13.5	12.5	13.0
To increase agro production by maximum utization of production inputs	10.7	10.1	12.2
To produce and use of drought/salinity/flood adapted crop varieties	15.8	14.7	13.6
To give appropriate value of crops, production/ marketing facilities of crops and promote agri-business	9.0	9.3	12.8
To develop marketing system and make agro- net work	11.5	9.3	12.2
To increase agro production through farmers' community/groups	12.2	17.2	14.1
Total	**100.0**	**100.0**	**100.0**

Table 55:Farmers' Opinion/suggestions on the needs of GO/NGO interventions to reduce the impacts of Climate Change for increased crop production at Patuakhali

Future Initiative	Farmers' Response (Percentage)		
	Dumki	Galachipa	Kalapara
To use fallow land through local innovations/adaptation options	14.4	14.5	8.5
Training for sustainable agricultural management	16.2	17.7	16.5
To increase awareness for vulnerable farmers	9.7	11.4	8.1
To increase agro production by maximum using of production inputs	13.4	14.1	12.9
To produce and use of drought/salinity/flood adapted seed	15.7	15.9	15.7
To give appropriate value of crop production/marketing facilities of crops	14.4	10.0	15.3
To develop marketing system and make agro net work	7.9	6.4	14.5
Total	**100.0**	**100.0**	**100.0**

4.3.3 Case Study on Health and Nutritional Aspects

Some Case Studies were conducted in assessing the status of human health and nutrition of the vulnerable people in the project sites. **Study showed that the vulnerable people especially women and children are suffering from malnutrition>cold/fever>**

dysentery/diarrhea>skin diseases> asthma/jaundice. The detailed problems of health and nutritional aspects of the vulnerable people have been described in the following table-56:

Table 56: Locations of Case Study on Health and Nutrition

District	Upazila	# HHs surveyed	DAE Field Staff in HHs survey	Major problems of health & nutrition
Barisal	Barisal Sadar Banaripara	42	SAAOs	Malnutrition: 23.3 %, dysentery: 20.4%, skin disease: 11.6%, cold/fever: 11.6%, gastric: 10.1% and diarrhea and asthma:8.7%
Pirojpur	Pirojpur Sadar Nazirpur	40	SAAOs	Cold/fever: 22.2%, dysentery: 20.4%, malnutrition:16.2%, diarrhea:15.5%, skin disease: 13.4%, and asthma:3.5%
Patuakhali	Dumki Kalapara Galachipa	60	SAAOs	Cold/fever: 27.6%, malnutrition: 25.3 %, asthma and jaundice:10.5-11.3% and skin disease, gastric and dysentery: 6-7%20.
Satkhira	Tala Shymnagar	40	SAAOs	Malnutrition: 23.3 %, dysentery: 20.4%, cold/fever: 15%, skin disease: 11.6%, and asthma:8.0%

4.3.4 Identifying Problems and Opportunities on Crop Production Practices

Under this project, Problems and Opportunities on Crop Production Practices were carefully studied through survey, field visits, FGDs, stakeholders' analysis, expert opinion, household survey, case studies etc. Findings are summarized in the following Table-57.

Table 57: Problems and Opportunities on Crop Production Practices in the Context of Climate Change

District	Problems/Constraints	Opportunities	Locations/areas
1. Cox's bazar	Flash flood, drought, salinity, low SOM (Cox's bazaar Sadar), intrusion of saline water, drought & iron toxicity (Chakaria), salinity, flash flood, cyclone & embankment failure, low bearing capacity of soils (Pekua), salinity, iron toxicity, erosion, inadequate irrigation facilities (Ramu), excess rainfall in Kh-I, drought & salinity (Ukhia), salinity, drought, flood, lack of irrigation facilities (Teknaf), drought, salinity & ground water level decreasing (Maheskhali) and salinity, tidal surge & flash flood (Kutubdia).	i) There is a great scope of introducing sorjan system of cropping using salt-tolerant crop varieties. -Improved rice-fish dual culture in ghers ii) To increase shrimp culture following modern technology and salt production using sea water and introduction of high value vegetable crop varieties (hybrid cucumber, ladies finger, chillis etc) as relay cropping in vegetable growing areas. iii) Encourage fruits and vegetables gardening iv) Embankment repair and introduction of late T.Aman variety v) Introduction of salt-tolerant crop varieties	i) Cox's bazaar Sadar and Maheskhali ii) Chakaria iii) Teknaf iv) Pekua v) Pekua, Ramu, Ukhia, Kutubdia
2. Noakhali	Drought,salinity, drainage congestion, water-logging and scarcity of irrigation water(Subarnachar), drought, salinity, lack of irrigation facilities and floods (Companyganj), soil salinity, water stagnancy and low SOM (Kabirhat), water-logging (Begumganj, Sunaimuri), Drought, water-logging, late rainfall & short winter (Senbag), high water table in Kh-II and water-logging (Chatkhil), drought, salinity, flood, embankment failure and river erosion (Hatiya).	i) Excavation of canals & ponds for saline free water and introduction of salt-tolerant crop varieties (rice,pulses, soybean, ground nut, cowpea), sorjan system, floating bed agriculture in water-logged areas. ii) Embankment and canal digging iii) Canal digging and standing water boro cultivation and introduce floating bed agriculture in water-logged situations. iv) Drainage improvement, introduce short duration and salt-tolerant crop varieties. v) Introduce standing water boro cultivation. vi) Making high embankment and introduce salt-tolerant varieties.	i) Noakhali Sadar & Subarnachar ii) Companyganj, Kabirhat iii) Begumganj & Sunaimuri iv) Senbag v) Chatkhil vi) Hatya

District	Problems/Constraints	Opportunities	Locations/areas
		vii)Promote fruit cultivation(banana, papaya, zuzubi) using composts.	
3. Barisal	Lack of irrigation facilities, high price of inputs, pest problems and water stagnancy (Babuganj, Bakerganj), low SOM, water-logging, knowledge gap , unavailability of HYV seeds and other inputs and problems of farm mechanization (Barisal Sadar, Hizla), water-logging, water loss due to canal problems (Wazirpur, Agailjhara), irrigation problems, river erosion, drainage problems & water stagnancy (Banaripara, Gournadi), drought, drainage congestion problems, water stagnancy and high price of fertilizers (Mehendiganj)	i) Introduce sorjan system of cropping for year round vegetables & fruits cultivation and floating bed agriculture. ii) Ensure balanced use of fertilizers following IPNS and supply of HYV seeds. iii) Introduce sorjan system of year round cropping and floating bed agriculture. iv) Introduce sorjan system of year round cropping, zero tillage and floating bed agriculture. v) Introduce sorjan system of year round cropping and zero tillage (potato).	i) Babuganj, Banaripara, Bakerganj ii) Barisal Sadar and Hizla iii) Wazirpur & Agaijhara iv) Banaripara & Gournadi v) Mehendiganj
4. Patuakhali	Water stagnancy, flash flood, drought, salinity and lack of irrigation facilities (Dumki, Patuakhali Sadar), intrusion of saline water, severe salinity and inactive sluice gate (Kalapara), drought, flood, lack of irrigation facilities & problems of sluice gate (Mirzaganj), intrusion of saline water, drought and lack of irrigation water (Galachipa), embankment failure, salinity, drought and tidal surge (Dashmina, Baufal),	i) Introduction of salt-tolerant pulse crops (mungbean, cowpea, soybean, ground nut) and sorjan system of year round cropping. ii) Introduction of salt-tolerant pulse crops (mungbean, cowpea, soybean, ground nut) and sorjan system of year round cropping and utilization of canal water by digging canals for cultivating boro crops in large fallow lands. iii) Introduction of sorjan system of year round cropping in tidal surge areas and floating bed agriculture in canals and rivers where water hyacinth is available.	i) Patuakhali Sadar, Dumki and Mirzaganj ii) Kalapara iii) Galachipa
5. Barguna	Drought, salinity and lack of irrigation facilities (Barguna Sadar), intrusion of saline water, low SOM, drought and faulty sluice gate (Betagi), drought, salinity and drainage problems keeping large fallows (Patharghata), short winter, drought, salinity and faulty sluice gate and lack of irrigation facilities-a large area (28,000 ha) are kept	i) Introduction of salt-tolerant pulse crops (mungbean, cowpea, soybean, ground nut), sorjan system of year round cropping and fruit gardening.. ii) Introduction of drought and salt-tolerant crop varieties creating facilities of irrigation for fallow lands.	i) Barguna Sadar & Betagi ii) Amtali & Bamna iii) Patharghata

District	Problems/Constraints	Opportunities	Locations/areas
	fallow (Amtali, Bamna)	iii) Introduction of zero tillage (potato), year round vegetable cultivation under sorjan system and digging ponds and canals for rain water harvest.	
6. Pirojpur	Tidal surge, salinity, flood, faulty sluice gate and large fallow lands (Bhandaria, Kawkhali), drought, salinity, water stagnancy and large fallow lands in rabi & kharif seasons (Pirojpur Sadar, Nazirpur), salinity, drought, tidal surge, water stagnancy and lack of suitable crop varieties (Zianagar, Nesarabad)	i) Introduction of zero tillage (potato), salt-tolerant crop varieties, year round vegetables and fruits cultivation on raised beds and fish culture in ditches under sorjan system and digging ponds and canals for rain water harvest. ii) Introduction of zero tillage (potato), salt-tolerant crop varieties, year round vegetables, fruits and spices cultivation under sorjan system, floating bed agriculture and digging ponds and canals for rain water harvest.	i) Bhandaria, Kawkhali ii) Pirojpur Sadar, Nazirpur & Nesarabad
7. Satkhira	Salinity, floods, short winter, fogginess and unavailability of salt-tolerant crop varieties (Assasoni, Debhatta), salinity, drought, soil wetness, water stagnancy (Satkhira Sadar, Tala), salinity, tidal surge, water-logging, foggy weather (Kalaroa, Kaliganj, Shyamnagar),	i) Introduction of zero tillage (potato), salt-tolerant crop varieties, year round vegetable cultivation under sorjan system and utilization of bunds under gher areas. ii) Introduction of salt-tolerant crop varieties, year round vegetable cultivation under sorjan system and floating bed agriculture in water-logged areas. iii) Introduction of zero tillage (potato), salt-tolerant crop varieties, year round vegetable cultivation under sorjan system and floating bed agriculture in water-logged areas. iv) Promote improved method of rice-fish dual culture in gher areas.	i) Assasoni & Debhatta ii) Satkhira Sadar, Tala iii) Kalaroa, Kaliganj, Shyamnagar iv) Shyamnagar, Kaliganj, Debhatta
8. Khulna	Severe salinity in rabi season, drought, water-logging, ground water salinity and unavailability of salt-tolerant	i) Introduction of zero tillage (potato, maize), salt-tolerant rice varieties, year round vegetable	i) Dumuria, Paikgacha ii) Digholia, Terokhada,

District	Problems/Constraints	Opportunities	Locations/areas
	crop varieties (Dumuria, Paikgacha), high temperature, drought, salinity, submergence, pests & diseases and drainage problems (Digholia, Terokhada, Fultala), water-logging, salinity, faulty embankment (Rupsa), water-logging, salinity, ground water salinity, iron toxicity (Koyra), drought, salinity, river erosion, tidal flood and faulty embankment (Dacope, Batiaghata, Mongla).	cultivation under sorjan system and utilization of bunds under gher areas using salt-tolerant vegetables. ii) Introduction of zero tillage (potato/maize), salt-tolerant rice varieties and year round vegetable cultivation under sorjan system and floating bed agriculture. iii) Introduction of zero tillage (potato/maize), salt-tolerant rice varieties and year round vegetable cultivation under sorjan system and floating bed agriculture. iv) Promote improved method of rice-fish dual culture in gher areas.	Fultala iii) Dacope, Batiaghata, Mongla). iv) Dumuria, Paikgacha
9. Bagerhat	Salinity, river water salinity, drought, river erosion, water-logging, drainage problems (Bagerhat Sadar, Sharankhola), drought, salinity, high temperature (Fakirhat), intrusion of saline water, increased salinity, scarcity of irrigation water, water-logging, floods, tidal surge and drainage problems (Rampal, Morrelganj, Chitalmari), irrigation problems, tidal flood, water stagnancy (Kachua, Mollahat)	i) Introduction of zero tillage (potato/maize), salt-tolerant rice varieties and year round vegetable cultivation under sorjan system and floating bed agriculture ii) Introduction of zero tillage (potato/maize), salt-tolerant rice varieties and year round vegetable cultivation under sorjan system and floating bed agriculture in water-logged areas. iii) Promote introduction of salt-tolerant pulses, spices and oil seed crops	i) Bagerhat Sadar, Sharankhola ii) Rampal, Morrelganj, Chitalmari iii) Bagerhat(S), Kachua, Fakirhat
10. Bhola	Soil wetness, salinity, cyclone, droughts, floods, tidal surge (Charfasion), soil wetness, tidal flood, suitable variety, lack of water source (Bhola Sadar, Tazumuddin, Borhanuddin), lack of irrigation facilities, drought, river bank erosion (Daulatkhan), salinity, short winter, flood, tidal surge, river erosion and cyclone (Monpura), lack of water source, late harvest of boro, soil wetness, tidal surges	i) Introduction of zero tillage (wheat, potato), short duration & salt-tolerant rice varieties and cultivation of ground nut, chilli & relay cropping of khesari, mungbean & mustard and floating bed agriculture in water-logged situations. ii) Introduction of zero tillage (potato), short duration & salt-tolerant rice varieties and cultivation of ground nut, chilli & relay cropping of khesari & mustard and early planting of T.Aman	i) Charfasion, Monpura ii) Daulatkhan, Tazumuddin iii) Borhanuddin, Tazumuddin

District	Problems/Constraints	Opportunities	Locations/areas
	(Lalmohan).	(Bridhan-33, 44) iii) Introduction of submergence tolerant rice varieties (Bridhan-51,52) in water-logging prone areas. iv) Quality seed production and develop storage facilities.	

4.3.5 Identification and Documentation of Adaptation Practices for Sustainable Agricultural Production

Based on the findings of the FGDs, field visits and discussion with farmers and review of the available literatures, a total 25-30 adaptation/innovative farming practices have been identified and documented. Identification of the innovative practices was considered based on i) analysis of the vulnerability, ii) suitability of the crops and practices to meet household needs, iii) possibilities of adoption by members of vulnerable communities, iv) targeted extrapolation area and above all v) possibilities of adaptation to the impact of climate change. Some promising adaptation practices have been summarized in Table 58.

