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Peception of Farmer's for impact of Climate Change on Crop Production and Adpatation Practices in South-Eastern Coast of Bangladesh

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Abstract

Coastal people of Bangladesh have been experiencing from lower crop productivity and fewer cropping intensity becasue of different climatic vulnerabilities. The research work was carried out in Banskhali upazila of Chattogram district and Teknaf of Cox's Bazar district to assess the impact of climate change on crop production process and to suggest suitable coping strategies and adaptation options for advancing the coastal agriculture for increased agricultural production. To attain the objectives of the research, the author were collected randomly 240 sampled respondents using pre-tested interview schedule. Participants stated that the current climate in the study area behaving differently than in the past on a number of climate risk factors like increased temperature, frequent drought, changes in seasonal rainfall pattern, long dry spells, increase of soil salinity, increase of tidal surges affecting crop production. 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 (20-40 % 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 (40-60 % yield loss) by soil wetness, excessive rainfall and water-logging in the selected areas. Sorjan system of cropping, rice-fish dual culture, utilization of bunds as vegetables/spices production in gher areas, floating bed agriculture and homestead gardening with introduction of salt-tolerant & drought tolerant crop varieties have been identified as potential adaptation options for development of coastal agriculture for increased agricultural production in attaining food security.

Key word: climate change, crop production, adaptability, food security.

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Introduction

Climate change is considered as the most critical global challenge of the century. It is predicted that global temperatures will increase further between 1.4 and 5.80 C by 2100. Sea level rise, polar ice melting, glacier melting, extreme weather events such as storms, ?oods, droughts and heat waves, changes in morphology, physiology, phenology, reproduction, species distribution, community structure, ecosystem and species evolutionary processes in marine, freshwater and terrestrial biological systems, change in crop production patterns, spread of infectious diseases and pests are some of the incidences likely to happen as a result of climate change (IPCC 2007; Barua et al., 2011; Barua and Rahman, 2017: Barua et al., 2017; Barua and Rahman, 2019)

Impacts of climate change on food production are global concerns, but it represent a particular threat for Bangladesh. Agriculture is already under pressure mainly due to an increase in demand for food, as well as to depletion of land and water resources. The prospect of global climate change makes this problem a priority for Bangladesh. Climate change further threatens food security. Higher temperature and water stress due to heat would result in decline in vegetation and agricultural production.

Bangladesh is predominantly an agricultural country. She is one of the densely populated countries having about 160.0 million of people in its 1, 47.570 square kilometer of area (BBS, 2010). The geographical location and geological setting of Bangladesh renders it one of the most disaster prone countries of the world (FAO, 2006). As a result of its natural set up, the country is highly vulnerable to almost all type of disasters i.e. floods, cyclones, droughts, tidal surges, tornadoes, earthquakes etc (Ali, 1996).

Changing climate is having its impact evident in different parts of Bangladesh, especially in eco- sensitive zones like coastal, drought and flood prone areas. Though the climate change is adversely affecting each and every sector, their impacts are going to be much higher on agriculture sector, worst affecting the agriculture dependent livelihood resources (LACC, 2008). The IPCC estimates that by 2050 rice production in Bangladesh could decline by 8% and wheat by 32% (against a base year of 1990) due to higher temperature and higher CO2 concentration (IPCC, 2001). As Climate change is going to have worst impact on livelihood, mainly in agriculture sector of Bangladesh (accounting for about 35% of the GDP and engaging more than 63% country population), it is needed that

special and immediate attention be paid to the sector to ensure food security and livelihood to a major portion of national population, which obviously is more vulnerable to adverse impacts of climate change (BBS, 2005). 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. There is dearth of research in the field to get the actual scenario of the problems. So, the researcher made an attempt to identify the real consequences of climate change in the coastal saline areas. Considering the above circumstances, the present study entitled "Farmer's Perception towards Impact of Climate Change on Crop Production and Their Adaptation Practices in Selected Coastal Saline Areas of Bangladesh" was undertaken with following objectives.

- To assess the farmers perception towards magnitude and trends of climate change during past 10 years.
- To identify and assess the different risk factors with extent and severity of affecting crop production systems in the coastal region.
- To investigate and explore the extent of adoption of the adaptive technologies to combat the changed climatic effect.

Methodology

Study Area

In order to study the climate change patterns and effects in coastal saline regions, two upazila namely Teknaf upazila of Cox's Bazar district and Banskhali Upazila of Chattogram district in the south-western region of Bangladesh were selected as the locale of the project.

Sample size and sampling technique

Two Union from each upazila were selected randomly. A list of all farm households of the selected unions were collected from the concerned Upazila Agricultural Extension office with the help of Sub Assistant Agriculture Officers (SAAOs). From the list 240 farmers were selected (60 from each union) as a sample of the project following simple random sampling technique.

