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### Impact of climate change on agriculture in Bangladesh: A study on Tangail district

**Shabikunnahar Bonna and Laily Akter**

#### Abstract

Climate change and its impact on agriculture are global concern but it's becoming a major threat for Bangladesh because where lives and livelihood depends on agriculture. In Bangladesh 164 million people depend on rice but due to climate change vulnerabilities the yield of rice has been reducing. This paper studies the impact of climate change on agriculture and adaptation of new strategies to fight against the different causes of climate changes of Tangail district. Tangail district is highly sensitive to climate events such as, flood, soil erosion, heavy rainfall, drought, storm surge etc. These natural disasters have increased due to climate change that threat on farmer's livelihood by destructing crops, houses and infrastructure. To support the analysis a questionnaire survey was conducted to gather farmer's perceptions of present situation and what different strategies should take to fight against climate change. The paper presented that the education level of the present generation of farmers is gradually increasing and they have perceptions that the temperature is rising, timely rainfall is not available and crop production seasons are shifting. The adaptations measures followed by the local people will increase their capacity to fight against climate change problems. A very few empirical research on the impacts of climate change in Tangail has been conducted, so researcher and policy makers get information about the concern topic by this study and implement policy for the climate change affected people of study area.

**Keywords:** Climate change, temperature, rainfall intensity, flood, cropping pattern, agricultural productivity, farmers perceptions

#### Introduction

Bangladesh is the agro-based developing countries in the world. About 62% people are engaged in agriculture and they manage their livelihood from agricultural production. The dependency on agriculture is more in rural area than urban area. 87% of the population in the rural areas depends on agriculture directly and indirectly. Agriculture has great contribution in annual national GDP. The rate of contribution in national GDP of agriculture has been decreasing gradually because the agricultural growth rate has been declining day by day. According to World Bank in 1972, agricultural contribution on GDP was about 52 percent of total GDP but in 2020, the contribution of agriculture is 12.6 percent of total national GDP. That means the agricultural production is being reduced and contribution in total GDP is also being reduced day by day. There are several reasons for the reduction of agricultural growth in Bangladesh, such as high population growth rate, excessive pressure on agriculture and climate change. More than one thousand people are living per-sq/km and national population is increasing by 2 million people every year. In Bangladesh climate change is the main reason for the reduction of agricultural production. Due to climate change Bangladesh is the most vulnerable country. Climate change is responsible for rising river erosion, flood and salinity of inland. Bangladesh is watered by a total of 57 trans-boundary rivers coming down to it: 54 from neighboring India and 3 from Myanmar and situated at the bottom of the mighty GBM river system (comprising the Ganges, the Brahmaputra and the Meghna). In Bangladesh nearly a quarter is less than seven feet above sea level. In agriculture, weather and climate are important factors which play significant role for increasing productivity. Climate change mainly changes in temperature, rainfall patterns which are closely related to agricultural sector. Temperature and rainfall are two main variables that shape the structure of agricultural system. Any change of rainfall and temperature system because of climate change agricultural production hampers significantly.

High temperature is a constraint to rice production because a significant yield reduction of all crops paddy plays the leading role by contributing 95% of food production. Climate is the most important factor in rice production and changes in climate have profound effect on rice production. Because of climate change rice production will be reduced in Bangladesh on average of 7.4% every year over the period 2005-2050. The characteristics of Bangladeshi crops are seasonal in nature and influenced different variables of climate such as temperature, rainfall, humidity, day-length etc. Crop often respond negatively with a steep decline in net growth of yield, if temperatures exceed the optimal level of biological processes. Climate change causes irregular rainfall and heavy rainfall which has taken place every year in BD. This heavy rainfall caused devastation of standing crops, damage infrastructure and sufferings of human. Usually, crop damage occurs due to high rainfall induced flooding, flash flood and riverine flooding. Aman rice that is planted in the monsoon is very much more vulnerable to flood waters. However, it is seen that the muddy waters of flood can substantially increase damage potentials. In Bangladesh rivers carry a huge amount of sediments from the upstream areas during the flood season for that reason flood water is so muddy which destroys rice and monsoon crops. At present time climate change has become a big challenge for agriculture in Bangladesh and if farmers want to increase production, they have to follow adaptation method to mitigate the effects of climate change.

### Objectives of the Study

The main objectives of the research paper are:

- Investigate the nature, causes and present scenario of climate and agriculture.
- Focuses on various strategies that can be taken to reduce climate change and increase agricultural production.