Table 58: Adaptation Practices for Sustainable Agricultural Production in the Context of Climate Change

District	Recommended Adaptation Practices	Locations	Priority Ranking
1.Cox's bazaar	-Sorjan system of cultivating year round vegetables, spices & fruits on raised beds and creeper vegetables on bed edges making trellis on ditches and cultivation of fish in ditches during wet months. -Introduction of salt-tolerant crop varieties -Encourage fruits and vegetables gardening -Promote improved rice-fish dual culture	- Cox's bazar, Maheskhali, Chakaria	High
	-Introduction of high value vegetable crop varieties (hybrid cucumber, ladies finger, chillis etc) as relay cropping in vegetable growing areas.	- Chakaria	High
	-To increase shrimp culture following modern technology and salt production using sea water	- Cox's bazar, Maheskhali	
	-Embankment repair and introduction of late T.Aman variety	- Maheskhali	
2. Noakhali	-Excavation of canals & ponds for saline free water and introduction of salt-tolerant varieties -Promote salt-tolerant pulses and oil seed crops (cowpea, soybean, mungbean, ground nut etc)	- Noakhali Sadar & Subarnachar	High
	-Introduce floating bed agriculture in water-logged areas. -Drainage improvement, introduce short duration and salt-tolerant crop varieties.	- Noakhali(S), Companyganj, Kabirhat, Begumganj & Sunaimuri	High
	-Introduce standing water (submergence var.) boro cultivation -Making high embankment and introduce salt-tolerant varieties	- Chatkhil - Hatya	Medium
3. Barisal	-Sorjan system of cultivating year round vegetables, spices & fruits on raised beds and creeper vegetables on bed edges and cultivation of fish in ditches during wet months. -Introduce/promote submergence tolerant rice	- Barisal Sadar, Babuganj, Bakerganj, Wazirpur, Agaijhara,	High

District	Recommended Adaptation Practices	Locations	Priority Ranking
	varieties (Bridhan-51, 52)	Banaripara & Gournadi	
	-Popularize floating bed agriculture.	-do-	High
	-Zero tillage (potato, maize) and floating bed agriculture.	- Water-logged areas	High
	-Introduce submegence tolerant ric varieties		
4.	-Sorjan system of cultivating year round vegetables, spices & fruits on raised beds and creeper vegetables on bed edges and cultivation of fish in ditches during wet months.	- Patuakhali Sadar, Dumki, Kalapara & Galachipa	High
	-Introduction of salt-tolerant pulse crops (mungbean, cowpea, soybean, ground nut) and sorjan system of year round cropping.	- Patuakhali Sadar, Dumki, Mirzaganj, Kalapara	High
	-Utilization of canal water by digging canals for cultivating boro crops in large fallow lands.	- Kalapara	Medium
	-Popularize floating bed agriculture in canals and rivers where water hyacinth is available.	- Galachipa	Medium
5. Barguna	-Introduction of salt-tolerant pulse crops (mungbean, cowpea, soybean, ground nut, sweet potato, chilli)	- Barguna Sadar & Betagi	High
	-Sorjan system of cultivating year round vegetables, spices & fruits on raised beds and creeper vegetables on bed edges and cultivation of fish in ditches during wet months.	-do-	High
	-Introduction of drought and salt-tolerant crop varieties creating facilities of irrigation in fallow lands.	- Amtali & Bamna	High
	-Introduction of zero tillage (potato)	- Barguna, Betagi	High
	-Digging ponds and canals for rain water harvest.	- Patharghata	Medium
6. Pirojpur	-Introduction of salt-tolerant crop varieties	- Bhandaria, Kawkhali	High
	-Sorjan system of cultivating year round vegetables, spices & fruits on raised beds and creeper vegetables on bed edges and cultivation of fish in ditches during wet months.	- Pirojpur Sadar, Nazirpur & Nesarabad	High
	-Digging ponds and canals for rain water harvest	-do-	-do-
	-Popularize zero tillage (potato)	-do-	-do-
	-Popularize floating bed agriculture	-do-	-do-
	-Popularize homestead gardening	-do-	-do-
7. Satkhira	-Introduction of salt-tolerant crop varieties in salt affected areas	- Assasoni, Shyamnagar & Debhatta	High
	-Promote rice-fish dual culture		High
	-Utilization of fallow bunds under gher areas for year round vegetable cultivation.	-do-	High
	-Sorjan system of cultivating year round vegetables, spices & fruits on raised beds and creeper vegetables on bed edges and cultivation of fish in ditches during wet months.	- Satkhira Sadar, Tala	High
	-Popularization of zero tillage (potato, maize)	- Kalaroa, Kaliganj, Shyamnagar	High
	-Cultivating water melon by *Kalshi Method*		

District	Recommended Adaptation Practices	Locations	Priority Ranking
	-Floating bed agriculture in water-logged areas.	- Assasoni, Tala	High
8. Khulna	-Introduction of salt-tolerant rice varieties in salt affected areas	- Dumuria, Paikgacha	High
	-Sorjan system of cultivating year round vegetables, spices & fruits on raised beds and creeper vegetables on bed edges and cultivation of fish in ditches during wet months.	- Dumuria, Paikgacha	High
	-Rain water harvest and utilization of fallow bunds in gher areas	- Dacope, Batiaghata, Mongla.	Medium
	-Introduction of zero tillage (potato/maize) and floating bed agriculture.	- Dacope, Batiaghata, Mongla	High
9. Bagerhat	-Introduction of salt-tolerant rice varieties in salt affected areas	- Bagerhat Sadar, Sharankhola	High
	-Sorjan system of cultivating year round vegetables, spices & fruits on raised beds and creeper vegetables on bed edges and cultivation of fish in ditches during wet months.	-do-	-do-
	-Introduction of zero tillage (potato/maize) and floating bed agriculture in water-logged areas.	- Rampal, Morrelganj, Chitalmari	-do-
10. Bhola	-Introduction of zero tillage (wheat, potato, pulses), short duration & salt-tolerant rice varieties and cultivation of ground nut, chilli & relay cropping of khesari, mungbean & mustard and floating bed agriculture in water-logged situations.	- Charfasion, Monpura, Daulatkhan	Medium
	-Early planting of T.Aman (Bridhan-33, 44) -Introduce submergence tolerant rice varieties (Bridhan-51, 52)	- Daulatkhan, Tazumuddin	High
	-Sorjan system of cultivating year round vegetables, spices & fruits on raised beds and creeper vegetables on bed edges and cultivation of fish in ditches during wet months.	- Bhola Sadar, Charfasion, Monpura, Daulatkhan	High

4.3.5.1 Selection of Viable Adaptation Practices

Promising and viable adaptation options were selected through a sequence of evaluation processes such as Upazila level discussion, focus group discussions (FGDs) at district level, household survey at selected upazilas and case studies and national level stakeholders' workshop. Adaptation options were prioritized according to the followings:

- Environmental friendliness and qualitative cost-benefit analysis
- Evaluation of adaptation options for their technical suitability
- Multi-criteria analysis
- Expert judgment.

Finally, adaptation options were evaluated based on the following criteria:

- **Salinity reduction/mitigation**- crop varieties potential to reduce salinity or potential for salt tolerance in terms of resources and economics

- **Drought mitigation** –potential to reduce drought impacts in terms of resources and economics
- **Climate change scenarios-suitability under high temperature, frequent dry spells, high evaporation, etc**
- **Environmental friendliness-** less impact on the environment in terms of deteriorating quality of resources and its secondary impacts
- Economic viability- cost effectiveness and cost-benefit ratio
- **Review and analysis of BCR of field trials/demos on innovative farming practices conducted under UNEP/APFED Showcase Programme in Bangladesh (2008-2009)**
- **Increased productivity**- capacity to improve the overall productivity per unit area
- **Sustainability**- long-term effectiveness and capability of continuance after the project
- **Social acceptability**- performance of the community in all sections
- **Gender integration**- capacity to give larger role to women due to the particular adaptation practice
- **Household income**- capacity to increase household income on a continuous basis
- **Employment opportunity**- year-round employment for family members
- **Relevance to vulnerable community**- effect on small farmers, wage labourers and small businessman
- **Applicability to multiple sectors**- use for sectors such as agriculture, livestock, fisheries, forestry and water resources management
- **Seasonal relevance**- use of adaptation practices during rabi, Kharif-I and Kharif-II seasons
- **Immediate need**- matching the adaptation practice to local community needs
- **Institutional support**- government policy and local institutions take up a particular adaptation practice
- **Expert acceptance**- feedback from the evaluation workshop organized at upazila, district and national level.

4.3.5.2 Dissemination and Extension of Adaptation Options

- **Dissemination and Extension of Adaptation Options-** The viable adaptation options need to be tested and disseminated at pilot villages of vulnerable coastal areas for their acceptance. The approaches followed initially for this purpose are limited to the followings:

  -Conducting field trials/demonstrations or block demos at farmers level

  -Arrange farmers' awareness raising and capacity building training

  -Arrange field days, farmers' rallies, group visits etc

  -Arrange stakeholders' workshop, orientation workshop etc

  -Preparation of booklets, leaflets , publicity materials etc on each adaptation practice.

4.3.5.3 Coordinated Actions for Continuous Adaptation –Adaptation to reduce the vulnerability of agriculture and allied sectors to the impacts of climate change requires coordinated actions, proper planning, financial resources and community involvement. Major activities include the followings:

-Incorporation of livelihood adaptations in the long-term planning process

-Introduction of new crop varieties suitable for the vulnerable situations

-Improvement of information dissemination network

-Market risk management in agriculture

-Access to credit facilities for agricultural inputs

-Developing institutions and socio-economic conditions

-Develop institutional guidelines

-Development of livelihood opportunities in vulnerable areas

-Integration of traditional knowledge and practices into adaptation options.

A list of recommended adaptation practices based on standard criteria for sustainable agricultural production in the coastal region is shown in the Table 59.

Table 59: Adaptation Practices for Sustainable Agricultural Production in the Context of Climate Change

District	Recommended Adaptation Practices	Remarks/Locations
1. Cox's bazaar	-Sorjan system of cultivating year round vegetables, spices & fruits on raised beds and creeper vegetables on bed edges and cultivation of fish in ditches during wet months. -Introduction of salt-tolerant crop varieties -Encourage fruits and vegetables gardening -Promote improved rice-fish dual culture	- Cox's bazar, Maheskhali, Chakaria
	-Introduction of high value vegetable crop varieties (hybrid cucumber, ladies finger, chillis etc) as relay cropping in vegetable growing areas.	- Chakaria
	-To increase shrimp culture following modern technology and salt production using sea water	- Cox's bazar, Maheskhali
	-Embankment repair and introduction of late T.Aman variety	- Maheskhali
2. Noakhali	-Excavation of canals & ponds for saline free water and introduction of salt-tolerant varieties -Promote introduction of salt-tolerant pulses and oil seed crops (viz. cowpea, soybean, mungbean, ground nut etc)	- Noakhali Sadar & Subarnachar
	-Introduce floating bed agriculture in water-logged areas. -Drainage improvement, introduce short duration and salt-tolerant crop varieties.	- Noakhali(S), Companyganj, Kabirhat, Begumganj & Sunaimuri
	-Introduce standing water (submergence var.) boro cultivation -Making high embankment and introduce salt-tolerant varieties	- Chatkhil - Hatya
3. Barisal	-Sorjan system of cultivating year round vegetables, spices & fruits on raised beds and creeper vegetables on bed edges and cultivation of fish in ditches during wet months. -Introduce submergence tolerant rice varieties (Bridhan-51,52)	- Barisal Sadar, Babuganj, Bakerganj, Wazirpur, Agaijhara, Banaripara & Gournadi
	-Popularize floating bed agriculture.	-do-

District	Recommended Adaptation Practices	Remarks/Locations
	-Zero tillage (potato, maize) and floating bed agriculture. -Introduce submegence tolerant ric varieties	- Water-logged areas
4. Patuakhali	-Sorjan system of cultivating year round vegetables, spices & fruits on raised beds and creeper vegetables on bed edges and cultivation of fish in ditches during wet months.	- Patuakhali Sadar, Dumki, Kalapara & Galachipa
	-Introduction of salt-tolerant pulse crops (mungbean, cowpea, soybean, ground nut) and sorjan system of year round cropping.	- Patuakhali Sadar, Dumki, Mirzaganj, Kalapara
	-Utilization of canal water by digging canals for cultivating boro crops in large fallow lands.	- Kalapara
	-Popularize floating bed agriculture in canals and rivers where water hyacinth is available.	- Galachipa
5. Barguna	-Introduction of salt-tolerant pulse crops (mungbean, cowpea, soybean, ground nut, sweet potato, chilli)	- Barguna Sadar & Betagi
	-Sorjan system of cultivating year round vegetables, spices & fruits on raised beds and creeper vegetables on bed edges and cultivation of fish in ditches during wet months.	-do-
	-Introduction of drought and salt-tolerant crop varieties creating facilities of irrigation in fallow lands.	- Amtali & Bamna
	-Introduction of zero tillage (potato)	- Barguna, Betagi
	-Digging ponds and canals for rain water harvest.	- Patharghata
6. Pirojpur	-Introduction of salt-tolerant crop varieties	- Bhandaria, Kawkhali
	-Sorjan system of cultivating year round vegetables, spices & fruits on raised beds and creeper vegetables on bed edges and cultivation of fish in ditches during wet months.	- Pirojpur Sadar, Nazirpur & Nesarabad
	-Digging ponds and canals for rain water harvest	-do-
	-Popularize zero tillage (potato)	-do-
	-Popularize floating bed agriculture	-do-
	-Popularize homestead gardening	-do-
7. Satkhira	-Introduction of salt-tolerant crop varieties in salt affected areas -Introduction of salt-tolerant rice crops (Bridhan-44,47)	- Assasoni, Shyamnagar & Debhatta
	-Utilization of fallow bunds under gher areas for year round vegetable cultivation.	-do-
	-Sorjan system of cultivating year round vegetables, spices & fruits on raised beds and creeper vegetables on bed edges and cultivation of fish in ditches during wet months.	- Satkhira Sadar, Tala
	-Popularization of zero tillage (potato, maize)	- Kalaroa, Kaliganj, Shyamnagar
	-Floating bed agriculture in water-logged areas.	- Assasoni, Tala
8. Khulna	-Introduction of salt-tolerant rice varieties(Bridhan-44,47) in salt affected areas	- Dumuria, Paikgacha

District	Recommended Adaptation Practices	Remarks/Locations
	-Sorjan system of cultivating year round vegetables, spices & fruits on raised beds and creeper vegetables on bed edges and cultivation of fish in ditches during wet months.	- Dumuria, Paikgacha
	-Rain water harvest and utilization of fallow bunds in gher areas	- Dacope, Batiaghata, Mongla.
	-Introduction of zero tillage (potato/maize) and floating bed agriculture.	- Dacope, Batiaghata, Mongla
9. Bagerhat	-Introduction of salt-tolerant rice varieties in salt affected areas	- Bagerhat Sadar, Sharankhola
	-Sorjan system of cultivating year round vegetables, spices & fruits on raised beds and creeper vegetables on bed edges and cultivation of fish in ditches during wet months.	-do-
	-Introduction of zero tillage (potato/maize) and floating bed agriculture in water-logged areas.	- Rampal, Morrelganj, Chitalmari
10. Bhola	-Introduction of zero tillage (wheat, potato, pulses), short duration & salt-tolerant rice varieties and cultivation of ground nut, chilli & relay cropping of khesari, mungbean & mustard and floating bed agriculture in water-logged situations.	- Charfasion, Monpura, Daulatkhan
	- Early planting of T.Aman (Bridhan-33, 44) -Introduction of submergence tolerant rice varieties (Bridhan-51,52)	- Daulatkhan, Tazumuddin
	-Sorjan system of cultivating year round vegetables, spices & fruits on raised beds and creeper vegetables on bed edges and cultivation of fish in ditches during wet months.	- Bhola Sadar, Charfasion, Monpura, Daulatkhan

4.3.5.4 Arrangement of Stakeholders' Workshops at Regional/District and National Level on Draft Project Completion Report

Purpose of the Workshop

- To present the Key Findings of the Project.
- To collect the Local Experiences from the Stakeholders
- To share the Findings of the Project with Local DAE Personnel, NARS Scientists and NGOs Representatives.
- To identify location-specific Problems and Opportunities/ Adaptation Practices related to Improvement of Coastal Agriculture
- To update/validate Research Findings based on the location specific information/ data collected from workshop participants.
- To collect more Site Specific Recommendations for future R&D Activities to Improve Coastal Agriculture.
- Finally, to update/ improve the Final Technical Report of the Research Project based on the Local Experiences and Suggestions.