Data collection

Primary data were collected through a intensive household survey and through the application of different RRA (Rapid Rural Appraisal) tools such as focus group discussion, key informants interview, crop calendar and direct eld observation. Focus group discussions was conducted to crosscheck and generate information on farmers' experiences of climate change, problems in farming practices, their indigenous knowledge systems and the different adaptation measures adopted. Household surveys were conducted with structured interview schedule to gather detailed information on farmers' perception of climate change and on their adaptation measures.

Analysis of the data

Data collected from both meteorological stations and household survey was analyzed by using the Statistical Package for Social Science (SPSS) and Microsoft excel. Qualitative information such as farmers' experiences regarding climate change and adaptation measures taken on their farmland collected from key informants interviews and local level institution were analyzed manually, both by the researcher and in conjunction with the villagers, and interpreted in relevant chapters to complement and supplement the quantitative information collected from household interviews and the meteorological stations.

Results and discussion

Climate Change Scenario

Change of climate particularly temperature and rainfall of the study area was examined through analysis of long-term meteorological data base and perception of the local community respondents.

Evidences from database

The evidences of climate change over time were documented through

analysis of long-term (1950-2010) climatic data of monthly temperature and rainfall to find out the trend of changes.

Trend of temperature

The findings of the long term temperature data showed a steady increasing trend of both maximum and minimum temperatures over time (Figure 01-04). The study revealed that the increase in maximum temperature was more distinct than minimum temperature, while increment rate per year of maximum and minimum temperatures was 0.056 and 0.233°C at Chattogram whereas 0.002 and 0.305 at Cox's Bazar respectively. It was observed that the minimum temperature during winter season had been slightly decreasing (December-January), while it exhibited increasing trend in rest of the months of the years in both locations. These changes of temperature trend indicated that the study location gradually became warmer regardless of seasons. These changes might have influenced the pest and disease infestation as well as productivity of the vegetation both trees and crops of the locality.

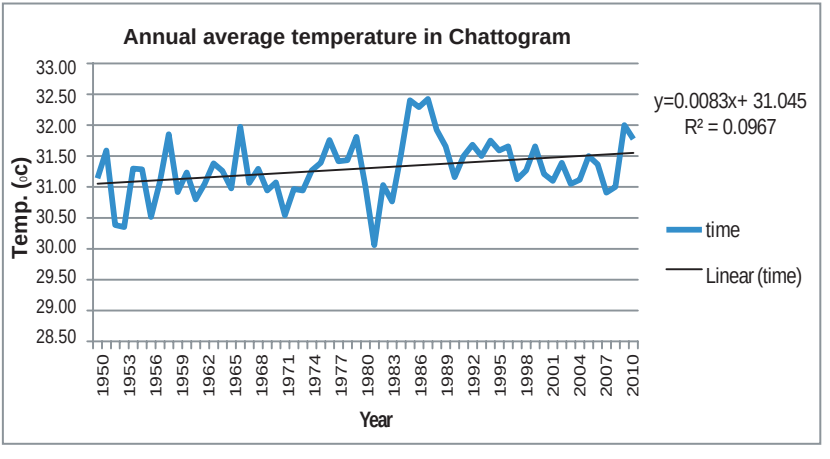

Figure 1. Long term (1950-2010) trend of annual average temperature in Chattogram

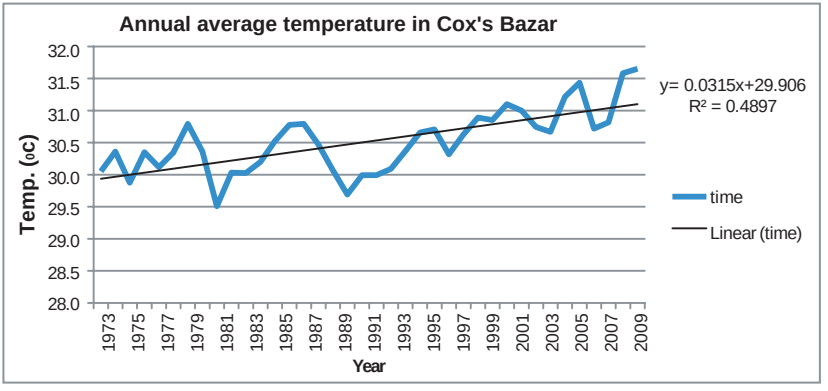

Figure 2. Long term (1950-2010) trend of annual average temperature in Cox's Bazar

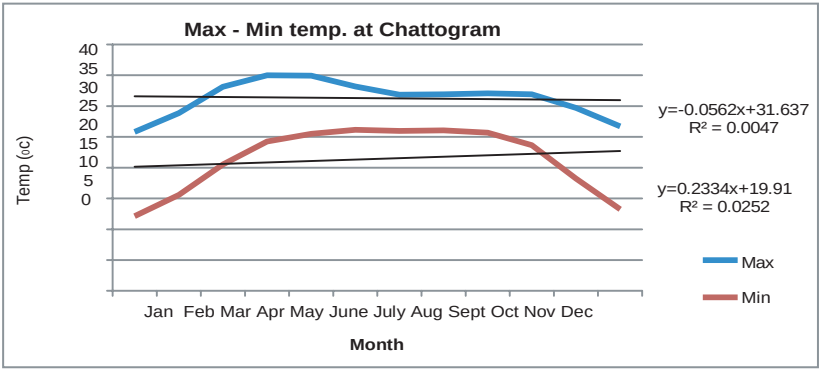

Figure 3. Long term (1950-2010) trend of maximum-minimum temperature in Chattogram.