### Literature Review

In 2003 Agrawala ET at used a subjective ranking system based on circulation models and previous studies to identify the main risk that Bangladesh faces from climate change. They also discounted the climate change impact on agriculture because some of the beneficial and adverse effects of climate change on crop yield may offset each other: A higher frequency of extreme potentially crop damaging weather events could be offset by higher yields with modestly warmer temperatures. In 2002, Ruttan stated that temperature and rainfall could potentially change agricultural productivity but grows effect was mainly region based. In 2007, Rashid and Islam noted that drought, flood, salinity, cyclones is the major climate events for which Bangladesh agriculture is more vulnerable. At the same time they identified a series of adaptation programs to mitigate potential impact of climate change on agriculture, such as: crop diversification away from those most vulnerable to climate changes, improving water efficiency, improving crop production strategies, investing in measures to mitigate the impact of cyclones and other natural disaster, reclaiming soil salinity by investing in cultivation Boro rice and sweet water shrimp, and investing in machinery to suitable farming operations. In 1996, Karim et al identified a series of Aus, Aman and Boro for rice and wheat models. They found that while higher concentrations of CO<sub>2</sub> increased yields with temperatures unchanged, higher temperatures

adversely affected yields even with higher CO<sub>2</sub> concentrations. In 2010, Basak ET at stated that on the yield of Boro rice climate change had a predominant adverse impact. They found that, if temperature increased because of climate change, this would cause grain fertility during the growing season and hence reduced yield. They also found that while changes to the level of atmospheric carbon dioxide and solar relation might offset the impact of increased temperatures to some degree, that it would not be sufficient to mitigate it together. In 2012, Sarker et al found that minimum temperatures were significant for the Aman and Boro varieties, with a negative impact on output in the former case and a positive impact in the latter.

### Methodology

For conducting the study both primary and secondary data have been used. Primary data were collected from 9 upazillas of Tangail district. A sample size of 150 respondents has been interviewed through a structured questionnaire during August to September 2021. Secondary data has been collected from Bangladesh Bureau of Statistics, relevant articles, reports, maps, journals, website etc. The collected data was coded in numerical numbers, tabulated and analysed on the light of relevant theories and expert views. Descriptive statistical measures involving the computation of percentage was employed to analyse the collected data. The researcher used the result to find out the solution of those difficulties in various ways.

### Study Area

Tangail district with an area of 3,424.39 sq km. is bounded on the north by Jamalpur district, on the south Dhaka and Manikganj districts, on the east Mymensingh and Gazipur districts, on the west Sirajganj district. Location of Tangail district is in 24.2449680N and 89.9113050E and located in agro-ecological zone 8: Young Brahmaputra and Jamuna floodplain. Main rivers of the study area include the Jamuna, the Dhaleshwari, the Jhenai, the Bangshi, the Louhajang, and the Turag. Madhupur forestry and Sakhipur and Ghatail hillocks are notable. Average annual temperature: maximum 33.3°C, minimum 12°C; annual rainfall 1,467 mm. Main occupations of the peoples are Agriculture (49.53%), fishing (1.05%), agricultural labourer (17.28%), wage labourer (2.53%), weaving (1.68%), industry (1.71%), commerce (9.56%), transport (2.14%), service (6.67%) and others (7.85%). Total cultivation land 3,38,653 hectares, fallow land 17,466 hectares; forestry 11,087 hectares; single crop 19%, double crop 50% and treble crop land 31%; land under irrigation 60%.