As per schedule, the following workshops were arranged to collect up-to-date relevant data/information and to exchange local experiences about the findings of the project for further improvement (Table 60):

Table 60: List of Stakeholders' Workshops arranged on Draft Project Completion Report

Name of Workshop	Date of workshop and Venue	Particulars of Participants/ Stakeholders*	# of Participants	Comments/suggestions obtained	Actions taken
1.Project Completion Workshop at national level	June 10, 2010 at Aristocrat Conf, Room	Concerned NARS Scientist, DAE, SRDI, BCAS and FAO Representatives	21	-Data sources should be mentioned -Data on vulnerable areas and climate risk factors affecting crop production needs updating -Since DAE participants not present, local experiences should be collected through organizing workshops at regional/district level.	-Regional/ district level workshops were arranged later for participation of local DAE Personnel
2.Project Completion Workshop at Regional Level	September 19, 2010 at AETI Auditorium, Khulna	ADA/DAE(2),DD/DAE (9), UAOs(26),NARS Scientist(9) and NGOs(6) of Khulna, Bagerhat and Satkhira districts	50	-Promote Paddy(boro)-Bagda Dual Culture -Promote cultivation of vegetables and spices on raised bunds in ghers -Introduce short duration varieties -Introduce rice varieties of low water requirement -Promote sorjan system of cropping -Promote salt-tolerant crop varieties (maize,mungbean, soybean, sesame) -Organic amendments in management of saline soils -Needs farmers' training on health and nutrional aspects.	-Comments and suggestions have already incorporated in the Final Report
3.Project Completion Workshop at Regional Level	September 21, 2010 at DD. Conf. Room, Barisal	ADA/DAE(2),DD/DAE (11), UAOs(30), NARS Scientist(9), NGOs(8) of Barisal, Pirojpur, Barguna and Patuakhali districts and FAO Representatives(4)	54	-Promote improved sorjan system, zero tillage(potato), floating bed agri. -Promote BR-41,42, 47 and submergence tolerant Bridhan-51,52 -Technology needs for utilization of large fallow lands -Introduce short duration rain fed aus crops(BR-42,43,48) -Improve defective embankments and re-excavation of canals -Promote dibbling method in aus rice cultivation(BR-27,42,43 -Promote horticultural crops(guava, zuzubi, amra etc)	-Comments and suggestions have already incorporated in the Final Report
4.Project	September	DD/DAE(3), UAOs(7),	17	-Promote submergence	-Comments

Name of Workshop	Date of workshop and Venue	Particulars of Participants/ Stakeholders*	# of Partici pants	Comments/suggestions obtained	Actions taken
Completio n Workshop at District Level	23, 2010 at DD. Conf. Room, Bhola	NARS Scientist(9), NGOs(6) of Bhola district and FAO Representative(1)		tolerant rice varieties (Bridhan-51,52) -Improve marketing network and ensure fair price at farm level -Promote Leaves by SMEs -Promote quality seed production, processing and preservation	and suggestions have already incorporated in the Final Report
5.Project Completio n Workshop at Regional Level	September 28, 2010 at DD. Conf. Room, Cox's bazar	DD/DAE(3), UAOs(8), NARS Scientist(3), NGOs(2) of Cox's bazaar district and FAO Representative(1)	19	-Temperature is increasing in rabi and boro seasons affecting crops -Boro areas being replaced by tobacco due to high price -Promote introduction of salt tolerant crop varieties -Promote cultivation of horticulture crops (banana, guava, papaya, zuzubi etc) under sorjan system. -People migration and malnutrition of Rohingas –an important issue. -Promote surface water for irrigation	-Comments and suggestions have already incorporated in the Final Report
6.Project Completio n Workshop at Regional Level	September 30, 2010 at DD. Conf. Room, Noakhali	DD/DAE(3), UAOs(8), NARS Scientist(3), NGOs(2) of Noakhali district and FAO Representative(1)	24	-Promote innovative practices in the cultivation of salt-tolerant and drought toleranat crop varieties (ground nut, soybean, cowpea, water melon, chilli etc) -Salinity management involving SRDI and BARI Scientists -Promote sorjan system of cropping and floating bed (vegetables) in water-logged areas. -Promote submergence tolerant rice varieties (Bridhan-51,52)	-Comments and suggestions have already incorporated in the Final Report

** List of Participants is shown in appendix*

5.0 KEY FINDINGS

Review and Analysis of Related Activities

The coastal belt is highly vulnerable to climate change. The intensity of disasters like sea level rise, tidal surge, soil salinity, salt water intrusion and cyclone in coastal belt are being increased. The salinity intrusion is a major factor which impedes the crop production at large in the coastal belt. Water and Soil salinity is a common hazard in many parts of the coastal zone. Consequently, the crop area is reducing and the cultivation of aus (summer rice), boro (dry season rice and other rabi (dry season) crops are being restricted. The major causes behind the expansion of salinity are :

- Salinity is expected to be exacerbated by climate change and sea-level rise.
- Decrease of upstream flow due to Farrakka Barrage
- Expansion of shrimp farms
- CEP (Coastal Embankment Project), implemented during the 1960s

a) Present Challenges in Coastal Agriculture are:

i) Changes in temperature and erratic rainfall

- Temperature is generally increasing in the monsoon
- Average monsoon max. & min. temperatures show an increasing trend annually 0.05 °C and 0.03°C respectively
- Lower rainfall in Aman season
- As per Global Circulation Model (GCM), precipitation will increase between 8-12%

ii) Large Fallow Lands

Utilization of countable area of agricultural land that remains fallow or seasonal fallow(30-50 % of concerned NCA) in drought prone char lands, flood prone and coastal areas due to vulnerabilities which will be aggravated further in future due to climate change. The main reasons of fallowing are: soil wetness/water stagnancy, late harvest of T.Aman, drought and increased salinity, expansion of shrimp culture, poultry farm and brick field etc.

iii) Problems of Introducing Suitable Salt-tolerant Crop Varieties

Problems of introducing/expanding of suitable salt-tolerant crop varieties(viz. Satabdi, Bijoy, Prodip of wheat, BARI Mung-5, BARI Til-3, bridhan-47 etc)in the coastal and charland regions and drought-tolerant varieties(viz. BARI Chickpea-5, BARI Bhutta-5, BARI Kaon for drought prone areas & char lands and submergence tolerant varieties(Sarna Sub-1, BR-11 Sub-1, IR-64 Sub-1, Bridhan-51,52) for water-logged areas.

b) FGD Findings

iv)Utilization of land in crop agriculture and changes in crops/cropping patterns

It was found that the average cropping intensity in the coastal areas has not increased as much compared to Flood Plain Agriculture during 1975-76 to 2005-06. The average cropping intensity ranges from 155-181 % except Bhola and Noakhali districts.

v) Conversion of Agricultural Lands into Non-crop/other purposes

There is a great change in the use of agricultural lands into other purposes due to climate change. The main reasons of conversion of agricultural land into non-crop agriculture/other purposes are: expansion of water-logging, shrimp culture, poultry farm and brick field.

vi) Yield reduction

- The main reasons of yield reduction (20-40 % yield loss) in T.Aman crop are erratic rainfall, increased intensity and frequency of drought, increased salinity, floods, cyclone, use of local varieties, increased incidences of pests & diseases etc in the context of climate change. The extent and severity of different crops loss due to climate risks varies from one district to another. Higher crop losses were found in Patuakhali, Noakhali, Barisal, Satkhira, Khulna, Bagerhat and Cox's bazaar districts due to climate risks. Study showed that total crop loss of T.Aman has been estimated to about 6.93 lakh ton per year based on last 5-10 years of local estimates/observations due to various climate risk factors.
- Average yield level of HYV Boro is being affected (30-40 % yield loss) by high temperature (causing sterility) and salinity and that of T.Aus/Aus crop is being affected (20-40 % yield loss) by tidal surge.
- Vegetables, pulses and oilseed crops are being affected (30-60 % yield loss) by salinity,soil wetness, excessive rainfall and water-logging in most coastal districts.
- From the study, total crop loss for major crops (viz. cereals, potato, pulses, oil seeds, spices and fruits) due to climate risks has been estimated to about 14.05 lakh tons per year based on local estimates, observations and experiences of last 3 years. **Crop damage or yield loss due to various climate risk factors has been summarized below (Table 61):**

Table 61: A Summary of Crop loss/yield reduction due to climate risk factors

Crop	% yield reduction or crop loss*	District	Total areas (in ha) affected	Total yield loss '000' MT	Major Climatic Risks
T. Aman	40-60	Cox's Bazar	35,500	71.00	Drought,flash floods, salinity, erosion, tidal surges, pests & diseases
	20-40	Patuakhali	76,200	114.30	Drought, water-logging, tidal floods, pests and diseases
	20-40	Barguna	27,500	41.25	Drought, flood, pests & diseases
	20-40	Pirujpur	25,600	38.40	Flood, drought, tidal surge, pests
	20-40	Barisal	57,750	86.62	Flood, water-logging, drought, pests & diseases
	20-40	Noakhali	59,950	89.93	Drought, flood, water, logging, pests & diseases
	20-40	Satkhira	35,700	53.55	Drought, water-logging, erosion, pests
	20-40	Khulna	28,850	43.27	Cyclone, water-logging, salinity, pests
	20-40	Bagerhat	61,270	91.90	Drought, flood, river erosion, pests
	20-40	Bhola	42,000	63.00	Drought, tidal flood, cyclone, pests
Total			**450,320**	**693.22**	
T.Aus	20-40	All districts	75,000	112.50	Submergence, drought, salinity, Fe toxicity, river & ground water salinity,

Crop	% yield reduction or crop loss*	District	Total areas (in ha) affected	Total yield loss '000' MT	Major Climatic Risks
					cyclone, pests & diseases
HYV Boro	20-40	All districts	150,000	300.00	Drought, salinity, Fe toxicity, river & ground water salinity, cyclone
Potato, Sweet Potato	40-60	All districts	28,055	140.25	Short winter, clayey soils, salinity, fogginess Average yield = 10-12 t/ha
Pulses (Khesari, M. bean)	20-40	- do -	201,850	60.55	Untimely rainfall, soil wetness, drought, salinity, Pests & diseases
Oilseed Crops (Mustard, sesame, G.nut)	20-40	- do -	63,750	19.12	Late/short winter, salinity, clayey soils, Pests & diseases
Spice Crops (Chilli, Onion, Garlic)	20-40	- do -	53,630	26.81	Early rainfall, soil wetness, salinity, pests and diseases.
Fruit crops (banana, papaya, water melon, amra, guava, amra etc)	20-40	-do-	10,625	53.12	Erratic rain, drought, high temperature, salinity, tidal flood, water-logging, pests & diseases and cyclone
Grand Total				**1,405.57**	

* Vulnerability/climate risks Ranking: Very severe (1) = > 60 % yield loss, Severe(2) = 40-60 % yield loss, Moderate (3) = 20-40 % yield loss and Low (4) = < 20 % yield loss.

Source: FGDs at district level compiled data from concerned upazilas and DAE District Office, 2008-09

vii) Erratic Rainfall Affecting Crop Cultivation Practices

- Study showed that erratic nature of rainfall, number of days without rainfall and more rain is occurring in short duration. Total rainfall in Kharif season is decreasing that affects the cultivation of rainfed crops in the coastal region.
- Level of rabi max. temperature is increasing compared to min. temperature affecting winter crops.
- Level of Kh-I max. and min. temp. is increasing.
- Level of Kh-II max. and min. temp. is increasing.
- Temp. rise in all three seasons indicate a sign of global warming.

viii) Long-term Crop Productivity Situations

- T.Aman production (both local and HYV) showing a declining trend due to tidal surge, erratic rainfall, salinity and increased incidences of pests
- Boro production slightly increasing due to introduction of salt-tolerant varieties with improved management practices
- Production of wheat and potato is decreasing due to short winter, drought and salinity
- Lentil production is decreasing due to sensitive to salinity and drought
- Production trend of mustard and M.bean (moderately salt tolerant) is increasing
- Winter vegetables and spices (mainly onion and garlic) being affected by short winter, drought and salinity
- Area and production of chilli and water melon (moderately salt-tolerant) is increasing.

ix) Increase in Temperature Affecting Crop Production

Temperature is generally increasing in the monsoon, average monsoon maximum & minimum temperatures show an increasing trend annually 0.05oC and 0.03oC respectively. Level of rabi max. temperature is increasing compared to min. temperature affecting winter crops. Level of both Kh-I & Kh-II max. and min. temperatures is increasing. Temperature rise in all three seasons indicated a sign of global warming in the coastal region.

x) Increasing soil salinity

Long-term data demonstrate that there is an increasing trend of pH level due to increasing salinity. The salinity level (Ec:ds/m) has increased almost double (Ec: 2.8-18.5 to 4.0-42.8 ds/m) in Sharankhola Upazila of Bagerhat district, Dumuria Upazila of Khulna district and Shymnagar Upazila of Satkhira district.

xi) Increasing salt affected areas

Study showed that salt affected areas have remarkably increased (27.2 % increase) to 937,950 hectares in 2009 from 737,340 hectares in 1977 in the coastal region.

xii Increasing River water salinity

- There is an increasing trend of river water salinity (12.9-24.5 % increase) in Bishkhali river at Pathorghata point, Andarmanik river at Kalapara point and Payra river at Taltali point during 2001 to 2009.
- Time series data/information on changes in river water salinity of some coastal districts (viz. Patuakhali, Pirojpur, Jhalkati, Barisal and Bhola) were collected from local offices of SRDI, DAE ,BWDB and BIWTA during survey and FGDs. The data showed that river water salinity has remarkably increased (12.9-24.5 % ds/m:3.1-25.3) in Patuakhali during last 8-10 years.

xiii) Increasing DTW/STW Water Salinity

There is an increasing trend of ground water salinity (5.8-25.6 % increase) in Pirojpur and Bhola districts during 2005 to 2009.

xiv) Sea Level Rise and Salt Water Intrusion

Data/information on water level (in meter) are recorded by BIWTA near to Sea Shore.Time series data/information on water level (in meter max/min level) of different measuring points were collected from local offices of BIWTA and BWDB during field visits and FGDs at project sites. Data on sea level rise based on water level measured/recorded near to sea shore at Galachipa River, Patuakhali ,Sandip, Khepupara, Charchanga, Hiron point and Cox's bazaar (BIWTA) showed an average increase of 0.283 M(at min.water level) and average increase of 0.415 M (at max.water level) which is an average increase of sea level during last 30-31 years(1.38 cm/yr) at max.water level. A summary of sea level rise is shown below:

Salt Water Intrusion during dry season.

2007:130,588.00 ha inundated (41.4 cm sea level rise during last 30 years)

2050:215,972.5 ha to be inundated (59.34 cm sea level rise during next 43 years)

xv) Increasing Water-logged Areas: Water-logged areas have significantly increased to 147,917.00 hectares in 2008-09 from 61,929.00 hectares in 1975-76 due to seasonal submergence, tidal surges, drainage congestion, increased roads & embankments, faulty sluice gate, increased shrimp culture under gher areas and heavy clays in the coastal region.

xvi) Increasing Vulnerable areas of Droughts, Floods, River Bank Erosion and Tidal Surges: Study showed that the vulnerable areas of drought prone, flood prone, river bank erosion and tidal surges have remarkably increased to 152,285.00 ha, 114,365.00 ha, 95,324.00 ha and 130,588.00 ha in 2008-09 compared to 1975-76 due to climate change.

xvii) Degradation of Land Quality and Nutrient mining: The availability of phosphorus, potassium, sulphur, zinc and boron in all sites has significantly decreased. But there is some indications of sulpher build up in Bhola, Porojpur and Noakhali. However, changes in nutrient status showed a significant depletion of plant nutrients supporting the over all degradation of land quality and soil fertility due to continuous cropping in the context of climate change.

- Long-term data showed that there is an increasing trend of pH due to increased salinity.
- The availability of phosphorus, potassium, sulphur, zinc and boron in all sites has significantly decreased.
- Changes in nutrient status showed a significant nutrient depletion leading to overall degradation of land quality and soil fertility.

c) Findings of Household Survey

xviii) Farmers' Response on Causes of Poverty and Food Insecurity

- Results showed that the main causes of poverty and food insecurity are: natural disasters, climate change, inadequate income, landless, low production and crop loss.
- The causes/factors of poverty and food security follow the order as shown: natural disaster/climate change>insufficient income>landless>crop loss>low crop yield>lack of educational awareness>health & nutritional deficiency etc.

xix) Local Perception on Climate Risks

Local perception of the impacts of climate hazards in coastal areas was assessed during FGDs and household survey. Participants stated that the current climate in this region is behaving differently than in the past on the following climate risk factors affecting crop production:

- Frequent drought
- Changes in seasonal rainfall pattern
- Seasonal rainfall
- Long dry spells
- Increase of soil salinity
- Increase of tidal surges

In addition, participants perceived that temperature has increased over the years and duration of winter has been shortened affecting the potential growing period of winter crops. Cultivation of wheat is being affected at grain filling stage due to high temperature and increased incidences of pests and diseases. Increased intensity of soil salinity was perceived by the farmers as white crust of salts on soil surface and crop burning during drier months in the coastal areas.

d) Findings of FGD and Household Survey

xx) Identification of Sustainable Adaptation Practices

Promising and viable adaptation options/practices were selected through a sequence of evaluation processes such as Upazila level discussion, focus group discussions (FGDs) at district level, household survey at selected upazilas and case studies and national level

stakeholders' workshop. Adaptation options were then prioritized according to the following:

- Environmental friendliness and qualitative cost-benefit analysis
- Evaluation of adaptation options for their technical suitability
- Multi-criteria analysis
- Expert judgment.

Finally, the following adaptation practices have been selected for improving coastal agriculture:

- **Sorjan system** of cultivating year round vegetables, spices and fruits on raised beds and creeper vegetables on bed edges making trellis on ditches and cultivation of fish in ditches during wet months in the water-logged/tidal surge areas.
- **Zero tillage**(maize, potato, garlic)
- **Floating bed agriculture** (vegetables and vegetable seedlings) using water hyacinth beds
- Cultivation of water melon in ring method/**Kalsi method**
- Introduction of some **salt-tolerant crop varieties** (viz.rice, wheat, maize, millet, mungbean, soybean, chickpea, water melon, chilli, ginger, turmeric) for coastal areas may be sustainable adaptation options for improving coastal agriculture.
- Utilization of bunds in gher areas in cultivating seasonal vegetables, fruits and spices
- Promote science based **rice-fish dual culture**
- Promote science based **boro rice-fish(bagda) dual culture at Khulna, Satkhira**
- Promote compost making and use of composts in homestead gardening

e) Findings of Case Study and Farmers' Perception

xxi) Assessing Human Health and Nutrition

- Some Case Studies were conducted in assessing the status of human health and nutrition of the vulnerable people in the project sites.
- Study showed that the vulnerable people especially women and children are suffering from malnutrition>cold/fever>dysentery/diarrhea>skin diseases> asthma/jaundice. The detailed problems of health and nutritional aspects of the vulnerable people have been described in the main text.

f) Dissemination and Extension of Adaptation Options

xxii) Dissemination and Extension of Adaptation Options

The viable adaptation options need to be tested and disseminated at pilot villages for their acceptance. The approaches followed initially for this purpose are limited to demonstrations, awareness raising, farmers' rallies, publicity materials etc.

xxiii) Coordinated Actions for Continuous Adaptation

Adaptation to reduce the vulnerability of agriculture and allied sectors to the impacts of climate change requires coordinated actions, proper planning, financial resources and community involvement.