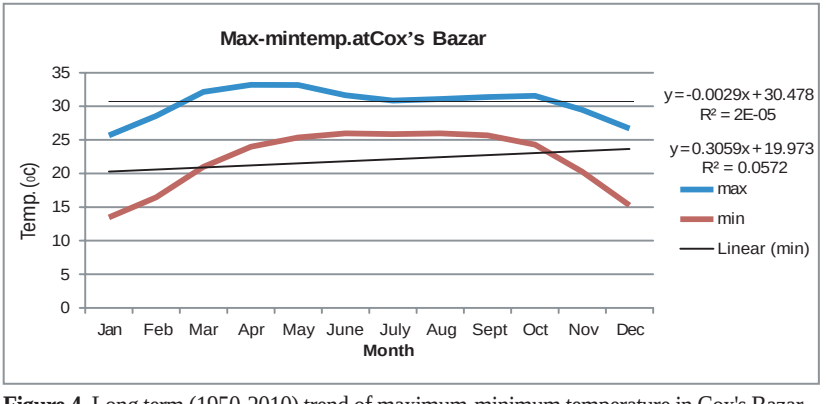

Figure 4. Long term (1950-2010) trend of maximum-minimum temperature in Cox's Bazar

Trend of rainfall and frequency of SPI

The analysis of long-term rainfall database reflected that change of rainfall pattern was not definite over seasons. The trend of annual rainfall indicated an increasing pattern in the study area and the increment rate was 354.7 mm in Chattogram (Figure 5) and 635 mm in Cox's Bazar (Figure 6) per three years. But there was sharp decreasing trend of annual rainfall has been recorded in both locations from 2007 to 2010 indicates that annual rainfall is decreasing in the recent year. This decreasing trend of annual rainfall hampered overall crop production in the selected study areas. Decreasing trend of winter season rainfall is associated with higher rate of increase in minimum temperature (Wang *et al.,* 2009) that might had hampered the growth of the vegetation. Subash and Mohan (2011) reported wide year-to-year variation in the monthly distribution of rainfall in Indo-Gangetic region.