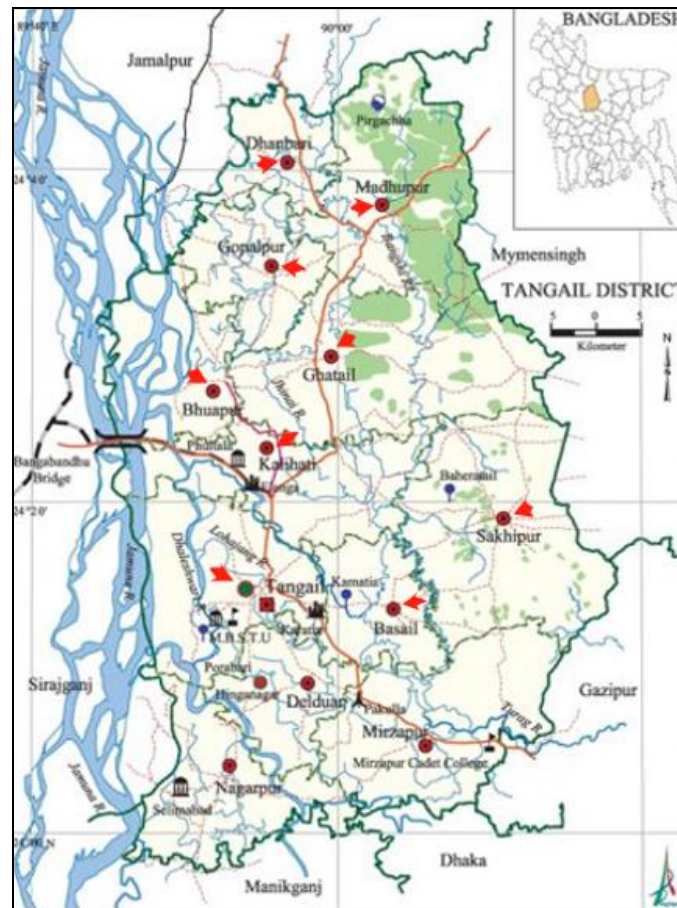
### Climate of Study Area

The climate of Tangail district is tropical in nature. There is much less rainfall in summer than winter. According to Köppen and Geiger, this climate is classified as Aw. Here the average temperature is 25.5 °C. About 1872 mm of precipitation falls annually. The warmest month of the year is June, with an average temperature of 28.2 °C | 82.7°F. In January, the average temperature is 18.2 °C | 64.8°F. It is lowest average temperature of the whole year. The difference in precipitation the driest month and the wettest month is 374 mm | 15 inch. The average temperatures vary during the year by 10.0 °C | 18.0 °F. The month with the highest relative humidity is September (85.11%). The month with the lowest relative humidity is March (57.65%). The

month with the highest number of rainy days is July (27.70 days). The month with the lowest number of rainy days is December (0.93 days). Tangail are in the middle and the summers are that easy to define. The best time to visit are March, April, October, November. In Tangail, the month with the most daily hours of sunshine is March with an average of 9.58 hours of sunshine. In total there are 296.38

sunshine throughout March. The month with the daily hours of sunshine in Tangail is January with an average of 6.64 hours of sunshine a day. In total there are 199.34 hours of sunshine in January. Around 2898.58 hours of sunshine are counted in Tangail throughout the year. On average there are 95.4 hours of sunshine per month (Wikipedia).

### Map of Tangail District



Studied Upazillas: ↑

Map of Tangail District

### Cropping Pattern of Study Area

Agriculture is the main occupation of the Tangail district. About 49.53% of people are involved with agricultural activities. Its main agricultural products are paddy, potato, jute, sugarcane, sesame, linseed, wheat, mustard seed and pulse. About 3,386.53 km<sup>2</sup> (1,307.55 sq mi) of cultivable lands are available in Tangail. The main fruit products are mangos, jackfruit, bananas, litchis, and pineapples. Other sectors, such as fisheries (446), dairies (189), industries, weaving and poultry farms (538) are developing in the Tangail district. Tangail is the home of the weavers of the world-famous "Tangail Saree" (Wikipedia). Although different varieties of crops are grown in Bangladesh, rice is overwhelmingly the dominant crop in terms of acreage and importance as the staple food. Rice alone accounts for about 75 per cent of the cropping area in the country. In terms of acreage, other important crops grown in the country are wheat (4.4%), jute (3.9%), potato (1.1%), pulses (2.79%), sugarcane (1.12%), and chilli (1.05%), and oil seeds (3.08%). Additionally, there are small scale cultivation of onion, gram, garlic and groundnut etc. (Mainuddin, *et al.*,

2011) [10]. Various factors that control the agricultural production are yield season, numbers of dry days, heavy rainfall, high temperature and potential evapo-transpiration (Banglapedia, 2008) [11].

### The Climate of Bangladesh

Bangladesh is situated in the northeast of the Indian subcontinent on the Bay of Bengal. Bangladesh is recognized as one of the most vulnerable countries to climate change because of its geographic exposure and greater reliance on climate sensitive sectors, such as agriculture. The severity of such exposure has continued to worsen by lack of the mitigation responses necessary to contain the changes in the global atmosphere. According to IPCC, the global average air temperature near the earth surface is found to rise by 0.74±0.18° during the hundred years ending in 2005. It was emphasized that global warming caused a serious threat for human increased flooding to spread the disease to the disruption of agriculture in many parts of the world. The global average and combined land and ocean surface temperature, show a

warming of 0.85 [0.65 to 1.06 °C], in the period 1880 to 2012, based on multiple independently produced data- sets<sup>5</sup>. The sea level of Bangladesh coast is rising at about 3 millimeters a year and sea surface temperature is also showing a rising trend (Bangladesh National Adaptation Program of Action, 2000). The reality of climate change due to global warming like other parts of the planet is faced by Bangladesh. Due to climate change is expected that humidity, wind flow and temperature of Bangladesh will be changed. This changing conditions cause an increasing insect, pests, disease and microorganisms in agriculture and crop production will decrease. Less rainfall during winter due to climate change will lead to decrease in moisture content of the top soil. Higher evaporation will cause drought. But in summer excessive rainfall worsen the flood situation, which will have negative effects on agricultural production.

**Socio-economic profile of the Farmers**

**Table 1:** Level of Education (Education Attainment of Respondent Farmers)

Range of Education	Can't Sign	Can Sign only	Primary	Secondary	Above Secondary
Number of Respondents	16	30	46	48	10
Percentage (%)	10.67%	20%	30.67%	32%	6.67%

Source: Field survey in Tangail district - 2021

Farmers' education attainment is presented in Table 1. In the table it is found that 10.67% farmers can't sign, 20% can sign only, 30.67% had education only at primary level, 32% at secondary level and only 6.67% at above secondary level.