6.0 POLICY IMPLICATIONS AND RECOMMENDATIONS

- **Location specific production plans**: An in-depth study is needed for developing location-specific production plans for better coastal agriculture. This would need to be based on soil-crop-climate suitability through proper assessment of soil-related constraints, climate risks and socio-economic problems that presently affect crop production systems and livelihood of vulnerable populations in the coastal region.

- **Livelihood Strategies:** There is need to identify community based livelihood adaptation strategies and options that will tailored to the needs of the farming community in vulnerable areas. There are many risk management related non-farm activities which are becoming less common and climate change may push these practices further and may create unemployment. There will be a more change in livelihood pattern of the farming community in the vulnerable areas. An implementation plan needs to be prepared in a phase wise manner for improving the livelihood of vulnerable people.

- **Developing Climate Change Scenarios based on GCMs : There is need for building upon existing** adaptation option menus if available, based on GCMs and innovative field practices that are locally viable. Assessment of past and current climate impacts; and understanding of local perceptions of climate impacts and local coping capacities and existing adaptation strategies is required. Capacity building in climate forecasting of DAE extension staff and community representatives should be an on- going part of such initiatives.

- **Women's Involvement in Agriculture:** Capacity building of women farmers and agriculturists is key for interventions to support and strengthen **ho**usehold coping strategies in agriculture and for managing climate variability. Given that women are increasingly engaged in homestead gardening, seed production and preservation, processing and compost making in the context of drought occurrences, it would empower women with technologies related short duration and drought-tolerant crop varieties, cropping systems and homestead gardening.

- **Capacity building and training : Capacity building and training for** strengthening local institutions, including self-help programmes and awareness raising for local institutions are is required. Strengthening/ carrying out awareness raising campaigns and advocacy on climate change and adaptation issues among vulnerable communities should be undertaken involving the community in participatory dialogue.

- **Farming and adaptation practices:** There is need for conducting, strengthening and expanding crop demonstrations and block farming based on adaptation practices. Introduction of risk resistant crop varieties in agriculture with emphasis on crop diversification should be an integral part of the TOT, farmers training and demonstrations.

- **Developing infrastructural facilities:** Road network, agro-processing and marketing infrastructure, canals and irrigation facilities need to be improved for mitigating impacts of crop production related vulnerabilities and climate change.

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- **Management of coastal saline soils:** There is need for improving the management of coastal line saline soils through protective embankment, proper sluice gate, land leveling and improved drainage systems.

- **Health and Nutrition:** Policy interventions should emphasize addressing nutrition and health concerns based on evidence and proven interventions. Improving and increasing health care coverage and access to integrated health services along with promoting the consumption of balanced diets are needed for vulnerable people especially women in coastal areas.

7.0 AREAS FOR FURTHER RESEARCH

Bangladesh agriculture is highly risk-prone, and is subject to frequent natural shocks, mainly droughts, salinity, tidal floods and cyclones in the coastal region. Frequent natural disasters and climate risks damage the crops, reduce the asset base of the vulnerable farmers and even completely destroy it. River erosion, tidal surges and agricultural land degradation make these problems further intense. Under the situation, a package of production incentives (suitable seeds, fertilizers, irrigation, pesticides and implements,) including credit may be provided to the vulnerable farmers for increased production through Block Farming.

- More study is needed for making location-specific production plan for better coastal agriculture based on soil-crop-climate suitability through proper assessment of soil-related constraints, climate risks and socio-economic problems presently affecting crop production systems and livelihood of the vulnerable people of the coastal region.
- There are many risk management non-farm activities but these are becoming less common, and climate change may push these practices further and create unemployment. There will also be change in livelihood pattern of the farming community in the vulnerable areas. So, a future study on Community Based Adaptation Strategies and Options should be taken up in identifying and implementing phase-wise adaptation options for increasing crop production and improving the livelihood of vulnerable people.
- Developing and updating Climate Change Scenarios based on GCMs need to be done considering several climate change prediction models as available in South Asia.
- Health and nutrition impact of climate change needs to be studied in terms of measurable indicators. The relation to specific health indicators such as respiratory infections, food borne illness as well as undernutrition needs to be demonstrated.

8.0 CONCLUSIONS

Coastal Agriculture is highly vulnerable to climate change and natural disasters. The intensity of disasters like sea level rise, tidal surge, soil salinity, salt water intrusion and cyclone in coastal belt are being increased. Consequently, the crop area is reducing and the cultivation of aus (summer rice), boro (dry season rice and other rabi (dry season) crops are being restricted. A vast area of agricultural land that remains fallow or seasonal fallow(30-50 % of NCA of concerned districts) in drought prone char lands, flood prone and coastal areas due to vulnerabilities which will be aggravated further in future due to climate change. The main reasons of fallowing are: soil wetness/water stagnancy, late harvest of T.Aman, drought and increased salinity, expansion of shrimp culture, poultry farm and brick field etc.

Presently, there are problems in introducing/expanding of suitable salt-tolerant crop varieties(viz. Satabdi, Bijoy, Prodip of wheat, BARI Mung-5, BARI Til-3, Bridhan-47, Bridhan-51,52 etc)in the coastal and charland regions and drought-tolerant varieties(viz. BARI Chickpea-5, BARI Bhutta-5, BARI Kaon for drought prone areas & char lands and submergence tolerant varieties(Sarna Sub-1, BR-11 Sub-1, IR-64 Sub-1,Bridhan-51,52) for water-logged areas.

Long-term data/information on climate change showed that there is a trend of temperature rise, erratic rainfall, drought spell, increased tidal surges, increase of soil salinity and water salinity, increase of sea level and intrusion of salt water into crop lands, submergence, cyclones etc affecting crop production systems in the coastal region.

The study showed that the main reasons of yield reduction (20-40 % yield loss) in T.Aman crop are erratic rainfall, increased intensity and frequency of drought, salinity, floods, cyclone, use of local varieties, increased incidences of pests & diseases etc in the context of climate change. Average yield level of HYV Boro is being affected (30-40 % yield loss) by high temperature and salinity and that of T.Aus/Aus crop is being affected (20-40 % yield loss) by tidal surge. Vegetables, pulses and oilseed crops are being affected (30-60 % yield loss) by soil wetness, excessive rainfall and water-logging in most coastal districts.

Results showed that the main causes of poverty and food insecurity are: natural disasters, climate change, inadequate income, landless, low production and crop loss. The causes/factors of poverty and food security follow the order as shown: natural disaster/climate change>insufficient income>landless>crop loss>low crop yield>lack of educational awareness>health and nutritional deficiency.

Local perception of the impacts of climate hazards in coastal areas was assessed during FGDs and household survey. Participants stated that the current climate in this region is behaving differently than in the past on a number of climate risk factors affecting crop production: These are: frequent drought, changes in seasonal rainfall pattern, in-seasonal rainfall, long dry spells, increase of soil salinity, increase of tidal surges. In addition, participants perceived that temperature has increased over the years and duration of winter has been shortened affecting the potential growing period of winter crops. Cultivation of wheat is being affected at grain filling stage due to high temperature and increased incidences of pests and diseases. Increased intensity of soil salinity was perceived by the farmers as a result of white crust of salts on soil surface and crop burning during drier months in the coastal areas.

During participatory FGD, stakeholders' consultation, household survey and case study, some promising adaptation practices were identified and documented for sustainable agricultural production in coastal region.

These are:

- Sorjan system of cultivating year round vegetables, spices and fruits on raised beds and creeper vegetables on bed edges making trellis on ditches and cultivation of fish in ditches during wet months in the water-logged/tidal surge areas.
- Zero tillage cultivation of maize, potato and garlic.
- Floating bed agriculture (vegetables and vegetable seedlings) using water hyacinth beds
- Cultivation of water melon in ring method/Kalsi method
- Introduction of some salt-tolerant crop varieties (viz.wheat, maize, millet, mungbean, soybean, chickpea and rice) for coastal areas may be sustainable adaptation options for improving coastal agriculture.
- Utilization of bunds in gher areas in cultivating seasonal vegetables, fruits and spices and promoting science based rice-fish dual culture. Similarly, compost making and use of composts in homestead gardening should be encouraged
- More study is needed in future for making location-specific production plan for better coastal agriculture based on soil-crop-climate suitability through proper assessment of soil-related constraints, climate risks and socio-economic problems presently affecting crop production systems and livelihood of the vulnerable people of the coastal region.
- There are many risk management non-farm activities but now they are becoming less common and climate change may push these practices further and may create unemployment. There will be change in livelihood pattern of the farming community in the vulnerable areas. So, a future study on Community Based Adaptation Strategies and Options should be taken up in identifying and implementing phase-wise adaptation options for increased production and improving the livelihood of vulnerable people
- Climate Change Scenarios based on GCMs and available prediction models need to be documented and developed.
- Women's involvement in agriculture and related activities needs to be enhanced in addition to capacity building and training of the vulnerable populations in promoting Adaptation Agriculture.
- Enhanced and increased health care with consumption of balanced diet by vulnerable communities, especially women and children in the coastal region should be promoted.

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ANNEXURES

Annexue I

1.2 Project Personnel

1.2.1 Principal Investigator: **Dr. Md. Muslem Uddin Miah**, Senior Agriculture Specialist, BCAS, Hs-10, Rd-16A, Gulshan-1, Dhaka, Tel: (880-2)8818124-27, 8852904, 8851417, Fax: (880-2)8851417, Cell: 0171-3248330, E-mail: muslem.uddin@bcas.net

1.2.2 Other personnel

Name	Type of inputs used	Purpose
1. Mr. Mozaharul Alam, Research Fellow	Co-Investigator	Program development & survey
2. Mr. Kh. Mainuddin, Sr. Expert on Statistics	Co-Investigator	-do-
3. Mr. Golam Rabbani, Environment Specialist	Co-Investigator	-do-
4. Mr.S.M.Alauddin, Sociologist	Co-Investigator	-do-
5. Mr. Aminur Rahman, Agriculturist	Research Assistant	Survey & data collection
6. Mr.Belayet Hussain, NRM Specialist	Research Assistant	Survey & data collection
7. Mr.Rabiuzzaman, Research Officer	Research Assistant	Survey & data collection
8. Mr.Farhad Hussain, Research Officer	Research Assistant	Survey & data collection
9. Mr.Rafiqul Islam, Ph.D Fellow	Research Assistant	Survey & data collection
10.Mr.Mohammad Shohel, Data Analyst	Research Assistant	Data compilation & analysis

Annexure II

FAO-FGD Checklist/ Questionnaire

Name of District:
Name of Upazila: **Name of UAO:**

1. Land use pattern and their consequences (from 1975-76 to 2005-06)

SL	Land use pattern	1975-76	2005-06	Remarks
01	Land (Homestead-Own)			
02	Land (Homestead-Lease/others)			
03	Land (Agriculture)			
04	Land (pond)			
05	Fallow land-Rabi			
06	Fallow land-Kharief-1			
07	Fallow land-Kharief-2			
08	Orchard/ Homestead garden			
09	Vegetable garden			
10	Pasture land			

2. Major crops/cropping patterns (both improper/exhaustive and sustainable)

Season	Farming Practices 1975-76	Average yield (t/ha)	Farming Practices (2005-06)	Average yield (t/ha)
Rabi (Mid October-Mid March)				
Kharif-I (Mid March-Mid July)				
Kharif-II (Mid July-Mid October)				
Irrigated Farming Rabi (Mid- October-Mid March)				
Kharif-I (Mid March-Mid July)				
Kharif-II (Mid July-Mid October)				
Name 10 major cropping patterns				

3. Conversion of agriculture land into other purposes (1975-76 to 2005-06).

SL	Agricultural land use	Land use (1975-76) in ha	Land use (2005-06) in ha	Remarks /purposes
01	Paddy (local varieties)			
02	Paddy (HYV)			
03	Vegetables (Summer)			
04	Vegetables (Winter)			
05	Tuber crops			
06	Pulse crops			
07	Oilseed crops			
08	Spice crops			
09	Fruit crops			
10	Wheat			
11	Maize			
12	Sugarcane			
13	Jute			
14	**Other purposes** -Brick field -Poultry farm -Fish/shrimp culture -Gardening/forestry -Industries -Housing -Others			

4. Land degradation and crop productivity trend

SL	Causes of land degradation (climate related)	Impacts on Crop Productivity(1975-76) in ha	Impacts on Crop Productivity(2005-06) in ha	Remarks/major affected
01	Salinity/tidal surge(ds/m)			
02	Depletion of SOM(%)			
03	Decrease of microbial activity			
04	Acidity/alkalinity(pH)			
05	Deterioration of soil physical condition			
06	River erosion			
07	Floods/flash flood			
08	Cyclone/tidal surge			
09	Sea level rise			
10	Sand deposition/carpeting due to river erosion			
11	Siltation due to floods			
12	Embankment failure			
13	Temperature variation			

SL	Causes of land degradation (climate related)	Impacts on Crop Productivity(1975-76) in ha	Impacts on Crop Productivity(2005-06) in ha	Remarks/major affected
14	Drought			
15	Cold wave			
16	Hot wave			
17	Rainfall variation(mm/yr)			
18	Change of winter period			
19	Excessive moisture/ water –logging			
20	Cloudiness			
21	Fogginess			
22	Extreme cold			
23	Extreme/high wind			
24	More greenery			
25	New weeds, pests and diseases			
26	Any other factor			

5. Identification of problems and opportunities on crop production practices

SL	Identification of problems	Opportunities	Remarks
01			
02			
03			
04			
05			
06			
07			
08			
09			

6. Identification of different risk/vulnerable factors affecting crop production with extent and severity. (Temperature variation-higher/lower(1), seasonal variation-period(2), rainfall variation-amount/quantity(3), changed timing of rainfall(4), floods/flash flood(5), drought/moisture stress(6), cold wave/hot wave(7), sunshine-low/high(8), salinity/tidal surge(9), submergence/water-logging-period(10), Excess moisture/soil wetness(11), Extreme wind/high wind(12), cyclone(13), new weeds/and pests(14), problem soils(15) and any other factors(16). **Please identify the climatic risk factors that affecting crop production(with areas in ha).**

Rainfed crops	Climatic factors	Very Severe*	Severe*	Moderate*	Low*
T.Aman rice					
Wheat					
Maize					
Potato/ Sweet potato					
Jute					
Sugarcane					
W.Vegetables S.vegetables					
Pulse crops					
Oilseed crops					
Spice crops					
Fruits crops					
Other crops					
Irrigated crops					
HYV boro					
T.Aus					
T. Aman					
Other crops					

*** Very severe= > 60% yield loss, Severe= 40-60% yield loss, Moderate=20-40% yield loss and Low=< 20 % yield loss**

7. Identification of sustainable practices/existing innovative/adaptation practices/probable adaptation practices for sustainable production.

SL	Adaptive practices	Intensive	Medium	Low
01	Adoption of new crop varieties in farming practices			
02	Early planting & earlier harvesting			
03	Introduction of short duration crop varieties			
04	Introduction of drought tolerant/salt tolerant/submergence tolerant			

SL	Adaptive practices	Intensive	Medium	Low
	crop varieties			
05	House DTW/STW for irrigation			
06	Rain water harvest technology			
07	Zero tillage			
08	Sorjan system			
09	Floating bed(agriculture)			
10	Compost making and homestead gardening			
11	Utilization of bunds in gher areas			
12				
13				
14				

8. Suggested future crops/farming practices in the context of climatic vulnerabilities

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Identifying Crop Production Packages of the locality in the Context of Climate Change

Crop/season	Method of cultivation	Suggested Production Package -Suitable seeds/variety(kg/ha) -Fertilizers(kg/ha) -Water management -Cultural practices etc	Expected Yield(t/ha)	Remarks(location/area should be mentioned)

9. Suggestions/recommendations for improvement of Coastal Agriculture and better livelihood

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10. Suggestions(on GO-NGO Contributions) for reducing the long-term impacts of vulnerabilities on crop production systems.