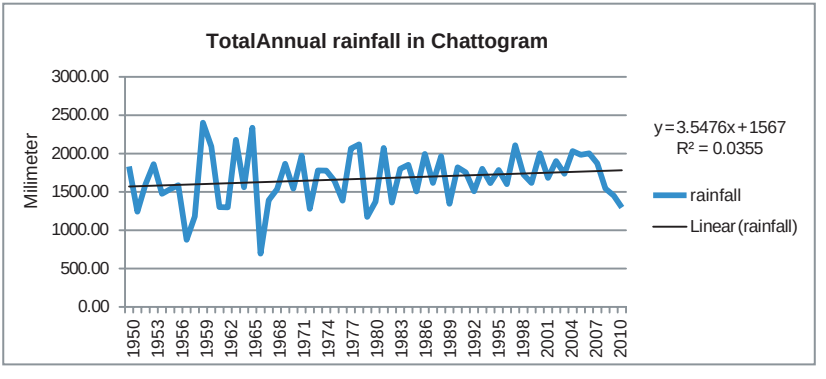

Figure 5. Long term (1950-2010) trend of annual total rainfall in Chattogram

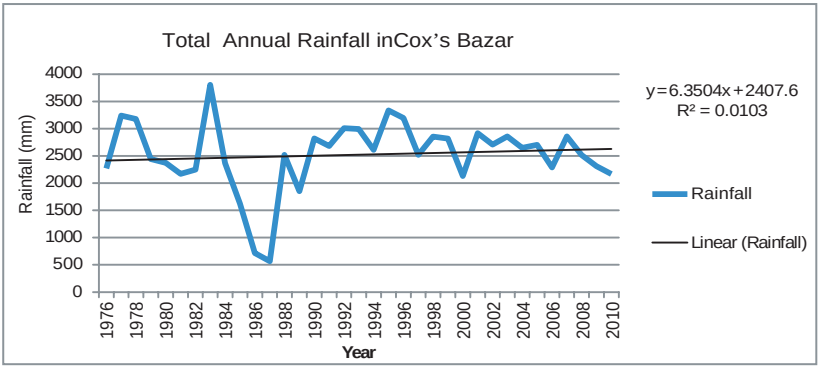

Figure 6. Long term (1950-2010) trend of annual total rainfall in Cox's Bazar

Farmer's Perception on Changes in Climatic Variables and Natural Hazards

The perception of the respondents on change of local climate and their important impacts over time (10 years ago) revealed that respondent's perceptions (Table 1) were almost similar to the evidences of climate change recorded from the meteorological database. Regarding the change of temperature over time, almost cent percent respondents opined that temperature had increased which was very consistent with the change of maximum temperature of meteorological database. Regarding rainfall intensity (precipitation), ground water availability and surface water availability almost cent percent respondents opined that the rainfall intensity had decreased over time which was very much consistent with the meteorological evidences. Regarding hotness, coldness, drought, fog and salinity, majority of the respondents opined that the intensity of these climatic variables had increased. Regarding flood and cyclone, majority of the respondents opined that the intensity of these two events became irregular. Though there was no evidence from database on frequency of above mentioned climatic components (hotness, coldness, ground water availability, surface water availability drought, fog, salinity, flood and cyclone) but this was confirmed by the respondents during FGD. However both metereological database and respondents perception strongly support the change of climate over time and increasing trend of impacts of climate change. This location specific information is also in good agreement with national database (MoEF, 2010).

Table 01. Farmer's perception on changes in climatic variables and natural hazards in studied coastal areas.

Climatic parameter	Respondents perception (respondents opinion expressed as percent)				
	Increased	Decreased	Unchanged	Irregular	Total
Temperature	93.33	-	-	6.67	100
Rainfall	-	100.00	-	-	100
Hotness	58.33	8.33	10.00	23.33	100
Coldness	43.33	8.33	16.67	31.67	100
Ground water availability	-	91.67	-	8.33	100
Surface water availability	-	90.00	10.00	-	100
Flood	-	10.00	8.33	81.67	100
Drought	61.67	5.00	23.33	6.67	100
Salinity	81.67	-	18.33	6.67	100
Cyclone	16.67	8.33	13.33	61.67	100
Fog	68.33	8.33	11.67	15.00	100

Impact of Climatic Vulnerabilities on Crop Production

In order to identify vulnerable climatic variables affecting overall crop production, FGD was conducted with farmers, village leaders and school teacher of the study areas. Results of FGD has been presented in Table 2 and Table 3.

Table 02. Impacts of different climatic risk factors on crop production at Teknaf upazila of Cox's Bazar districts

Crop	Climatic risk/ vulnerable factors	Severity of vulnerable factors	Crop yield loss/ yield reduction (%)
T.Aman	Drought, salinity, flood	Moderate	20-40
Wheat	Temperature variation Late winter/short cold period	Severe	40-60 ,,
Maize	Drought Rainfall variation High wind	Severe Severe Severe	40-60 ,, ,,
Potato	Temperature variation Late winter/short cold period Clayey soils Salinity	Severe Severe Severe Moderate	40-60 ,, ,, 20-40
Oilseed crops (mustard, ground nut)	Temperature variation Late winter/short cold period Clayey soils Salinity	Severe Severe Severe Moderate Moderate	40-60 ,, ,, 20-40 ,,
Spice crops (chilli, onion, garlic)	Salinity Pests and diseases Soil wetness	Severe Moderate Moderate	40-60 20-40
Jute Sugarcane	Temperature variation High rainfall High wind	Severe Severe Severe	40-60 ,, ,,

Results of FGD 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. Similarly, average yield level of HYV Boro is being affected (20-40 % 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. But the people are to live with these climatic vulnerabilities and risks in the coastal region.

Table 03. Impacts of different climatic risk factors on crop production at Banskhali upazila of Chattogram district

Crop	Climatic risk/ vulnerable factors	Severity of vulnerable factors	Crop yield loss/yield reduction (%)
Irrigated crops HYV boro	Saline ground water	Severe	40-60
	Unavailability of surface water	Severe	,,
			20-40
	Salinity, Pests and diseases	Moderate	,,
T.Aus	Water stagnancy/floods	Moderate	20-40
	Salinity	Moderate	,,
	Submergence	Moderate	,,
	Pests and diseases	Moderate	,,
T.Aman	Floods/water stagnancy	Moderate	20-40
	Drought	Moderate	,,
	Changed timing of rainfall	Moderate	,,
	Pests and diseases	Moderate	,,
Wheat	Temperature variation	Severe	40-60
	Late winter/short cold period	Severe	,,
Maize	Drought	Severe	40-60
	Rainfall variation	Severe	,,
	High wind	Severe	,,
Potato	Temperature variation	Severe	40-60
	Late winter/short cold period	Severe	,,
	Clayey soils	Moderate	,,
	Pests and diseases	Moderate	,,
Pulse crops (khesari,mung bean, soybean, cowpea)	Heavy rain/excess moisture	Moderate	,,
	Soil wetness	Moderate	20-40
	Drought	Moderate	,,
	Salinity, tidal surges	Moderate	,,
	Pests and diseases	Moderate	,,
Oilseed crops	Temperature variation	Severe	,,
	Late winter/short cold	Severe	40-60