**Table 2:** Income of the respondent farmers

Income Range	0-25000	26000-50000	50000 to Above
Number of Respondents	68	33	49
Percentage (%)	45.33%	22%	32.67%

Source: Field survey in Tangail district - 2021

Farmers' income level is presented in Table 2. 45.33% farmer income level was 0-25000Tk, 22% farmer income level was 26000-50000Tk and 32.67% farmer income level was above 50000Tk.

**Table 3:** Land ownership of respondent farmers

Land Ownership Category	0 to 2 Acre	2.1 to 3 Acre	Above 3.1 Acre
Number of respondents	75	56	19
Percentage (%)	50%	37.33%	12.67%

Source: Field survey in Tangail district - 2021

Land ownership of respondent farmers is presented in table 3. Majority (50%) farmers had 0 to 2acre land, 37.33% had 2.1 to 3acre land and only 12.67% had above 3.1.acre land.

**Table 4:** Farming experience of respondent famers

Experience Year	Below 5 Years	5 to 10 Years	11 to 15 Years	Above 16 Years
Number of Respondents	1	69	35	45
Percentage (%)	0.67%	46%	23.33%	30%

Source: Field survey in Tangail district - 2021

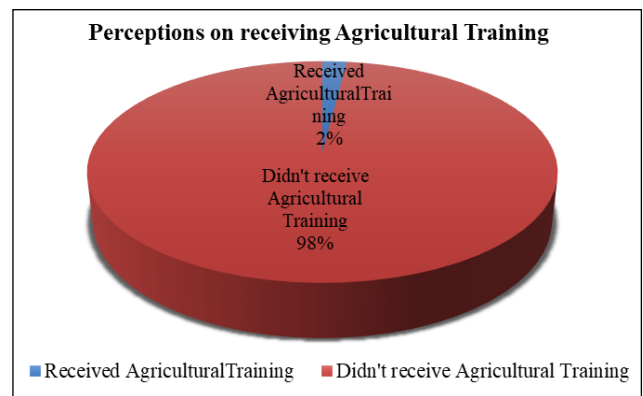
Farming experience of respondent farmers is presented in Table 4. Majority of the farmers (46%) had farming experience in 5 to 10 years, 0.67% had below 5 years, 23.33 had 11 to 15 years and 30% had above 16 years.

**Table 5:** Perceptions of respondent farmers on receiving agricultural training in creating human capacity development

Yes		No	
Number of Respondents	Percentage (%)	Number of Respondents	Percentage (%)
3	2%	147	98%

Source: Field survey in Tangail district - 2021

Perception of farmers agricultural training received in creating human capacity development is presented in Table 5. Only 2% farmer received agricultural training and majority (98%) farmer had no training.



**Fig 1:** Perceptions of respondent farmers on receiving agricultural training in creating human capacity development

Above figure is showing that only 2% of respondents' farmers have received agricultural training in creating human capacity development while 98% farmers didn't receive training. According to respondents, they don't have enough idea about agricultural training. Where to get training, what is the benefit, is there any cost involvement as training fees are the mostly common concern of respondents. Government should concentrate to make easily accessible agricultural training and aware farmers in creating human capacity development.

**Table 6:** Perceptions of farmers about access to credit facilities of respondent farmers

Yes		No	
Number of Respondents	Percentage (%)	Number of Respondents	Percentage (%)
59	39.33%	91	60.67%

Source: Field survey in Tangail district - 2021

Perception of farmer about access to credit facilities of respondent farmer is shown in Table 6. The proportion of farmer having no credit facilities was higher 60.67% than those had credit facilities (39.33%).

**Table 7:** Perceptions of farmers about modern technology in used of agriculture productions of respondent farmers

Modern Equipment used	Always	Occasionally	Never
Number of Respondents	7	147	0
Percentage (%)	4.67%	95.33%	0

Source: Field survey in Tangail district - 2021

Perception of farmer about modern technology in used of agricultural production is presented in Table 7. The proportion of farmers using of modern technology used always was 4.67% and occasionally 95.33%.