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Annexure-I: Information to be collected
Upazila Profile
1.General

Sl. #	General information	Numbers
1	Total area(sq km)	
2	Water body(ha)	
3	Forest land(ha)	
4	Town(municipality)	
5	Union	
6	Village	
7	Blocks	
8	Population	
9	Male	
10	Female	
11	Population/sq km)	
12	Farm household	
13	Large farm(7.5 acre or more)	
14	Medium farm(2.5 to 7.49 acre)	
15	Small farm(1.5 to 2.49 acre)	
16	Marginal farm(0.5 to 1.49 acre)	
17	Landless(0.0 to 0.49 acre)	
18	Literacy(%)	
19	Total food production(rice &wheat by mt in 2006)	
20	Total demand(rice &wheat by mt in 2006)	
21	Surplus(+) or Shortage(-) by mt	

2.Agricultural land and land use

Sl. #	Description of agricultural land	Area(ha)
1	Total agriculture land area	
	High land	
	Medium high land	
	Medium low land	
	Low land	
2	Permanent fallow land	
3	Current/seasonal fallow land(with fallow period) -Rabi fallow	

Sl. #	Description of agricultural land	Area(ha)
	-Kharif-I fallow -Kharif-II fallow	
4	Net cropped area	
5	Single cropped area	
6	Double cropped area	
7	Triple cropped area	
8	Total cropped area	
9	Cropping intensity(%)	
10	Irrigated land area(%)	
11	Climatic data -Month-wise temperature(o C) from 1975-76 to 2005-06 -Month-wise rainfall(mm) from 1975-76 to 2005-06 -Month-wise humidity(%) from 1975-76 to 2005-06 -Month-wise sun shine hour from 1975-76 to 2005-06	

3.Present Crop Production and Area coverage(2005-06)

Sl. #	Crop	Area(ha) in 1975-76	Total production(MT) In 1975-76	Area(ha) in 2005-06	Total production(MT) in 2005-06
1	Aus rice				
2	Aman rice				
3	Boro rice				
4	Total rice				
5	Wheat				
6	Maize				
7	Oilseeds -Mustard -Sesame -Sunflower -Groundnut -Others				
8	Pulses				

	-Khesari -Mung bean -Soybean -Cowpea -Chickpea -Others				
9	Tuber crops -Potato -Sweet potato				
10	Winter vegetables				
11	Summer Vegetables				
12	Total Vegetables				
13	Fruits -Watermelon				
14	Spices -Chilli -Onion -Garlic				
15	Jute				
16	Sugarcane				
17	Bamboo				
18	Betel nut				
19	Betel vine(Pan)				

Annexure III

Household Survey Questionnaire

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

National Food Policy Capacity Strengthening Programme (NFPCSP), Bangladesh
(GCP/BGD/034/MUL)

Assessing long –term impacts and vulnerability on crop production due to climate change in the coastal areas of Bangladesh

Section A: Basic Socio-economic Information of the Household

1. Identification of the Respondent:

Name of the respondent:	**Village/Para/ Area:**
Age:	Ward No:
Sex: Male [1] Female [2]	Mouza:
Ethnicity:	Union:
Relationship with Household Head:	Upazila: District:

Code for relationship: husband = 1, wife = 2, son = 3, daughter = 4, father = 5, mother = 6, brother = 7, sister = 8, Nephew = 9, nice = 10, grandson = 11, grand daughter = 12, sister in law = 13, brother in law = 14, self = 15, daughter in law= 16, son in law= 17, Widower = 18, others (specify) = 19.

1.A Site description

1. Land type: 2. Soil type: 3.Drainage condition:

4.pH: 5.Salinity: 6. Fertility condition: 7.Rainfall & humidity condition:

2.Demographic features of the household

SL	Name (write the name of HH head first)	Age Yrs.	Sex (Male-1, Female- 2)	Marital status	Education	Primary Occupation	Secondary Occupation

Code for marital status: Married = 1, Single = 2, Widow = 3, Divorced/Separated = 4, Other (specify) = 5

Code for education: Illiterate = 0, Can sign only=1, Primary = 2, Secondary = 3. Higher Secondary = 4, other (specify) = 5

Code for Occupations: Service holder=1, Wage labour = 2, Paid domestic work = 3, Share cropping = 4, Rickshaw/van puller/carts driver = 5, Boatmanship =6, Fishermen/Fishing = 7, Livestock raring = 8, Poultry raring = 9, Gardening and horticulture = 10, Small trading = 11, Handicrafts = 12, Begging = 13, Farmer = 14, Jhum cultivation=15, Honey collector=16, Wood collector=17, Hawker=18, Housewife=19, Tailor= 20 and Others (specify) = 21.

3. Productive Assets and Wealth of the family

SL	Items	No./Area (decimal)	Value (Taka)
01	Land (Homestead-Own)		
02	Land (Lease/others)		
03	Land (Agriculture/pond)		
04	Cow/Buffalo		
05	Goat/sheep		
06	Poultry		
07	Swine		
08	Rickshaw/Van/carts		
09	Boat/Net		
10	Trees/Plants		
11	Houses		
12	Khat/Table/Chair		
13	Solar panel		
14	Mobile phone		
15	Cycle/Radio/Television		
16	Ornaments		
17	Others (specify)		**Total Taka**

4. Household average monthly Income, Expenditure and status of loan

4. A. Sources of Family monthly income and Expenditure

Sources of income	Total Taka	Expenditure	Total Taka
Agriculture		Rice/food	
Vegetables		Pulses	
Wage labor		Meat	
Small business		Fish	
Rickshaw, van, cart puller		Vegetables and fruits	
Fishing		Cloths	
Hanhdicrafts		Household construction/Repair	
Livestock		Education	
Service		Transport	
Remittance		Health/Medicine	
Others		Electricity	

4.B. Monthly income and sources of income

Baishak	Jaishta	Ashar	Sraban	Bhadra	Aswin
Tk. Source:	Tk. Source:	Tk. Source:	Tk. Source:	Tk. Source:	Tk. Source:
Kartik	Agrahayan	Poush	Magh	Falgun	Chaitra
Tk. Source:	Tk. Source:	Tk. Source:	Tk. Source:	Tk. Source:	Tk. Source:

4. C. Average household income, expenditure, savings and deficit (in Taka)

4.1 What is your household's average gross monthly income? …….....

4.2 What is your household's average gross monthly expenditure? …….....

4.3 What is your household's average gross monthly savings/deficits? …….....

4.4 Reasons for monthly savings/deficit…….

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4D . Status of loan

4.1 Did you receive any loan from bank or other sources?

Yes=1, No=2

If yes, describe your loan receiving status by sources

Sources of loan	**Amount of total loan (TK) received**	**Outstanding amount (Tk)**	**Rate of interest**
1. Bank			
2.NGOs			
3. Money lender			
4.Relatives			
5. Samity			
6. others (specify)			

5. Habitation, social and organizational status

5. A. Status of habitation

Are you a permanent settler in this area? Yes=1, No=2

Have you been migrated here? Yes=1, No=2

If yes, Permanent migration=1, Seasonal migration=2

Year of Migration? ……

Where from? ….....

Causes of migration(use tick mark): river bank erosion=1, lack of employment=2, floods=3, water stagnancy=4, problem soils=5, problems of cultivation=6, low productivity=7, low wage rate=8, family causes= 9, Lack of agricultural activity=10, lack of own agril. Land=11, tidal surge/salinity=12, Cyclone=13, Drought=14, other (specify) =15

5. B. Social and organizational status

Do your or your family members are group members of any NGOs and government organizations?

Yes=1, No=2

If Yes, Please mention type of NGOs and government organizations.

BRAC =1, Proshika= 2 ASA= 3, Grameen Bank= 4, CCDB= 5, CARITAS= 6, Social Welfare= 7, Health Centre= 8, BRDB= 9, Women Affaires= 10, Youth development department= 11, RDRS= 12,

Union Parishad= 13, Others (specify)=14

-**Are you getting food assistance/financial benefits from such organizations?**

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6.Status of Livelihood and causes of poverty in the Family

6.A. Livelihood Status of the Family

Wealth category	(Use Tick mark)	Monthly income(Tk.)	Remarks
Rich			
Medium rich			
Poor			
Marginal poor			
Extreme poor			

6. B. What are the causes of poverty in your family?

Low wage earning =1, Inadequate income = 2, Landlessness = 3, Unemployment = 4, Number of disable people in the family = 5, Household Head is widow or separated women = 6, Natural disaster = 7, Food grain deficit in the region = 8, High price of food grains = 9, Lack of access in market = 10, Multiple marriage= 11, Court Cases= 12, Diseases=13, Cheating=14, Drug addicted= 15, To be out of a job=16, Lack of educational awareness=17, low crop yield=18, crop loss=19, health & nutritional deficiency=20, climatic hazards=21, political crisis=22, others (specify) = 23

7. Daily intake of food by family members

7.A. How many meals do you /your family members take in a day?

3 times = 1, 2 times = 2, 1 time = 3

7. B. Quantity of Food: Sufficient= 1, Insufficient=2

7.C. Quality of Food: Good=1, Average=2, Bad=3

7.D. Did you take the following food items during last week? (please give tick mark)

Food items		Tick mark	Quantity(sufficient/not sufficient)
01	Rice/bread		
02	Fish		
03	Meat		
04	Eggs		
05	Vegetables		
06	Milk		
07	Fruits		

7. E. When do you face food scarcity in a year? **Name of months and Causes of hunger/ starvation:**

Baishak	Jaishtha	Ashar	Sraban	Bhadra	Aswin
Causes:					
Kartik	Agrahayan	Poush	Magh	Falgun	Chaitra
Causes:					

8. Causes of food insecurity within a family

8. A. What are the causes of food insecurity in your family?

Low wage earning =1, Inadequate income = 2, Landlessness = 3, Unemployment = 4, Number of disable people in the family = 5, Household Head is widow or separated women = 6, Natural disaster = 7, Food grain deficit in the region = 8, High price of food grains = 9, Lack of access in market = 10, more wife= 11, case and courts= 12, Diseases= 13,Cheating=14, Drug addicted= 15, To be out of a job=16, Lack of educational awareness=17, Low productivity=18, High production cost=19, Crop loss due to climatic risks=20, Heavy rains/floods=21, drought=22, Cyclone=23, Poor management in food distribution=24, others (specify) = 25

8. B. In your opinion, which are the groups are mainly affected by the poverty in your locality

Beggar=1, destitute women=2, unable to work/disable=3. Etim/destitute Children=4, landless= 5, marginal group=6, minority groups=7, other (specify) =8

Section B: Issues Relating to Climate Change

9. Household responsiveness on climate change risk affecting crop production

9.A Do you think that Climate change has any impacts on agricultural production?

Yes ☐ No ☐

If yes,

9.B Identify factors affecting crop production due to climate change and its vulnerabilities in your locality

Climate Change and Climate Variability Issues	Cereal crops	Tuber crops	Vegetables	Pulse crops	Oilseed crops	Spice & fruit crops	Severity of climatic risks*
Sea level rise (SLR)/Inundation							
Salt water intrusion/salinity intrusion							
Increase of tropical Cyclones							

Climate Change and Climate Variability Issues	Cereal crops	Tuber crops	Vegetables	Pulse crops	Oilseed crops	Spice & fruit crops	Severity of climatic risks*
Storm Surges							
Tidal surge							
Flood							
Water- logging							
River bank erosions							
Sedimentation/carpeting							
Drought							
Erratic Rainfall/Change and unpredictability in rain pattern							
Increased rainfall							
Decreased rainfall							
Heat Waves/Increased average temperature							
Cold Waves							
Any other events							

Note: **Rank the level of impacts on crop production** of the above mentioned climatic events from 1-5 with '1' representing minimum level of impact and '5' representing maximum level of impact. Where:1 - Very low; 2 – Low; 3 – Moderate; 4 – Severe; and 5 – Very severe.

**** Very severe= > 60% yield loss, Severe= 40-60% yield loss, Moderate=20-40% yield loss and Low=< 20 % yield loss***

10.How natural resources used for livelihood in the family

Natural resource	High	Medium	Low	Nil
Land				
Water				
Forest				
Local vegetation				
Fishery resources				
Homestead				

11. Assessing Extent and severity of land degradation affecting crop production due to climate change

CC Events	High	medium	Low	Very low
Sea Level Rise				
Tidal surge/salinity				
Cyclone/Storms Surge				
Water pollution				
Sedimentation				
Flood				
Water logging				
Drought				
Erratic Rainfall				
Decrease of SOM				
Other				

12.Conversion of agricultural lands into other purposes and changes of professionals at household levels

Agricultural practices	Conversion into other crops/varieties	Conversion into other purposes/ practices*	Changes of professionals	Causes
Paddy (local varieties)				
Paddy (HYV)				
Vegetables (Summer)				
Vegetables (Winter)				
Pulse crops				
Oilseed crops				
Spice crops				
Fruit crops				
Wheat				
Sugarcane				
Jute				
Other crops				

*** Other practices: Fish/shrimp culture, poultry, gardening/forestry, brick field, industries, housing, others.**

13. Long term impacts of climate variability's on crop production during 1975-76 and 2005-06 with level of impacts on different crops at household level.

Agricultural practices	Crop production during 1975-76(Av. Yield: t/ha)	Crop production during 2005-06(Av.Yield: t/ha)	Climatic risk factors
Paddy (local varieties)			
Paddy (HYV) Hybrid rice			
Vegetables (Summer)			
Vegetables (Winter)			
Pulses			
Wheat			
Oilseeds			
Spices			
Maize			
Sugarcane			
Jute			
Fish/shrimp culture			
Gardening/forestry			
Others			

Code for severity: 1 - Very low; 2 – Low; 3 – Moderate; 4 – Severe; and 5 – Very severe.

Code for vulnerabilities: Sea Level Rise, Salt Water Intrusion, Salinity, Water stagnancy, Cyclone/Storms Surge, Flood, Drought, Erratic Rainfall, Heat Weaves/Temp rise, Cold Weaves and Other

14. Assessing present impacts and probable impacts of climate change
Do you think there is any impact of CC on Poverty?

Yes ☐ **No** ☐

If yes, how and at what level Climate Change affects the poor?

CC Events	Severe	Moderate	Low	Very low	Future probable impacts
Sea Level Rise					
Salt Water Intrusion					
Salinity					
Cyclone/Storms Surge					

Flood					
Water logging					
Drought					
Erratic Rainfall					
Heat Weaves/Temp rise					
Cold Weaves					
Other					

15. Future impacts of climate change on different sectors

CC Events	Av. Annual Income(Tk.)	Food Security	Education	Health (safe water & sanitation)
Sea Level Rise				
Salt water intrusion				
Salinity				
Cyclone/Storms Surge				
Flood				
Water logging				
Drought				
Erratic Rainfall				
Heat Waves/Temp rise				
Cold Waves				
Other				

16. Listing of sustainable/adaptable/innovative or coping strategies/practices for increased sustainable agricultural production in the context of climate change.

Sustainable practices	Crop/season	Intensive	Medium	Low	Remarks
Adoption of new varieties in farming practices					
Early planting and early harvesting					
Introduction of short duration varieties					
Introduction of drought-tolerant, salt-tolerant, submergence tolerant varieties					
Irrigation facilities					
Rain water harvesting technology					
Zero tillage					
Sorjan system					
Floating Bed(agriculture)					
Any other					

17. Identifying Crop Production Packages of the locality in the Context of Climate Change

Crop/season	Method of cultivation	Suggested Production Package -Suitable seeds/variety(kg/ha) -Fertilizers(kg/ha) -Water management -Cultural practices etc	Expected Yield(t/ha)	Remarks

18. Poverty level impacts of CC on livelihood with reasons*

Wealth category	Very high	high	Medium	Low
Very rich				
Rich				
Poor				
Marginal				
Extreme poor				

Explain reasons:

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19. Access to production inputs/assistance from GO/NGO sectors for increasing crop production in your farms

Inputs	After cyclone	Flood/water logging	Tidal surge	Salinity intrusion
Production inputs				
Training				
Seeds				
Fertilizers/pests				
Credit				
Machinaries				

20. What are the present adaptation/innovative practices are being practiced on your farms in reducing/coping climate change impacts in agricultural production?

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21. What are the cultural practices at present in your locality may be followed to reduce the climate change impacts?

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22. What are the religious/social practices may be followed to cope with the different vulnerabilities?

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23. Suggestions for reducing the impacts of vulnerabilities on crop production (GO/NGOs and civil society's interventions/financial assistance).