(mustard, sesame, ground nut)	period Clayey soils Salinity	Severe Moderate	,, ,,
Spice crops (chilli, onion, garlic)	Early rainfall Temperature variation Pests and diseases	Moderate Moderate Moderate	,, 20-40 ,,
Jute Sugarcane	Temperature variation High rainfall	Severe Severe	60 ,,
Fruit crops (papaya, banana, water melon)	High wind Salinity High wind Excessive rainfall Pests and diseases	Severe Severe Moderate Moderate Moderate	40-60 ,, ,, ,, 20-40

From household survey most vulnerable climatic factors were identified. Respondents perceived that temperature has increased over the years facilitates more pest/ disease infestation in different crops and duration of winter has been shortened affecting the potential growing period of winter crops. 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, flash floods, erratic rainfall etc in crop production systems. Based on farmers' perception and farmers' response about climate change, most vulnerable crop specific climatic factors has been identified (Figure 07 -16).

T. aman rice

Data presented in Figure 7 reveals that majority of the respondents in Chattogram districts opined pest and disease infestation, salt water and waterlogging were the major risk factors in T. aman crop. Whereas in Cox's Bazar tropical cyclone, pest and disease infestation and drought were the major risk factors in T.aman crop (Figure 8).

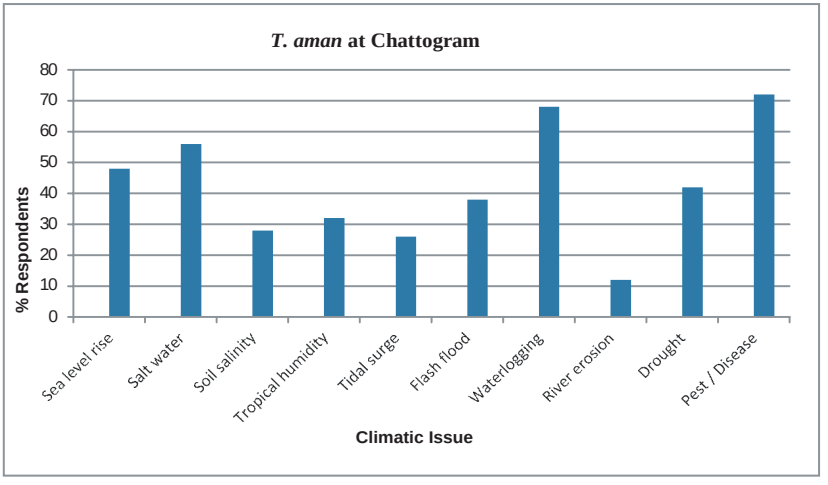

Figure 7. Farmers response on long term impacts of climate change affecting T. aman at Chattogram

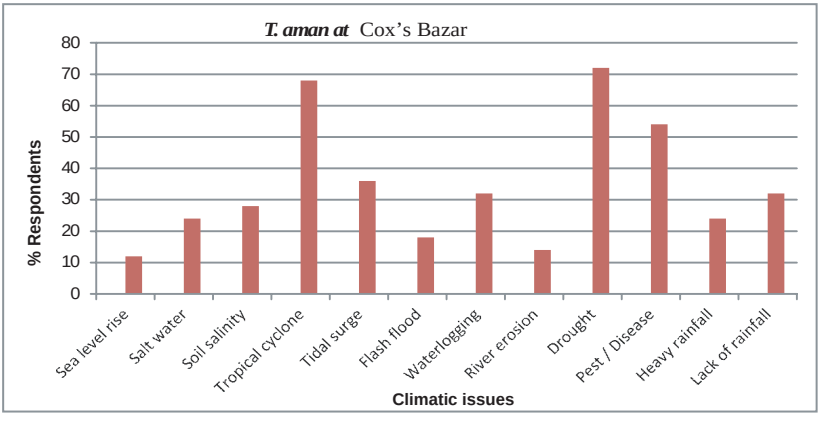

Figure 8. Farmers response on long term impacts of climate change affecting T. aman at Cox's Bazar

Boro rice

Data presented in Figure 9 reveales that more than half of the respondents in Chattogram opined that disease and pest infestation and storm/hail were the major risk vulnerabilities in boro rice whereas soil salinity, pest and disease attack and drought were the major risk factors in boro rice at Cox's Bazar (Figure 10).