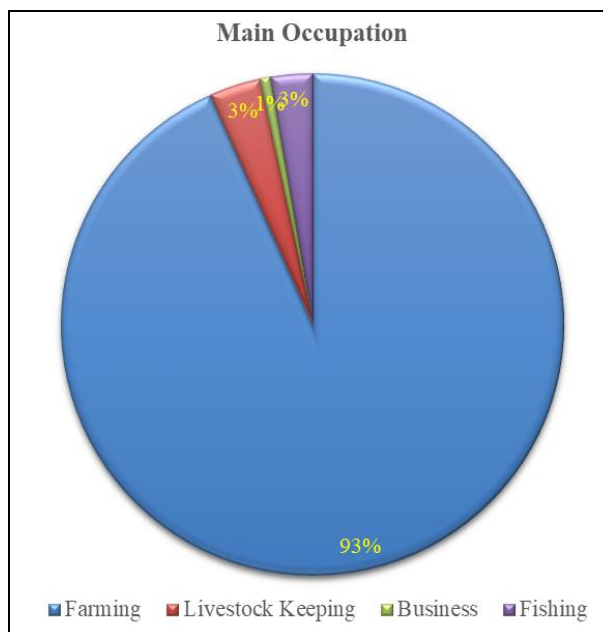
**Table 8:** Perceptions of farmers about access to help of agricultural officer

Yes		No	
Number of Respondents	Percentage (%)	Number of Respondents	Percentage (%)
146	97.33%	4	2.67%

Source: Field survey in Tangail district - 2021

Perception of farmer about access to help of agricultural officer is presented in Table 8. It is shown that majority (97.33%) get help of agricultural officer and 2.67% not get help of agricultural officer.

**Economic activity of the study area**



**Fig 2:** Main occupation of respondent farmers

Here, the Pie chart is showing the percentage of farmers who are involved in farming, livestock keeping, business and fishing. As we see the most part of farmers are engaged in farming to lead their livelihood, so we should concentrate to eradicate existing problems and introduce modern technology and new crop patterns to develop this sector.

**Table 10:** Percentage farming system in the study area of the respondent farmers

Farming System	Crop Farming	Mixed Farming	Shifting Cultivation	Agro forestry
Number of Respondents	18	102	26	4
Percentage (%)	12%	68%	17.33%	2.67%

Source: Field survey in Tangail district - 2021

Percentage farming system in the study area is presented in Table 10. In the study area, there are various farming system, such as crop farming (production of crops only),

**Table 9:** Main occupation of respondent farmers

Occupation	Farming	Livestock keeping	Business	Fishing
Number of Respondents	140	5	1	4
Percentage (%)	93.33%	3.33%	0.67%	2.67%

Source: Field survey in Tangail district - 2021

Main occupation of respondent farmers is presented in Table 9. From the survey data the major economic activity of the study area was farming (93.33%). Livestock keeping (3.33%) was second economic activity in the study area. All livestock keepers are also farmers. Fishing ranked as the third economic activity. Business was the fourth major economic activity in the study area. Farming and livestock keeping was the main economic activities in the study area, this implies that climate change will have a profound effect on the livelihood of these communities.

mixed farming (production of crops and livestock keeping), shifting cultivation and agro-forestry.

**Discussion on climate change on study area**

**Table 11:** Perceptions of farmers about climate change starting

Starting Period	Very Recent (0-4 Years)	Moderate Time age (5-15 Years)	Long Time Age (Above 15 years)
Number of Respondents	125	20	5
Percentage (%)	83.33%	13.33%	3.33%

Source: Field survey in Tangail district - 2021

Farmer perceptions of starting of climate change are presented in Table 11. It is found that majority of the farmers (86.67%) believed that climate change started very recent time ago (0-4 years). 13.33% farmers believed that it started moderate time ago (5-15 years) and 3.33% believed that it started long time ago (above 15 years).

**Table 12:** Perceptions of farmers about causes of climate change

Explanation	No Explanation	Man-Made Causes	Supernatural Factor
Number of Respondents	12	136	2
Percentage (%)	8%	90.67%	1.33%

Source: Field survey in Tangail district - 2021

Farmer perceptions of causes of climate change are presented in Table 12. It is found that majority (90.67%) of the farmers thought that climate change is caused by

environmental factors. Only 1.33% respondents described it as supernatural factors and 8% had no explanation.

**Table 13:** Perceptions of farmers about changes in the duration of season

Perception	Don't know		Reduced		No change		Increased	
	No. of respondents	%	No. of respondents	%	No. of respondents	%	No. of respondents	%
Rainy season	0	0	130	86.67%	0	0	20	13.33%
Hot Season	0	0	3	2%	0	0	147	98%
Cold season	0	0	150	100%	0	0		

Source: Field survey in Tangail district - 2021

Perception of changes in duration of season is shown in Table 13. It is found that majority of farmers (86.67%) believed that the duration of rainy season reduced and only 13.33% believed that the duration of rainy season increased.

In case of hot season 98% respondents said that duration increased and 2% said that duration reduced. 100% farmers felt that cold season duration reduced.

**Table 14:** Perceptions of farmers about changes in temperature, rainfall and wind

Perception	Don't Know		Reduced		Increased	
	No. of Respondents	Percentage (%)	No. of Respondents	Percentage (%)	No. of Respondents	Percentage (%)
Temperature	0	0	8	5.33%	142	94.67%
Rainfall	0	0	128	85.33%	22	14.67%
Wind Speed	0	0	115	76.67%	35	23.33%

Source: Field survey in Tangail district - 2021

Farmer perception of changes in temperature, rainfall and wind is shown in Table 14. It is found that most of the farmers (94.67%) believed that temperature increased whereas only 5.33% believed that temperature reduced. Majority (85.33%) of them believed that rainfall reduced. In

case of wind speed 76.67% farmers responded as reduced and 23.33% responded increased. Research in other developing countries should that most of the farmers perceive temperatures to have become warmer and rainfall reduced over the past decade.