-Utilization of seasonal fallow lands based on local innovations
-Training on adaptation/coping practices for adoption of sustainable practices
-Awareness building on coping/adaptation practices among vulnerable community
-Efficient utilization of production inputs for increased agricultural production
-Introduction of drought tolerant, salt-tolerant and submergence tolerant crop varieties among vulnerable farmers
-Promotion of agri-business, value addition etc of agriculture produce
-Developing marketing infra-structures/network systems
-Formation of Farmers' Group for Community Based Adaptation

Name of interviewer: ***Name of supervisor:***

Signature: ***Signature:***

Date: **Date:**

Annexure IV

Case Study for Assessing Long-term Impacts of Climate Change on Crop Production and Health & Nutritional Aspects of Vulnerable People under FAO Project : Assessing long –term impacts and vulnerability on crop production due to climate change in the coastal areas of Bangladesh

Section A: Basic Socio-economic Information of the Household

1. Identification of the Respondent:

Name of the respondent:	**Village/Para/ Area:**
Age:	Ward No:
Sex: Male [1] Female [2]	Mouza:
Ethnicity:	Union:
Relationship with Household Head:	Upazila: District:

Code for relationship: husband = 1, wife = 2, son = 3, daughter = 4, father = 5, mother = 6, brother = 7, sister = 8, Nephew = 9, nice = 10, grandson = 11, grand daughter = 12, sister in law = 13, brother in law = 14, self = 15, daughter in law= 16, son in law= 17, Widower = 18, others (specify) = 19.

2.Members of the household

SL	**Name (write the name of HH head first)**	**Age Yrs.**	**Sex** (Male-1, Female- 2)	**Marital status**	**Education**	**Any member(s) suffering from any disease(s)- please mention**	**Mention three main diseases**
01							
02							
03							
04							
05							
06							
07							
08							
09							

Code for marital status: Married = 1, Single = 2, Widow = 3, Divorced/Separated = 4, Other (specify) = 5

Code for education: Illiterate = 0, Can sign only=1, Primary = 2, Secondary = 3. Higher Secondary = 4, other (specify) = 5

Code for Occupations: Service holder=1, Wage labour = 2, Paid domestic work = 3, Share cropping = 4, Rickshaw/van puller/carts driver = 5, Boatmanship =6, Fishermen/Fishing = 7, Livestock raring = 8, Poultry raring = 9, Gardening and horticulture = 10, Small trading = 11, Handicrafts = 12, Begging = 13, Farmer = 14, Jhum cultivation=15, Honey collector=16, Wood collector=17, Hawker=18, Housewife=19, Tailor= 20 and Others (specify) = 21.

Code for diseases:

Diarrhoea=1, disentry=2, dengu=3, malaria=4, skin diseases=5, mental problems=6, malnutrition/deficiencies of vitamins=7, general cold/cough/fever=8, typhoid=9, asthma=10, jaundice=11, tubeculasis/virus hepatitis=12, other=13 (please mention)

3. In what time/season, the family members being affected by different diseases ?

No.	**Time/season**	**Mention three main diseases**		
01	**Before rainy season**			
02	**During rainy season**			
03	**After rainy season**			
04	**During dry (winter) season**			

Code for diseases:
Diarrhoea=1, disentry=2, dengu=3, malaria=4, skin diseases=5, mental problems=6, malnutrition/deficiencies of vitamins=7, general cold/cough/fever=8, typhoid=9, asthma=10, jaundice=11, tubeculasis/virus hepatitis=12, other=13 (please mention)

4. Are you/family members suffering from vitamin deficiencies ? Please give tick.
Codes for vitamin : vitamin A=1, vitamin B=2, vitamin C=3, vitamin D=4, vitamin E=5, vitamin K=6

5.(a) Do you have any idea/experience of taking balanced diet ?
Yes=1, No=2

(b) What are the things present in balanced diet ?

1. 2. 3. 4. 5. 6.

(c) Malnutrition/vitamin defiencies symptoms and remedies

Vitamin	Deficiency symptoms	Vitamin rich food items	Ways of remedies
A			
B			
C			
D			
E			
K			

(d) Causes of malnutrition/vitamin deficiencies

-
-
-

6.(a) How any times take food by your family members ? Please give tick

Three times a day=1, Two times a day =2, Only one time a day =3

(b) Quantity of food intake

Plenty/enough =1, Average =2, Not enough =3

(c) Identify standard/quality of foods

Good =1, Average =2, Poor =3

(d) Intake of food items by family members during last week

Sl.No.	Food items	Quantity(enough=1 , not enough=2)	Quantity(gram/ number)	Remarks
01	Rice/bread			
02	Fish			
03	Meat			
04	Egg			
05	Vegetables			
06	Milk			
07	Fruits			
08	0thers			

7. During last 5 years, your family members were affected by any diseases ? Please give tick

Yes =1, No=2

If Yes, please mention at least three diseases

Code No.	Diseases	Main three diseases
01	Diarrohea	•
02	Dysentry	•
03	Dengu	•
04	Malaria	
05	Skin diseases	
06	Mental problems/disease	
07	Malnutrition/vitamin deficiency	
08	General cold/fever/cough	
09	Typhoid	
10	Asthma	
11	Jaundice	
12	Tuberculasis/virus hepatitis	
13	Other	

8. Among the family members, who are affected sereously ? Please give tick

Male =1, Female =2, Children (<14 years) =3,
Old (>50 years) =4 , Others =5

9. Please give your comments about the above diseases. Please give tick

Increasing diseases =1, Decreasing diseases =2, Same trend =3, Do not Know =4

10. Please mention the possible causes/reasons of the above diseases. Please give tick

i) Changes of temperature (high temperature/heat/high cold)
ii) Erratic rainfall (drought/untimely rainfall/excessive rainfall)
iii) Water pollution
iv) Drainage congestion
v) During disaster (floods/drought/cyclone/tidal surges/salinity etc)
vi) Not known
vii) Others (please specify)

11. During last 5 years, any family members were affected by climate hazards and how many times affected ? Please give tick

Sl.No.	Climate hazards	If affected, please give tick	No. Of times affected
01	Floods		
02	Droughts		
03	Cyclone		
04	Tidal surges		
05	Salinity/salt water intrusion		
06	Others (please specify)		

12. Are there any problems related human health and nutrition faced by family members during the above climate hazards in your area ?

Yes =1, No =2
If yes, please mention at least three problems related to human health and nutrition.

-
-
-

13. What were the sources of your drinking water during climate hazards ?

Sl.No.	Sources of drinking water	Prioritize the sources as 1, 2, 3
01	Tube well	
02	Deep Tube Well	
03	Rivers/Canals	
04	Ponds	
05	Rain water	
06	Mud well	
07	Others (please specify)	

14. What were the sources of water for cooking, cleaning etc of a family during climate hazards (floods, droughts, cyclone, tidal surges etc) ?

Code No.	Sources of water	Give code based on priority before hazard	Give code based on priority during hazard
1	Tube well		
2	Deep Tube Well		
3	Rivers/Canals		
4	Ponds		
5	Rain water		
6	Mud well		
7	Others (please specify)		

15. Please mention the plenty/not plenty of sources of water for drinking , cooking, cleaning etc of a household.

Type of using water	Code No.	Sources
Drinking water		
Household use (cooking etc)		

Code No. Plenty =1, Not Plenty =2

16. Are there family members being affected by health and nutritional problems due to scarcity of drinking water and cooking water in your area ?

Yes =1 No =2

If the answer is yes, please mention the health and nutritional problems due to scarcity of water.

-
-
-
-
-

17. What are the steps/devices you follow to face such health & nutritional problems ?

Code No.	**Steps/devices**	**Please give tick**
1	Nothing to do	
2	Traditional treatment	
3	Medicine shop	
4	Kabiraj/Hawak	
5	MBBS Doctor	

18. If contacted to Doctors/Health Assistants for treatment, did you tell them about the following health and nutritional problems in your area ?

Yes =1 No =2

If the answer is yes, what were the major diseases identified during last 10 years ?

Code No.	Diseases	Please mention 3 codes based on priority
1	Diarrohea	
2	Dysentry	
3	Dengu fever	
4	Malaria	
5	Skin diseases	
6	Mental disease	
7	Malnutrition/vitamin deficiency	
8	General cold/cold/fever/cough	
9	Typhoid	
10	Asthma/respiratory tract	
11	Jaundice	
12	Tuberculusis/virus hepatitis	
13	0thers (please specify)	

19. What do you mean by climate change ? or, do you have any idea about climate change ?

Code No.	Issues of climate change	Please give tick
1	Changes due to long-term causes of natural events/man made activities	
2	Temperature rise and erratic rainfall	
3	Others (please specify)	
4	Not known	

20. What are problems of climate change and what are crops being affected due to climate change ?

Code No.	Climate change issues	Please give tick	Affected crops	Rate of crop damage
1	Sea level rise			
2	Drought/moisture stress			
3	Floods			
4	Salinity/salt water intrusion			
5	Cyclone			
6	Tidal surges			
7	Others (please specify)			

Code of crop damage: High (>50 % yield loss)=1, Moderate (20-50 % yield loss) =2, Low (<20 % yield loss) =3

21. What are the main diseases come out/may come out due to climate hazards ?

Climate hazards	Please mention 3 main diseases(use code no.)		
Sea level rise			
Drought			
Floods			
Salinity			
Tidal surges			
Cyclone			
Excessive rain			
Others (please specify)			

Code for diseases:
Diarrhoea=1, disentry=2, dengu=3, malaria=4, skin diseases=5, mental problems=6, malnutrition/deficiencies of vitamins=7, general cold/cough/fever=8, typhoid=9, asthma=10, jaundice=11, tubeculasis/virus hepatitis=12, other=13 (please mention)

22. Do you think there is a relation of crop production systems/crop damage and diseases outbreak with climate change ?

Yes =1 No =2

If your answer is yes, please mention at least three reasons of causing major diseases and nutritional problems of vulnerable people of your area.

-
-
-

Comments of data/information collector:

Name of Data/Information Collector:

Signature of Supervisor with date

Annexure V

Subject of Group Discussions

FAO Project : Assessing long –term impacts and vulnerability on crop production due to climate change in the coastal areas of Bangladesh

1. Rural areas, Population, Homestead, Socio-economic conditions

    a. Source of income, Population (Male/ Female), Occupation (Service, Fisherman, Farmer, Labour, etc.)
    b. Education (Educational institutes- School/ College, Madrasha etc. Number, Percent of education)
    c. Communication system
    d. Health Service(Hospital, Clinic, Doctors, Pharmacy, Others heath facilities)

2. Weather related concept

a. Temperature: Trend of last ten years
    1. Cold- Winter duration, Variation of Temperature
    2. Hot- Summer duration, Variation of Temperature

b. Trend of Rainfall
    1. Variation of Rainfall
    2. Heavy rainfall in short duration or no rainfall for long time

3. Which kind of Hazards/ calamity/ hit/ occurred in these areas. How many times these hazard occurred/ hit and nature of its intensity during last ten years

4. Hazards types and impact on Human Health
    a. Name of diseases/ Classification.
    b. Who are mostly affected (male/ female, children) etc.
    c. Present trend of diseases is high/ low than previous

5. Lack of Vitamin due to malnutrition

6. Water Supply and sanitation system
    a. Source of Water.
    b. Quality and Quantity of water.

7. Climate Change and Health Problem
    a. What you understand by Climate Change?
    b. What kind health problem related to Climate Change?
    c. What are the ways that we could escape from this problem?

8. Illness and Treatment related
    a. Where and whom you meet for treatment if you fall in sick?

Annexure VI

Climate Change and Health Impact
In Depth Interview Guideline

Name of the Respondent:

1. Village: Union: Upazilla: Zilla:
2. Is there any deficiency of Vitamin?
3. What area the major diseases mostly affect in your family members?
4. In which season/time your family members mostly suffer from illness?
5. What area the major diseases that mostly affected in your family members last five members?
6. Who was mostly suffered /affected from illness among your family members (Male/ Female, Children)?
7. What is your comments about this diseases (high/ low than previous?)
8. What are the possible reasons of these diseases?
9. What are the hazards that affect your family members during last five years?
10. Which kind of health problem you faced/ suffered during Hazard period?
11. What was the source of drinking water during Hazard period?
12. What was the source of domestic (Cleaning, cooking, sanitary etc.) Water during Hazard (Flood, Drought, Cyclone) period?
13. Is water is available for safe drinking, cooking, sanitary purposes (sufficient/ in-sufficient)
14. Is there any health problem due to insufficient water for drinking and domestic purposes?
15. Which kind of measures you undertake/ whom you meet for treatment in case of such kind of illness?
16. Is doctor/ health worker mentioned the name of the diseases of your family members after met with them for treatment?
17. What is meant by “Climate Change”?
18. What kind of problems/ calamity created from Climate Change?
19. What kind of diseases affects mostly / may be affected in future during disaster?
20. Do you think that due to climate change people facing health problem in your area?

Name of the Interviewer: ***Date:***

Annexure -VII

App Table 1: Long term data on changes of temperatures

Salinity/Tidal Surge Prone Area (Satkhira)

Year	Rabi (max)	Rabi (min)	Kharif-1(max)	Kharif-1(min)	Kharif-2 (max)	Kharif-2 (min)
1975	29.0	15.6	34.5	25.3	32.2	25.5
1976	30.0	16.8	34.5	25.1	32.5	24.8
1977	29.6	16.8	32.9	25.1	32.4	25.3
1978	29.2	16.1	34.2	25.1	31.7	25.7
1979	29.6	17.7	35.0	26.5	32.4	25.5
1980	28.6	16.7	34.6	25.6	31.3	25.3
1981	27.6	15.6	31.8	24.8	31.8	25.1
1982	28.0	15.8	34.3	25.8	31.8	24.9
1983	28.3	15.6	33.6	25.2	31.2	24.9
1984	29.2	14.3	33.7	25.5	32.5	24.9
1985	30.3	16.3	34.7	25.5	32.8	24.9
1986	30.4	16.3	34.7	25.1	32.7	24.8
1987	30.1	16.3	35.0	25.7	33.3	25.2
1988	30.0	16.5	33.8	25.9	32.6	25.0
1989	29.0	15.5	34.4	26.1	32.2	25.4
1990	28.9	16.5	33.4	25.7	31.9	25.0
1991	28.9	16.5	34.1	26.1	32.2	25.3
1992	28.7	16.0	34.7	25.4	32.6	25.1
1993	29.4	15.9	33.6	25.2	32.2	25.2
1994	29.2	16.2	34.1	25.7	32.8	25.1
1995	28.6	15.8	34.6	26.2	32.4	24.9
1996	29.2	15.9	34.3	25.4	32.2	24.5
1997	28.5	15.8	33.5	24.3	32.4	24.3
1998	28.1	16.1	34.2	25.9	32.6	25.4
1999	29.9	15.1	34.0	24.7	31.6	23.8
2000	28.6	15.0	33.6	25.0	32.4	25.5
2001	28.6	15.7	33.1	25.2	32.5	25.8
2002	28.9	16.4	33.9	25.8	32.1	25.1
2003	27.8	15.9	34.2	26.2	32.3	26.0
2004	28.5	16.4	34.0	26.0	31.6	25.1
2005	28.7	16.6	34.8	26.2	31.8	25.6
2006	29.3	16.9	33.4	26.0	31.9	25.5
2007	27.8	16.16	33.7	26.1	32.1	25.4

Source: Meteorological Department, 2009

App Table 2: Long term data on changes of rainfall pattern

Flood prone area (Station: Rangpur)			Salinity/Tidal surge prone area (Station: Satkhira)			Drought prone area (Station: Rajshahi)		
Year	Total rainfall in Rabi	Total rainfall in Kharif	Year	Total rainfall in Rabi	Total rainfall in Kharif	Year	Total rainfall in Rabi	Total rainfall in Kharif
1978	75	2070	1978	223	1895	1978	225	1509
1979	152	1716	1979	162	1012	1979	308	1240
1980	107	2013	1980	279	324	1980	259	1317
1981	90	569	1981	297	1776	1981	240	2001
1982	78	2123	1982	138	1222	1982	189	914
1983	361	1834	1983	396	1404	1983	389	1240
1984	226	3522	1984	115	1738	1984	234	1341