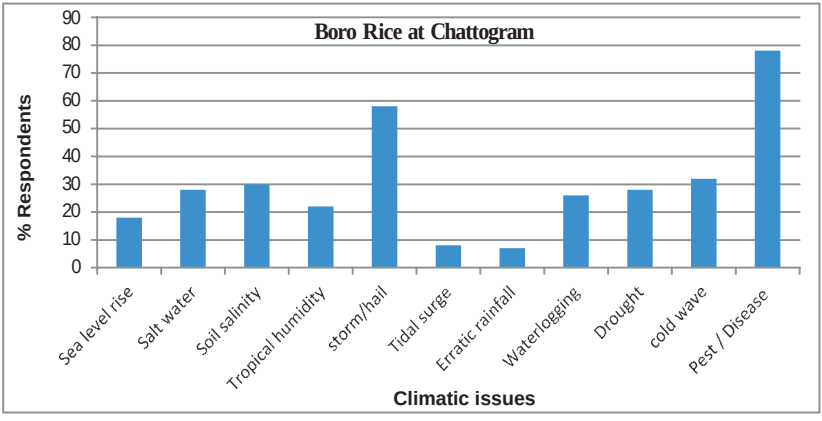

Figure 9. Farmers response on long term impacts of climate change affecting Boro rice at Chattogram

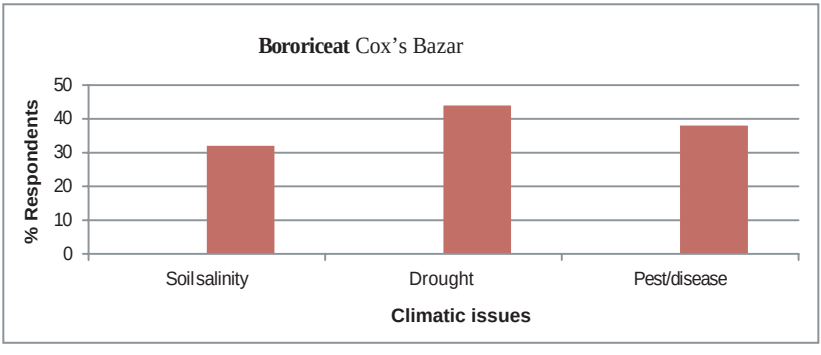

Figure 10. Farmers response on long term impacts of climate change affecting Boro rice at Cox's Bazar

Vegetable cultivation

Data presented in Figure 11 and Figure 12 reveals that pest and disease attack, soil salinity, salt water and water logging were the major problems in cultivation of vegetables in Chattogram districts. In Cox's Bazar districts major problems in vegetable cultivation were pest and disease attack, lack of rainfall, drought and waterlogging were the major risk vulnerabilities (Figure 13).

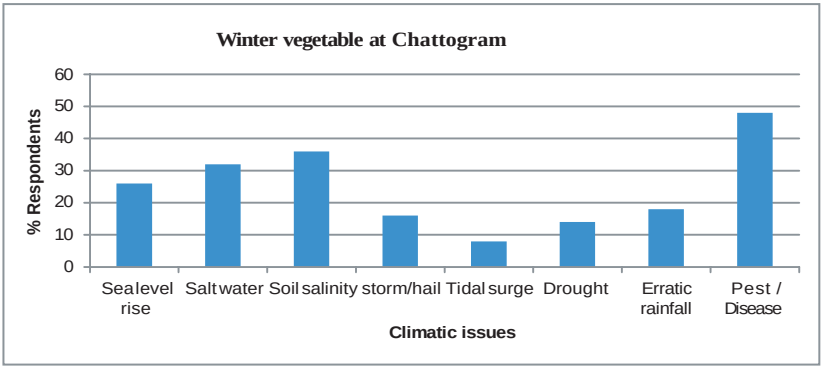

Figure 11. Farmers response on long term impacts of climate change affecting winter vegetables at Chattogram

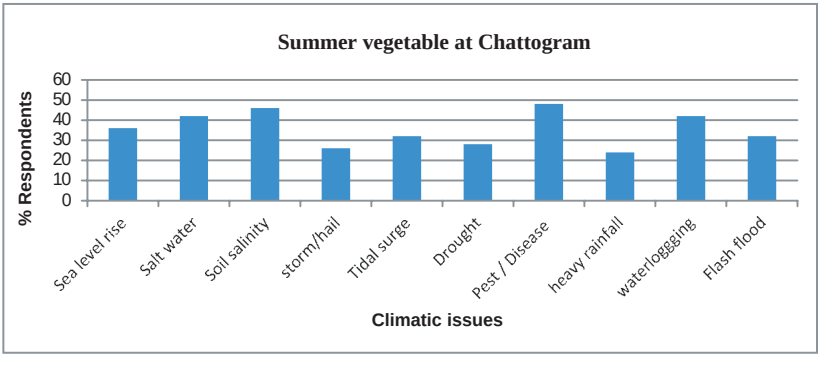

Figure 12. Farmers response on long term impacts of climate change affecting summer vegetables at Chattogram