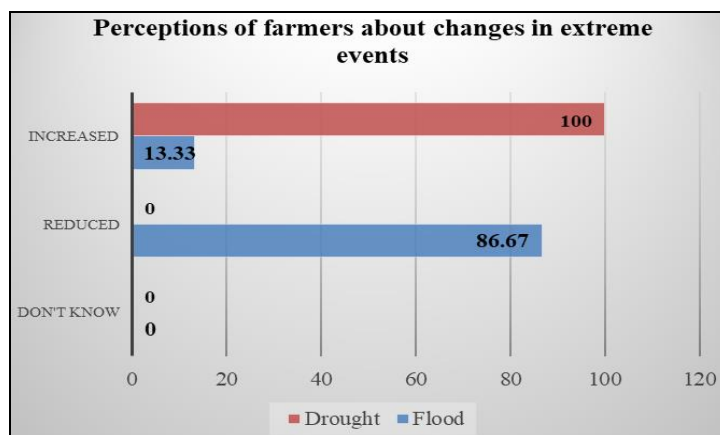
**Table 15:** Perceptions of farmers about changes in extreme events

Perception	Don't Know		Reduced		Increased	
	No. of Respondents	Percentage (%)	No. of Respondents	Percentage (%)	No. of Respondents	Percentage (%)
Flood	0	0	130	86.67%	20	13.33%
Drought	0	0	0	0	150	100%

Source: Field survey in Tangail district - 2021

Farmers' perception of changes of extreme events is presented in table 15. It is found that most of the respondents (86.67%) believed that the incidence of flood has reduced whereas 13.33% respondent believed that incidence of flood has increased. In case of drought, all the respondents (100%) believed that it has increased.

Above Bar diagram is representing that 86.67% of surveyed respondents gave positive feedback on the occurrence of flood has been reduced a lot and the other hand 100% of respondent farmers agreed that drought has been increased significantly at various upazillas of Tangail district.



**Fig 3:** Perceptions of farmers about changes in extreme events

**Climate change and agriculture in the study area**

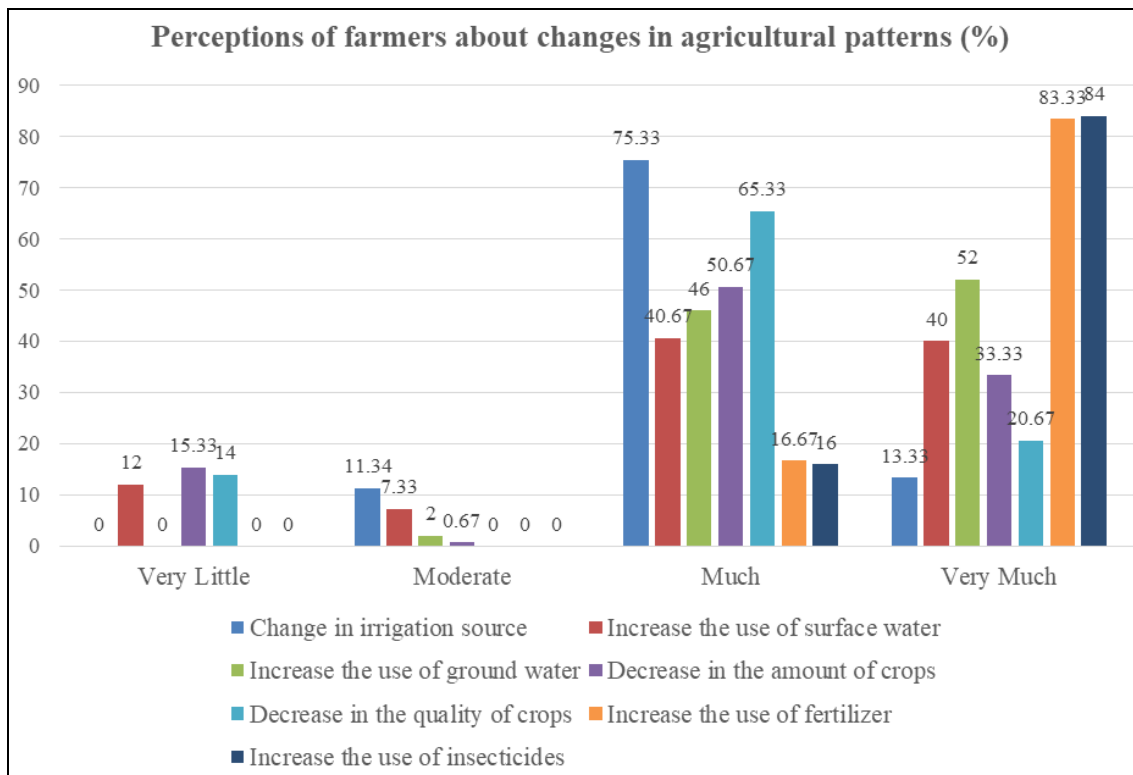
**Table 16:** Perceptions of farmers about changes in agricultural patterns