Flood prone area (Station: Rangpur)			Salinity/Tidal surge prone area (Station: Satkhira)			Drought prone area (Station: Rajshahi)		
Year	**Total rainfall in Rabi**	**Total rainfall in Kharif**	**Year**	**Total rainfall in Rabi**	**Total rainfall in Kharif**	**Year**	**Total rainfall in Rabi**	**Total rainfall in Kharif**
1985	225	2657	1985	199	1305	1985	106	1075
1986	257	2007	1986	413	1782	1986	255	1255
1987	326	2921	1987	67	1549	1987	68	1259
1988	125	2399	1988	216	1747	1988	188	1040
1989	81	1797	1989	198	1172	1989	103	1222
1990	465	2022	1990	416	1512	1990	224	1543
1991	175	2088	1991	276	1492	1991	239	1259
1992	158	1849	1992	220	1288	1992	68	775
1993	196	2314	1993	320	1480	1993	271	1352
1994	179	1122	1994	122	1493	1994	211	931
1995	173	2288	1995	323	1442	1995	115	1317
1996	172	1832	1996	378	1197	1996	143	1126
1997	81	1890	1997	213	1894	1997	132	1930
1998	471	1894	1998	655	1072	1998	304	1236
1999	318	2613	1999	115	1501	1999	156	1706
2000	38	1707	2000	204	1798	2000	163	1527
2001	501	1991	2001	267	1416	2001	194	1188
2002	158	3396	2002	132	1771	2002	96	1349
2003	504	1898	2003	566	1171	2003	383	1029
2004	535	2145	2004	250	1783	2004	163	1623
2005	662	2191	2005	620	1362	2005	394	1011
2006	156	1526	2006	87	1914	2006	53	1092
2007	213	1824	2007	409	1463	2007	163	1855

Source: Meteorological Department, 2009

App Table 3: **Trend of crop production (t/ha) at Satkhira district due to climate change**

Yield (Ton/hactore)

Year	T aman (HYV)	T aman (local)	Boro (HYV)	Wheat	Potato	Jute
1990	2.7	1.4	4.1	2	15.7	10.4
1991	2.6	1.4	3.2	2.1	15.1	10
1992	2.6	1.3	2.8	2.2	12.7	11
1993	2.6	1.6	3	2.2	18.3	10.6
1994	2.5	1.5	3.2	2.6	17.9	11
1995	2.6	1.2	3.2	2	17	11
1996	2.3	1.4	3.2	2.2	16.4	11.6
1997	2.2	1.2	3.2	2.2	12.5	10.7
1998	2.4	1.3	3.4	2.2	12.7	11.5
1999	2.8	1.6	3.1	2.1	14	11
2000	1.82	1	3.8	2.1	17.5	11.4
2001	2.7	1.1	3.4	2.2	17.5	11.7
2002	2.6	1.4	3.5	2.4	17	10.4
2003	2.6	1.5	3.4	2.4	17.4	11.6
2004	2.3	1.4	3.6	1.7	14.6	12.3
2005	2.9	1.6	3.5	1.7	15.3	11.4
2006	2.7	1.6	3.8	1.6	13.4	10.5
2007	2.3	1.3	3.8	2.2	13.6	11
2008	2.7	1.5	3.6	2.2	12.5	

Year	Mustard	Sesame	Lentil	Mung bean	Onion	Chillies
1990	0.7	1.1	1.2	0.8	7.7	
1991	0.7	1.1	0.7	0.7	8.1	
1992	0.7	1.0	0.9	0.7	15.4	
1993	0.7	0.8	0.7	0.8	12.0	
1994	0.8	1.0	0.9	0.7	10.8	
1995	0.7	1.6	0.5	0.7	11.3	
1996	0.7	1.1	0.6	0.8	14.7	
1997	0.9	1.2	0.7	0.8	15.0	
1998	0.8	0.8	0.7	0.8	14.0	
1999	0.8	1.0	0.8	1.0	9.8	
2000	0.9	0.9	0.8	1.2	4.3	4.6
2001	0.9	0.9	0.8	0.7	10.4	2.5
2002	0.9	0.8	0.2	0.6	8.0	1.8
2003	1.1	1.0	0.9	0.8	8.5	8.4
2004	1.0	0.9	1.0	0.8	8.1	7.4
2005	1.2	1.1	1.1	1.0	8.5	6.7
2006	1.0	1.0	0.8	0.9	7.2	6.1
2007	0.9	1.0	0.9	0.8	8.0	7.0
2008	1.1	1.0	0.8	1.0	6.0	1.4

Annexure IX

Salinity Data

App Table 4: Estimation of Salt affected areas (in '000' ha) in Coastal Region

District	Year	Salinity Level*				Salinity increase over 4 decades		Remarks
		S_1	S_2	S_{3*}	S_4	Area (000'ha)	%	
Khulna	1973	3.90	92.54	13.95	9.80	21.39	17.80	Batiaghata, Dacope, Dumuria, Koyra, Digholia, Paikgacha
	2000	29.04	38.32	59.49	19.61			
	2009	24.64	26.88	47.78	30.57			
Bagerhat	1973	8.30	77.08	3.60	0	48.03	53.98	Chitalmari, Fakirhat, Kachua, Mongla, Rampal
	2000	35.66	42.56	41.23	6.74			
	2009	32.33	42.48	52.96	9.24			
Satkhira	1973	26.50	85.60	34.50	10.90	4.76	3.02	Asasuni, Debhatta, Kaliganj, Shyamnagar
	2000	29.03	39.01	60.55	22.01			
	2009	31.00	32.96	69.72	28.58			
Pirojpur	1973	20.40	1.90	0.00	0.00	13.53	60.67	Bhandaria, Mathbaria, Nazirpur
	2000	22.93	6.05	2.43	0.00			
	2009	23.11	9.94	2.78	0.00			
Barisal	1973	0.00	0.00	0.00	0.00	0	-	Agailjhara, Ujirpur
	2000	2.35	2.70	0.00	0.00			
	2009	8.12	2.54	0.70	0.00			
Bhola	1973	9.18	30.81	0.00	0.00	54.58	136.48	Burhanuddin, Charfession, Monpura, Lalmohan
	2000	32.44	33.70	26.13	5.27			
	2009	42.11	28.84	20.62	3.00			
Paltuakhali	1973	68.50	46.60	0.00	0.00	43.28	37.60	Galachipa, Kalapara, Sadar, Dashmina
	2000	40.11	43.62	46.10	9.52			
	2009	57.73	39.90	44.98	15.77			
Barguna	1973	96.39	7.20	0.00	0.00	-2.67	-2.58	Amtali, Patharghata, Sadar
	2000	37.22	30.77	33.47	3.77			
	2009	32.11	30.90	32.60	5.31			
Noakhali	1973	6.30	39.90	1.80	0.00	4.52	9.42	Hatiya, Sudharam (Sadar)
	2000	13.04	16.93	15.83	7.75			
	2009	15.36	13.33	22.21	1.62			
Cox's Bazar	1973	7.20	16.20	17.30	14.00	1.65	3.02	Chakoria, Maheshkhali, Teknaf
	2000	2.83	11.08	35.55	10.50			
	2009	2.81	13.63	33.84	6.07			
Grand Total	**1973**	**246.67**	**397.83**	**71.15**	**34.7**			
	2000	**244.65**	**264,74**	**320.78**	**85.17**	**189.07**	**26.71**	**Above mentioned Upazilas**
% Increase	**2009**	**269.32**	**241.4**	**339.9**	**100.16**			

* S_1 *= 2.0 – 4.0 ds/m,* S_2 *= 4.1 – 8.0 ds/m,* S_3 *= 8.1 – 16.0 ds/m,* S_4 *= >16.0 ds/m*

App Table 5: Upazila-wise Estimation of Salt affected areas (in '000' ha) of Satkhira district

Upazila	Year	Salinity Level*				Total	Remarks
		S_1	S_2	S_3	S_4		
Asasuni	1973	0.90	7.43	8.30	18.13	34.76	Salinity, tidal surge
	2000	0.91	7.46	8.32	18.11	34.8	
Debhatta	1973	2.72	3.61	2.70	4.12	13.15	
	2000	2.77	3.65	2.85	4.20	13.47	
Kalaroa	1973	1.21	0.53	-	-	1.74	
	2000	1.47	0.74			2.21	
Kaliganj	1973	4.61	10.25	3.41	6.78	25.05	
	2000	4.70	16.44	4.10	9.84	35.08	
Satkhira(S)	1973	7.14	6.31	1.47	1.04	15.96	
	2000	7.30	6.40	1.57	1.14	16.41	
Shymnagar	1973	2.45	6.80	5.70	22.77	37.72	
	2000	2.36	6.78	5.90	23.87	38.91	
Tala	1973	6.40	6.45	1.52	0.30	14.67	
	2000	7.52	6.51	1.63	0.46	16.12	
Total	1973	25.43	41.38	23.1	53.14	143.05	
	2000	27.03	47.98	24.37	57.62	157.00	

* S_1 = 2.0 – 4.0 ds/m, S_2 = 4.1 – 8.0 ds/m, S_3 = 8.1 – 16.0 ds/m, S_4 = >16.0 ds/m

Annexure X

App. Table 6: Percentage Distribution of Households Surveyed for Assessing Causes of Poverty and Food Insecurity

Causes of Poverty and Food Security	Study Area									
	Barisal	**Bagerhat**	**Bhola**	**Borguna**	**Cox's Bazar**	**Khulna**	**Noakhali**	**Patuakhali**	**Pirojpur**	**Satkhira**
Low wage	3.1	1.0	1.7	1.4	3.0	2.3	1.1	0.4	3.1	2.0
Insufficient income	7.8	8.8	7.4	12.3	10.3	9.1	8.1	10.4	9.2	7.6
Landless	2.3	1.4	2.6	4.7	7.8	2.1	4.2	1.2	3.8	1.7
Lack of job	4.2	3.2	3.4	6.3	7.2	5.3	4.4	2.3	4.9	4.3
Disabled people	1.6	1.8	1.5	1.1	2.5	1.6	0.7	1.8	0.9	0.5
Impact of climate change	10.3	11.1	13.9	11.6	8.2	12.0	10.4	15.4	10.2	9.5
Natural disaster	11.4	12.5	12.5	12.9	10.0	11.6	10.2	14.0	11.1	10.8
Crop loss/damage	15.9	15.8	14.3	12.3	11.7	15.8	17.3	13.2	13.2	18.9
High price of daily food	6.3	8.7	4.1	2.4	4.3	4.6	5.6	6.8	3.6	5.6
Low market price of commodity	4.8	5.2	7.6	0.7	0.4	3.5	5.7	2.7	7.0	6.1
Lack of agricultural education/awareness	1.9	1.4	2.8	4.1	4.8	1.4	2.4	0.5	3.1	1.7
Low crop productivity	10.6	9.2	8.9	7.6	5.9	10.2	10.0	8.5	10.2	8.9
Low fertility of land	7.8	9.1	7.7	7.3	7.5	6.9	9.1	7.5	6.1	7.8
Lack of nutrition and health	6.4	5.3	5.0	5.9	4.9	6.0	6.3	6.5	6.3	6.5
Widow/separated from household head	-	0.3	0.4	0.2	1.6	-	0.2	0.3	0.4	0.4
More marriage	-	-	0.1	0.1	0.3	-	-	0.1	0.1	0.2
Court case	0.8	1.3	1.0	0.2	2.8	1.5	0.2	1.8	0.7	0.9
Disease	3.3	3.5	4.0	8.0	4.6	5.5	2.9	5.8	4.9	5.3
Fraud	-	-	0.2	0.2	0.6	0.1	0.2	0.3	0.1	0.2
Drug addicted	-	-	0.1	0.1	0.3	-	-		-	-
Laziness	-		0.4	-	0.9	0.1	0.2	0.1	0.2	-
Political crisis	1.2	0.3	0.3	0.5	0.3	0.2	0.8	0.3	0.6	0.8
Others	0.3	0.1	0.1	0.1	0.1	0.2	-	0.1	0.3	0.3
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Annexure XI

Project Completion Workshop on *"Assessing long term impacts and vulnerabilities on crop production due to Climate Change in the costal areas of Bangladesh"*

Venue	:	Aristocrat, House -16, Road-15, Gulshan-1, Dhaka -1212.
Date	:	0 June, 2010
Time	:	09:30 hrs to 15:30 hrs
Chief Guest	:	Mr. Mirza Fazlul Karim, Director General, FPMU, MoFDM.
Special Guest	:	Dr. M. Eusuf Miah, Director General, BARI, Joydebpur, Gazipur
Chairperson	:	Dr. A. Atiq Rahman, Executive Director, BCAS
Key Note Speaker	:	Dr. Md. Muslem Uddin Miah, Senior Agriculture Specialist, BCAS and Principal Investigator of the Project
Organized By	:	BANGLADESH CENTRE FOR ADVANCED STUDIES House #10, Road #16A, Gulshan-1, Dhaka-1212

Sl No.	Name of the Participants	Designation	Organization
1	Mr. Mirza Fazlul Karim	Director General, FPMU, MoFDM	Ministry of Food and Disaster Management
2	Dr. A. Atiq Rahman	Executive Director,	Bangladesh Center for Advance Studies (BCAS)
3	Dr. Md. Muslem Uddin Miah	Senior Agriculture Specialist	BCAS
4.	Dr. Md. Yusuf Miah	Director General	BARI
5.	Dr. A.K.M.Habibur Rahman	SSO(OFRD),ARS	BARI, Benarpota Farm, Satkhira
6.	Dr. M. Moznur Rahman	Director (Research)	BARI
7.	Md. Soeb Hasan	CSO	BARI, Gazipur
8.	Dr. Md. Syedul Islam	ASR & CSO	BRRI
9.	Dr. Md. Fazlul Hoque	Ex CSO	OFRD, BARI
10.	Dr. Pijush Kanti Sarkar	PSO & Head, IWM Division	BARI, Gazipur
11.	Dr. Abul Kasem Chowdury	Professor	Patuakhali Science & Technology University
12.	Md. Anwar Hossain	PSO	SRDI, Dhaka
13.	Shamim Al Mamun	Lecturer	Mawlana Bhasani Science & Technology University
14.	Md. Nazrul Islam	Principal Scientific Officer	SRDI, Dhaka
15.	Dr. Anwar Hossain	Agriculture Specialist	BCAS
16.	Md. Rafiqul Islam	Ph.D Fellow & Senior Cartographer	SRDI, Dhaka
17.	Md. Ikbal Hossain	Co- Investigator of the Project	BCAS
18	Md. Belayet Hossain	Senior Research Officer	BCAS
19	Dr.Nur Ahmed Khondaker	Res. Grant Admnistrator	NFPCSP-FAO
20	Dr. Rezaul Karim Talukder	TAT Member	NFPCSP-FAO
21	Dr. Lalita Bhattacharji	TAT Member	NFPCSP-FAO

Project Completion Workshop on *"Assessing long term impacts and vulnerabilities on crop production due to Climate Change in the costal areas of Bangladesh"*

Venue : DD/DAE Conference Room, Khulna.
Date : 19 September, 2010
Time : 09:30 hrs to 15.30 hrs
Chief Guest : Mr. Md. Bazlul Haque, Addl. Director, DAE, Jessore Region
Chairperson : Mr. Makhan Lal Das, DDAE, Khulna.
Key Note Speaker : Dr. Md. Muslem Uddin Miah, Senior Agriculture Specialist, BCAS and Principal Investigator of the Project
Organized By : BANGLADESH CENTRE FOR ADVANCED STUDIES
House #10, Road #16A, Gulshan**-1, Dhaka-1212**

Sl No.	Name of the Participants	Designation	Organization
1	Mr. Makhan Lal Das	DAAE, Khulna	DAE, Khulna
2	Ashit Kumar Saha	PPS	DAE, Khulna
3	Md. Rafiquzzaman	DD/DAE	Satkhira
4.	Mr. Biplob Kumar Saha	DD/ADAE	Jessore
5.	Md. Bazlul Haque	Additional Director, DAE	DAE, Jessore Region
6.	Khandaker J.K. Saha	Horticulturist	DAE, Khulna
7.	Kazi Anisuzzaman	CPS	DAE, Khulna
8.	Md. Hafizur Rahman	UAO Dighalia, Khulna	DAE
9.	Bevash Chandra Saha	UAO Paikgacha, Khulna	DAE
10.	Sudhendu Shekar Malakat	UAO	DAE, Khulna
11.	Inty Brut Nag	UAO Rupsa, Khulna	DAE
12.	Arabinda Biswas	UAO Koyra, Khulna	DAE
13.	KBD Pankaj Kanti Majumder	UAO Koyra, Khulna	DAE
14.	KBD S M Ferdous	Metro Agriculture Officer	Khulna, DAE
15.	G.M.Mostafizur Rahman	Scientific Officer	DAE, Khulna
16.	Md. Nazrul Islam	UAO Dacope, Khulna	DAE
17.	Md. Motaher Hossain	AEO	DAE
18	Md. Joinal Abedin	Scientific Officer	SRDI, Khulna
19	Badal Chandra Biswas	UAO	Fultala, Khulna
20	Md. Kayem Uddin	DDAE	Bagerhat
21	Dr. Prashanta K. Sardar	SSO	BARI, Khulna
22	SK Abu Hassan Sarkar	ED	Mukto Alo, Khulna
23	Q.S.Islam Mukto	CEO	Pathikrit, Khulna
24	Shanazz Shovan	Agriculture Engineer	DAE, Khulna
25	Fazlul Haque	UAO	Shorankhola, Bagerhat
26	Ashok K. Sharma	UAO	Fakirhat, Bagerhat
27	Md. Nurul Isalm	UAO	Assasuni, Satkhira
28	Md. Abdul Latif	UAO	Kalaroa, Satkhira
29	Sheikh Amunul Haque	UAO	Tala, Satkhira
30	G.M.A Gafur	UAO	Dedhata, Satkhira
31	Md. Nurul Islam	AEO	Kaligonj, Satkhira
32	Dipok Kumar Roy	UAO	Sadar, Satkhira