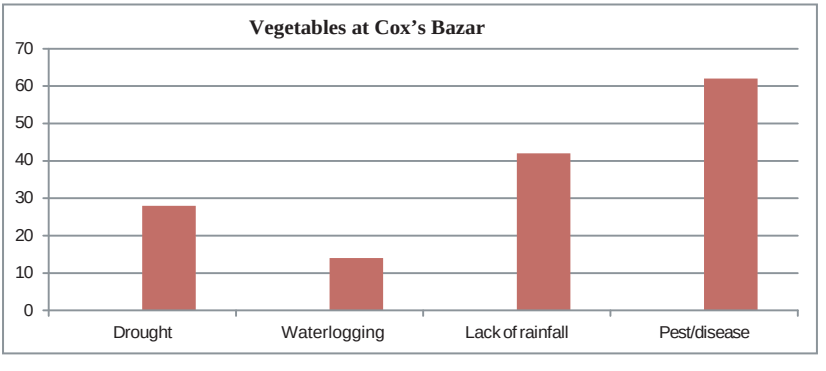

Figure 13. Farmers response on long term impacts of climate change affecting vegetable crops at Cox's Bazar

Pulse crops

Information in Figure 14 shows that water logging was the major risk vulnerabilities in pulse crops at Chattogram as majority of the respondents opined. Other factors were pest and disease attack, soil salinity and sea level rising. None of the selected respondents were found to cultivate pulse crops at Cox's Bazar.

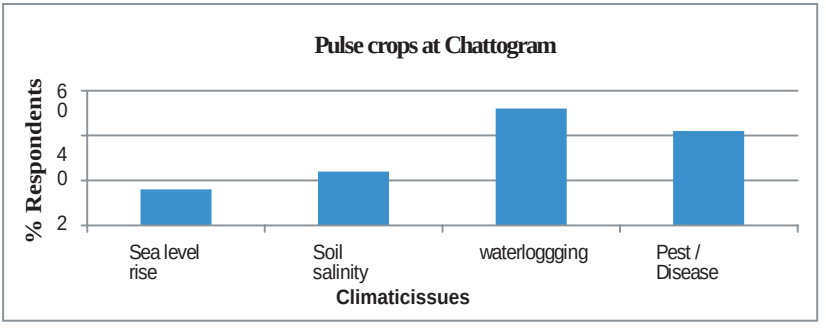

Figure 14. Farmers response on long term impacts of climate change affecting pulse crops at Chattogram

Oil seed crops

Data presented in Figure 15 reveals that majority of the respondents in Chattogram opined pest and disease outbreak is the most vulnerable factors in oil seed crop. Other risk vulnerabilities were erractic rainfall, soil salinity and cold wave. In Cox's Bazar, pest and disease attack, tropical cyclone and drought were the major risk vulnerabilities (Figure 16).

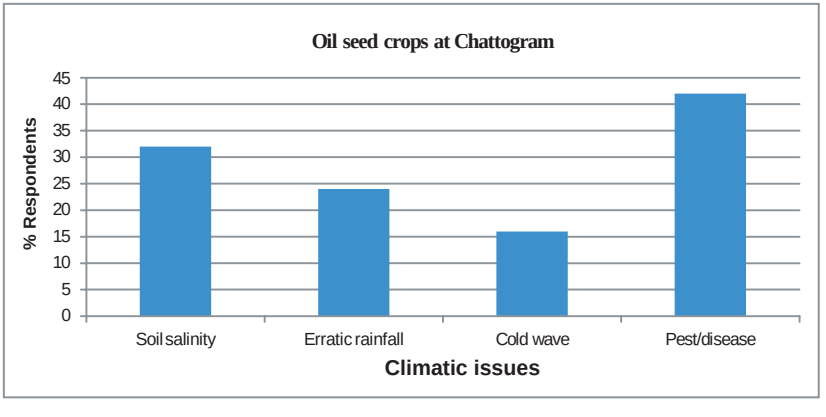

Figure 15. Farmers response on long term impacts of climate change affecting oil seed crops at Chattogram

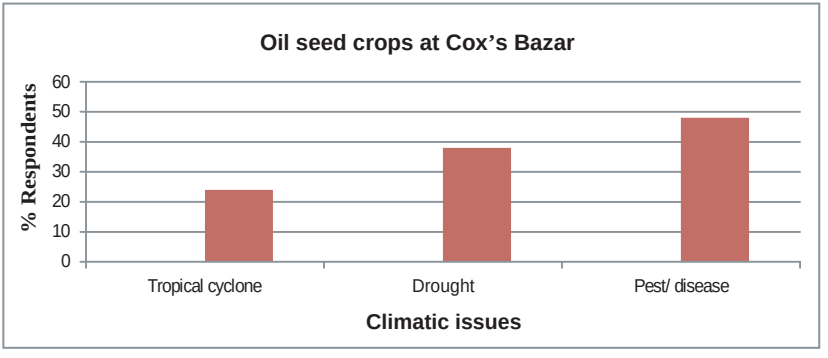

Figure 16. Farmers response on long term impacts of climate change affecting oil seed crops at Cox's Bazar

Adaptation Practices for Sustainable Agricultural Production

There were distinct changes of local climate specially temperature, rainfall, salinity, drought, flood, hotness, coldness and fog. which might have combined effect on productivity of crop production in the study area. Against the impacts of those changes, government as well as local community has undertaken some sort of adaptation measures.