Agricultural patterns	Very little		Moderate		Much		Very Much	
	No. of Respondents	(%)	No. of Respondents	(%)	No. of Respondents	(%)	No. of Respondents	(%)
Change in irrigation source	0	0	17	11.34%	113	75.33%	20	13.33%
Increase the use of surface water	18	12%	11	7.33%	61	40.67%	60	40%
Increase in the use of ground water	0	0	3	2%	69	46%	78	52%
Decrease in the amount of crops	23	15.33%	1	0.67%	67	50.67%	50	33.33%
Decrease in the quality of crops	21	14%	0	0	98	65.33%	31	20.67%
Increase in the use of fertilizer	0	0	0	0	25	16.67%	125	83.33%
Increase in the use of insecticides	0	0	0	0	24	16%	126	84%

Source: Field survey in Tangail district - 2021

Farmer perception of changes in agriculture patterns is presented in Table 16. Due to climate change there was very much changes in the agricultural patters. In case of changes in the irrigation sources at Tangail there was moderate (11.34%), much (75.33%) and very much (13.33%) changes can be seen from above table. Ground water use was increased very much (52%), which is very alarming. 50.67% respondents believed that production of crops was reduced due to climate change and quality of crops also reduced said 65.33% respondents. Increase in the use of fertilizer and

insecticide was respectively said 83.33% and 84% respondents. Increasing use of fertilizer and insecticides should be reduced and organic fertilizer use should be increased for increasing the fertility and quality of land. For increasing use of ground water, layer of water is going down. For that reasons sources of drinking, cooking and bathing water were chanced. Before people used river and pond water but now they use shallow tube well and deep tube well water. For this the distance of water sources has increased that is very alarming for our universe.



**Fig 4:** Perception of farmers about changes in agricultural patterns

In the column chart, according to majority farmers the source of irrigation source has been changed a lot. Use of surface water and ground water raised much. On the other hand, amount of crops and quality of crops has been decrease mostly. The use of ground water has been increased very much in some areas of Tangail district. Most of the farmers of surveyed areas agreed that the use of chemical fertilizer and insecticides have been raised

significantly which are playing a negative role in crop quantity and quality. As the source of irrigation have been changed much, so government should concentrate on digging of small canals and river to use seasonal water to cultivate lands. Government also should concentrate chemical fertilizer and insecticides uses. Because of these are related to health hazardous impact. We should increase the use of natural compost fertilizers.

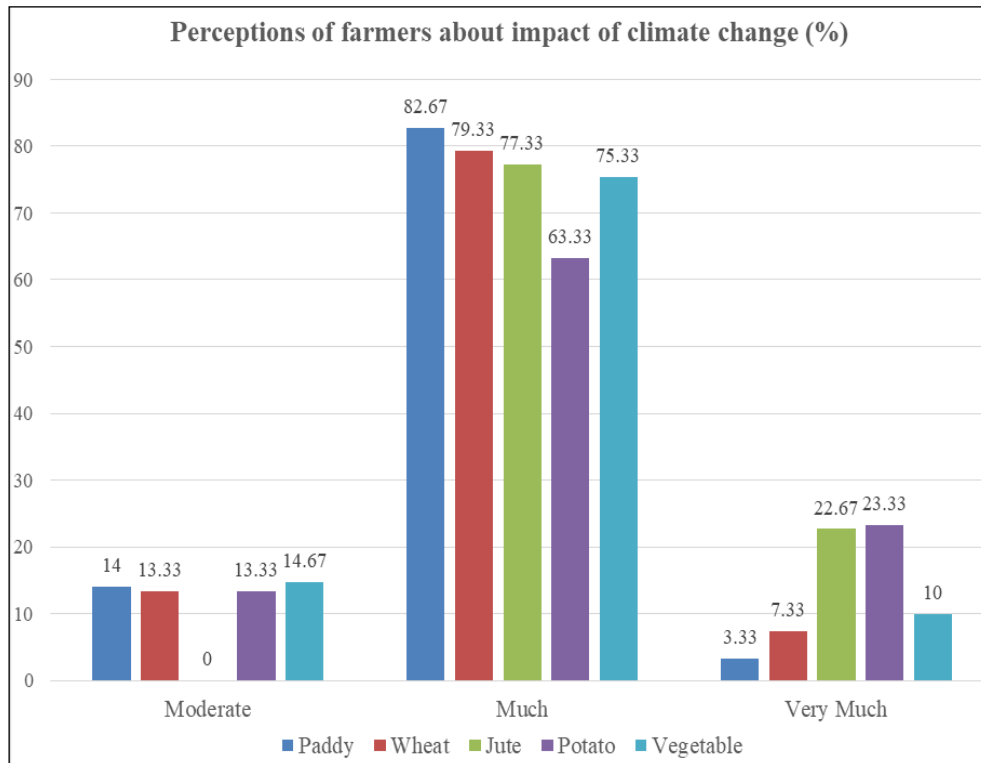
**Table 17:** Perceptions of farmers about impact of climate change on the types of agricultural crops