Sl No.	Name of the Participants	Designation	Organization
33	Kazi Jahangir Hossain	UAO	Mollahat, Bagerhat, DAE
34	Khandaker Moazzam Hossain	UAO	Kachua, Bagerhat,DAE
35	Md. Aftab Uddin	UAO	Sadar, Bagerhat, DAE
36	Md. Abdul Gani	AAEO	Morelgonj, Bagerhat, DAE
37	Gonesh Chandra Mondol	CPS	Satkhira, DAE
38	Md. A.Aziz Farazi	CPS	Bagerhat, DAE
39	Schindra Nath Gain	PPS	Bagerhat, DAE
40	Sheikh Md. Shahiduzzama	UAO	Mongla, Bagerhat
41	Sheikh Iftekher Hossain	HS	Satkhira
42	Dr. AKM Habibur Rahman	PSO	BARI, Satkhira
43	Rabindranath Biswas	PO (Agr.) SADP	WVB
44	Md. Hasan Warisul Kabir	UAO	Chitalmari, Bagerhat
45	Narayan Chandra Kundu	UAO	Rampal, Bagerhat
46	Md. Ali Hasan	UAO	Symnagar, Satkhira
47	Md. Jashim Uddin	AEO	Metropolitan, Khulna
48	Dr. Muslem Uddin Miah	Principal Investigator of the Project	BCAS
49	Mohammed Ikbal Hossain	Senior Research Officer	BCAS
50	Ms. Ranu Begum	Accounts Officer	BCAS

Project Completion Workshop on *"Assessing long term impacts and vulnerabilities on crop production due to Climate Change in the costal areas of Bangladesh"*

Venue : DD/DAE Conference Room, Barisal.
Date : 21 September 2010
Time : 09:30 hrs to 15:30 hrs
Chief Guest : Mr. Shah Alam, Addl, Director, DAE, Barisal Region
Special Guest ; Mr, Tariq Hassan, Ex. Director General, DAE
Chairperson : Mr. Bikash Indu Mondol, DD/DAE, Barisal.
Key Note Speaker : Dr. Md. Muslem Uddin Miah, Senior Agriculture Specialist, BCAS and **Principal Investigator of the Project**
Organized By : BANGLADESH CENTRE FOR ADVANCED STUDIES

Sl No.	Name of the Participants	Designation	Organization
1	Mr. Bikash Indu Mondol	DD	DAE, Barisal
2	Dr. Musherref Husain	Consultant	FAO
3	Professor Sultan Uddin Bhuiyan	Consultant	FAO
4.	Nikhil Ranjan Mondol	DD	DAE, Patuakhali
5.	Md. Shah Alam	Addl. Director	DAE, Barisal Region
6.	Mojibul Haque	HS	DAE, Barisal
7.	A.T.M. Shahidul Islam	DTG	DAE, Barisal
8.	Md. Lutfar Rahman	PPS	DAE, Barisal
9.	A.KM. Monirul Alam	UAO	Sadar, Barisal
10.	Humayun Kabir	UAO	DAE, Barisal
11.	Tushar Kanti Samaddar	UAO	Bakergonj, Barisal,DAE
12.	Md. Abdul Mannan	CPS	Barisal, DAE
13.	Ramendra Nath Barai	UAO	Aggailjhara, Barisal,DAE
14.	Md. Farhad Hossain	UAO	Hizla, Barisal ,DAE
15.	Haridas Sikari	UAO	Banaripara, Barisal ,DAE
16.	M.M.Mahmud Hasan	UAO	Muladi, Barisal ,DAE
17.	M.Jalilur Rahman	UAO	Mehendigonj, Barisal ,DAE
18	Ratan Kumar Mondol	UAO	Gouranadi, Barisal ,DAE
19	Md. Sajedur Rahman		Barisal ,DAE
20	Khairul Islam	AEO	Sadar Barisal ,DAE
21	Md. Moshiur Rahman	Agr. Engineer	Sadar Barisal ,DAE
22	Alamgir Biswas	UAO	Uzirpur, Barisal,DAE
23	Mrinal Kanti Das	DD	Pirojpur,DAE
24	Md. Abdul Amin	UAO	Sadar, Pirojpur,DAE
25	Md. Shahidullah	UAO	Madbaria Pirojpur,DAE
26	Hridayeshwar Datta	UAO	Nesarabad,DAE
27	Ramesh Chandra Brahman	UAO	Kawkhali,DAE
28	Amitav Mondol	UAO	Zianagar, Pirojpu,DAE
29	Mr. Quddus Akand	UAO	Bhandaria, Pirojpur,DAE
30	Sushech Mistry	AAEO	Nazirpur,DAE
31	Dr. Md. Habibullah	CSO, RARS	Barisal,DAE
32	Md. Golam Mannaf	Horticulture Specialist	Patuakhali,DAE
33	Santi Ranjan Mondol	Plant Protection Specialist	Patuakhali,DAE

Sl No.	Name of the Participants	Designation	Organization
34	Md. Shahjahan	UAO	Mirzagonj,DAE
35	Mohammed Alauddin	UAO	Dashmina, Patuakhali,DAE
36	Abu Huda Md. Jafar	UAO	Sadar, Patuakhali,DAE
37	Md. Matiur Rahman	UAO	Dumki, Patuakhali,DAE
38	Md. Fazlul Haque	UAO	Bauphal, Patuakhali,DAE
39	Sanjib Mridha	AEO	Dashmina, Patuakhali,DAE
40	Sabinay Chowdhury Paik	SAPPO	Kalapara, Patuakhali,DAE
41	Abu Jafar	Field Monitoring Officer	IFDC, Patuakhali
42	Md. Sabbir Hossain	SSO,	SRDI, Patuakhali
43	Md. Harun ur-Rashid	UAO	Sadar, Patuakhali,DAE
44	Abdul Razzak	UAO	Bamna, Barguna.DAE
45	Santosh Chandar Mondol	UAO	Amtali, Barguna,DAE
46	Md. Nurul Islam	UAO	Amtali, Barguna,DAE
47	S.M.Badrul Alam	UAO	Pathargata, Barguna,DAE
48	Md. Nazmul Karim	PPS	Barguna,DAE
49	Dr. Md. Shahidul Islam	SSO & Head BRRI	Barisal
50	Dr. Muslem Uddin Miah	Principal Investigator of the Project	BCAS
51	Mohammed Ikbal Hossain	Senior Research Officer	BCAS
52	Ms. Ranu Begum	Accounts Officer	BCAS
53	Mr. Tariq Hassan	Consultant	FAO
54	Dr. M. Shahjahan	Consultant	FAO

Project Completion Workshop on *"Assessing long term impacts and vulnerabilities on crop production due to Climate Change in the costal areas of Bangladesh"*

Date **: 23 September 2010**
Time **: 09:30 hrs to 15:30 hrs**
Venue **: DD/DAE Office Conference Room, Bhola**
Key Note Speaker **: Dr. Md. Muslem Uddin Miah, Senior Agriculture Specialist, BCAS** and **Principal Investigator of the Project**
Chairperson **: Mr. Afsar Ali Khan, Deputy Director (Agril. Extension), Bhola**
Organized By **: BANGLADESH CENTRE FOR ADVANCED STUDIES House #10, Road #16A, Gulshan-1, Dhaka-1212**

Sl No.	Name of the Participants	Designation	Organization
1	Mr. Afsar Ali Khan	DDAE	DAE, Bhola
2	Dr. Musherref Husain	Consultant	FAO
3	Sunil Chandra Dhae	PPS	DAE, Bhola
4.	Md. Imam Ali Saha	H.S	DAE, Bhola
5.	Md. Ziaul Islam	UAO	Sadar, Bhola
6.	Md. Nazrul Islam Matabber	UAO	Lalmohon, Bhola, DAE
7.	Md. Anisur Rahman	AM	BRAC, Bhola
8.	Md. Abdullah Al Mamun	Programme Officer	Muslim AID
9.	Swapan Kumar Khan	UAO	Daulatkahn, Bhola, DAE
10.	Binoy Krishna Devnath	UAO	Tajumuddin, Bhola, DAE
11.	Sharif Md. Ismail Hossain	UAO	Borhanuddin, Bhola,DAE
12.	Monotosh Sikder	UAO	Charfesson, Bhola,DAE
13.	Muhammad Ali Jinnah	UAO	Monpura, Bhola,DAE
14.	Md. Asaduzzaman	Business Development Officer	International Development Enterprise (IDE)
15	Dr. Muslem Uddin Miah	Principal Investigator of the Project	BCAS
16	Mohammed Ikbal Hossain	Senior Research Officer	BCAS
17	Ms. Ranu Begum	Accounts Officer	BCAS

Project Completion Workshop on "*Assessing long term impacts and vulnerabilities on crop production due to Climate Change in the costal areas of Bangladesh*"

Venue : **DD/DAE Conference Room, Cox's Bazar.**
Date : **28 September 2010**
Time : **09:30 hrs to 15:30 hrs**
Chairperson : **S.M.Hafiz Golam Kibria, DD/DAE, Cox'Bazar.**
Key Note Speaker : **Dr. Md. Muslem Uddin Miah, Senior Agriculture Specialist, BCAS** and **Principal Investigator of the Project**
Organized By : **BANGLADESH CENTRE FOR ADVANCED STUDIES, Dkaka**
House #10, Road #16A, Gulshan-1, Dhaka-1212

Sl No.	Name of the Participants	Designation	Organization
1	S.M.Hafiz Golam Kibria,	DDAE	DAE, Cox'Bazar
2	Dr. Nur Ahamed Khondaker	Research Grant Administrator (RGA)	FAO
3	Kamrun Nahar	Sub- Assistant Director	BADC
4.	Showrav Das	SSAO	Ramu, Cox's Bazar, DAE
5.	Amdadul Islam	SSAO	Moheshkhali, Cox's Bazar
6.	Md. Imar Hossain	SA	Sadar, Cox's Bazar
7.	Jogesh Chandra Paul	SSAO	Chakaria, Cox's Bazar
8.	Md. Nazem Uddin	SAPPO	Pekua, Cox's Bazar
9.	Md. Fazlul Bari	UAO	Ukhiya, Cox's Bazar
10.	Mohammed Harun	APO	YPSA, Cox's Bazar
11.	Uttam Kumar Bhoimik	Deputy Manager	ASA, Cox's Bazar
12.	Md. Atiq Ullah	UAO	Kutubdia, Cox's Bazar
13.	Md. Abdul Gafur Mollah	UAO	Teknaf, Cox's Bazar
14.	Abul Kalam	PPS	Cox's Bazar
15	Md. Yousuf Bhuiyan	UAO	Sadar, Cox's Bazar
16	Md. Shah Alam	Horticulture Development Officer	DAE, Cox's Bazar
17	Dr. Muslem Uddin Miah	Principal Investigator of the Project	BCAS
18	Mohammed Ikbal Hossain	Senior Research Officer	BCAS
19	Ms. Ranu Begum	Accounts Officer	BCAS

Project Completion Workshop on *"Assessing long term impacts and vulnerabilities on crop production due to Climate Change in the costal areas of Bangladesh"*

Venue : **DD/DAE Conference Room, Noakhali.**
Date : **30 September 2010**
Time : **09:30 hrs to 15:30 hrs**
Chief Guest : **Professor Sayedul Hoque Chowdhury, Vice Chancellor, Noakahli University of Science & Technology (NUST), Noakhali.**
Key Note Speaker : **Dr. Md. Muslem Uddin Miah, Senior Agriculture Specialist, BCAS** and **Principal Investigator of the Project**
Chairperson :**Mr. Rafiqul Islam, Deputy Director (Agril. Extension), Noakhali**
Organized By : **BANGLADESH CENTRE FOR ADVANCED STUDIES, Dkaka House #10, Road #16A, Gulshan-1, Dhaka-1212**

Sl No.	Name of the Participants	Designation	Organization
1	Professor Sayedul Hoque Chowdhury	Vice Chancellor	NUST
2	Dr. Nur Ahamed Khondaker	Research Grant Administrator (RGA)	FAO
3	Md. Rafiqul Islam	DDAE	DAE, Noakhali
4.	Mostaque Ahmed	CPS	DAE, Noakhali
5.	Mds. Mahbubur Rahman	UAO	Senbag, Noakhali
6.	Md. Nurul Islam	AAEO	Sonaimuri, Noakhali
7.	Mushfiqur Rahman	Manager	Sagorika Samaj Unnayan Sangasta (SSUS), Noakhali
8.	Md. Hasan Uddin	Regional Officer (Accounts & Audit)	Dip Unnayan Sangyasta, Noakhali
9.	Aminul Haque Chowdhury	UAO	Sadar, Noakhali
10.	Md. Nasir Uddin	UAO	Kabirhat, Noakhali
11.	A.S.M. Abul Khair	Plant Protection Specialist	DAE, Noakhali
12.	D.K.Roy Chowdhury	AAEO	Begumgonj, Noakhali
13.	Puspendu Barua	UAO	Companygonj, Noakhali
14.	Md. Enamul Haque	SO	BARI, Noakhali
15	Dr. M. Amir	PSO	BARI, Noakhali
16	Md. Amir Faisal	SO	OFRD,BARI, Noakhali
17	Md. Mozammal Haque	Director	ATI, Noakhali
18	Dr. M.M.U.Chowdhury	SSO	OFRD,BARI, Noakhali
19	Zahir Ahamed	UAO	Chatkhil, Noakhali
20	Md. Jalal Uddin	SSO	SRDI, Noakhali
21	Srinibas Devnath	UAO	Subarnachar, Noakhali
22	Dr. Muslem Uddin Miah	Principal Investigator of the Project	BCAS
23	Mohammed Ikbal Hossain	Senior Research Officer	BCAS
24	Ms. Ranu Begum	Accounts Officer	BCAS

PHOTOGRAPHIC RECORD OF THE PROJECT ACTIVITIES

PHOTOGRAPHIC RECORD OF THE PROJECT ACTIVITIES

FGD at Barisal

Floating Bed Agriculture at Barisal

HH Survey on health and Nutrition at Barisal Sadar

W0men Farmers Making doula for floating beds at Pirojpur

Collection of Soil samples from Patuakhali

FGD at Patuakhali

Farmers making Sorjan beds at Pirojpur

FGD at Barguna

Grazzing Field at Noakhaki

Char Land at Noakhali

Field visit at Cox's Bazar (sorjan system)

Salinity and soil cracking at Dumuria, Khulna

Chief Guest addressing his speech in the Project Completion Workshop at Dhaka 10 June, 2010

Participants of Project Completion Workshop at Dhaka 10 June, 2010

Key Note Speaker (Dr. M.U.Miah) Presenting his Draft Final Report at Dhaka on 10 June, 2010

ED, BCAS addressing his speech in the Project Completion Workshop at Dhaka 10 June, 2010

Regional Workshop at Khulna on 19 September, 2010

Regional Workshop at Khulna in 19 September, 201020102010

Regional Workshop at Barisal in 21 Sep, 2010

Regional Workshop at Barisal in 21 Sep, 2010

District Workshop at Bhola in 23 Sep, 2010

Districtl Workshop at Bhiola in 23 Sep, 2010

District Workshop at Cox's Bazar in 28 Sep, 2010

District Workshop at Cox's Bazar in 28 Sep, 2010

DDAE, Noakhali, VC NUST and FAO RGA seen in the Audience at Workshop Noakhali in 30 Sep, 2010

VC, NUST and FAO RGA at Workshop, Noakhali in 30 Sept, 2010

Participants of the Workshop Noakhali in 30 Sep, 2010

VC, NUST, FAO, RGA, DDAE and BACS Principal Investigator of the Project at Workshop in Noakhali in 30 Sept, 2010