Based on the findings of the FGDs, field visits and discussion with farmers and review of the available literatures, some 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 04 and Table 05.

A number of adaptation options/practices were being used by the respondents. Promising and viable adaptation options/practices were selected by the farmers. Among the different adaptation practices against climatic vulnerabilities, farmers were mostly habituated with "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", "Floating bed agriculture", "Introduction of some salt-tolerant

crop varieties (viz.wheat, maize, millet, mungbean, soybean, chickpea and rice)", "Utilization of bunds in gher areas in cultivating seasonal vegetables, fruits and spices and promoting science based rice-fish dual culture", "compost making and use of composts in homestead gardening" and " shrimp culture". With the changing climate, coastal people have been undertaken by the community to sustain their production system owing to their livelihood. Among those, coastal people changes their seed sowing/ seedling transplanting time accordingly. The respondent opined that due to having irrigation facilities and experience from erratic behavior of climatic variables the planting time have been shifted.

Table 4. Adaptation Practices for Sustainable Agricultural Production in the Context of Climate Change in Teknaf upazila of Cox's Bazar District

Sl	Adaptation Practices	% Respondents adopted
1.	Introduction of salt-tolerant crops (rice, mungbean, cowpea, soybean, ground nut) and sorjan system of year round cropping.	68.33
2.	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.	55.00
3.	Using pond water in seed bed to escape salinity	45.00
4.	Promote compost making and use of compost in homestead gardening	28.33
5.	Utilization of canal water by digging canals for cultivating boro crops in large fallow lands	23.33
6.	Floating bed agriculture (vegetable and vegetable seedlings) using water hyacinth bed	20.00
7.	Utilization of bunds in gher areas in cultivating seasonal vegetables, fruits and spices.	18.33

Table 05. Adaptation Practices for Sustainable Agricultural Production in the Context of Climate Change in Banskhali Upazila

Sl	Adaptation Practices	% Respondents adopted
1.	Introduction of salt tolerant crop varieties (rice, wheat, maize, potato, strawberry, mungbean, cowpea, soybean, ground nut) in salt affected areas	71.67

2.	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 et months.	61.67
3.	Cultural practices (mulching, changes in planting time)	43.33
4.	Promote compost making and use of compost in homestead gardening	40.00
5.	Floating bed agriculture in water logged areas	28.33
6.	Shrimp culture	15.00
7.	Boro rice-fish (bagda) dual culture	11.67

Farmers' Opinion/Suggestions

Long-term impacts of climate change on crop production systems of the study areas were evaluated through household survey. There is a great scope of bringing the coastal area under intensive farming practices. In this context the respondents provided different suggestions to overcome the problems. 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 (Table 6).

Table 06. Farmers' opinion/suggestion on the needs of Govt./NGO interventions to reduce the Impacts of Climate Change

Sl	Adaptation Practices	% Respondents adopted	
		Banskhali	Tekanf
1.	Training of farmers for increased sustainable agricultural production	23.33	15.00
2.	To use fallow land through local innovations/ adaptation practices	20.00	23.33
3.	To produce and use of drought/salinity/flood adapted crop varieties	28.33	35.00
4.	To increase awareness among vulnerable farmers	21.67	20.00
5.	To increase agro production through farmers' community/groups	13.33	28.33
6.	To increase agro production by maximum utilization of production inputs	15.00	23.33
7.	To give appropriate value of crops production/ marketing facilities of crops and promote agrobusiness	35.00	31.67
8.	To develop marketing system and make agro net work	20.00	13.33

Conclusion

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 in some areas. A vast area of agricultural land that remains fallow or seasonal fallow (30-50 % of NCA of concerned districts) in drought prone, 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 and expansion of shrimp culture.

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 (20-40 % 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 (40-60 % yield loss) by soil wetness, excessive rainfall and water-logging in the selected areas.

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.

Sorjan system of cropping, rice-fish dual culture, utilization of bunds as vegetables/spices production in gher areas, floating bed agriculture and homestead gardening with introduction of salt-tolerant & drought tolerant crop varieties have been identified as potential adaptation options for development of coastal agriculture for increased agricultural production in attaining food security.

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.

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 household 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 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.

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

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.

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 of the vulnerable people of the coastal region.

Climate change scenarios based on GCMs need to be done considering several climate change prediction models as available in South Asia.

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