Agricultural crops	Moderate		Much		Very Much	
	No. of Respondents	Percentage (%)	No. of Respondents	Percentage (%)	No. of Respondents	Percentage (%)
Paddy	21	14%	124	82.67%	5	3.33%
Wheat	20	13.33%	119	79.33%	11	7.33%
Jute	0	0%	116	77.33%	34	22.67%
Potato	20	13.33%	95	63.33%	35	23.33%
Vegetable	22	14.67%	113	75.33%	15	10%

Source: Field survey in Tangail district - 2021

Farmer perceptions on the impact of climate change on the types of agricultural crops are presented in Table 17. Due to climate change, production of paddy, wheat, jute, potato and vegetables are being hampered. Due to climate change

native species of paddy and other crops are replaced by artificial species. For that reasons people are suffering from malnutrition.



**Fig 5:** Perceptions of farmers about impact of climate change on the types of agricultural crops.

Above figure is showing that number of farmers varying 63.33% to 82.67%, are representing the impact of climate

change has a negative effect on various crops yielded locally in Tangail district.

**Table 18:** Total area and production of different rice crops from 2014- 15 to 2020- 21 in Tangail

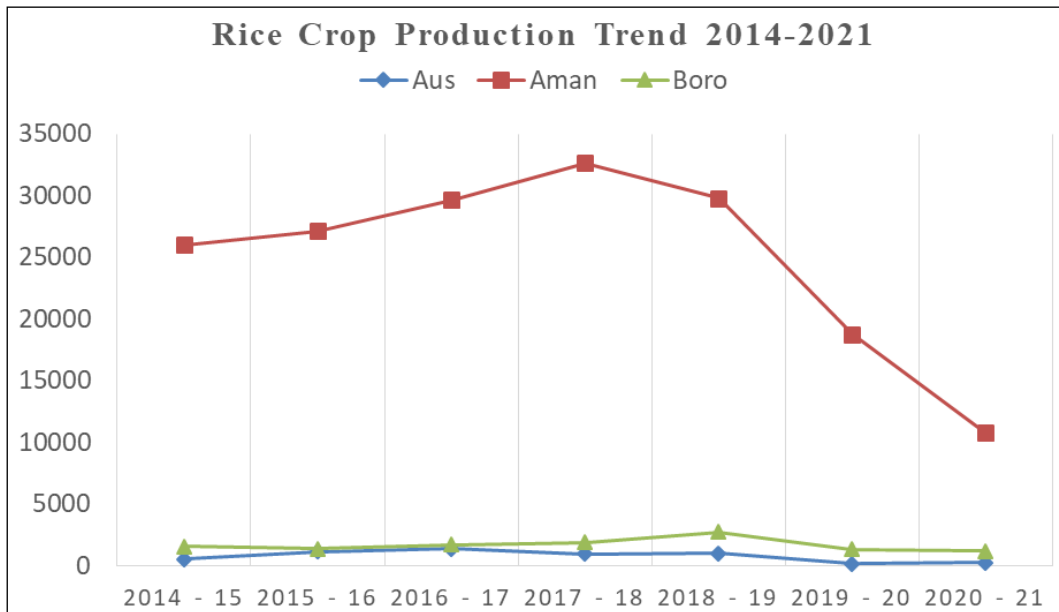
Year	Aus		Aman		Boro	
	Area (Hectors)	Production (MT)	Area (Hectors)	Production(MT)	Area (Hectors)	Production(MT)
2014 -15	329	483	23314	26021	875	1517
2015 -16	1114	1116	23895	27110	948	1361
2016 -17	987	1338	25936	29665	856	1653
2017 -18	679	937	32645	32645	844	1881
2018 -19	684	948	33001	29771	792	2681
2019 -20	103	142	17525	18751	733	1310
2020 -21	163	199	16297	10733	676	1168

Source: bbs.gov.bd

Table- 18, shows that the cultivable land of Aus, Aman and Boro have been reduced significantly these years. This also

shows that the quantity of production of crops in Aus, Aman and Boro has been reduced accordingly.





**Fig 6:** Production changing trend of various rice crops (2014- 2021)

In above line chart, vertical axis is showing the production quantity trend in (MT) and horizontal axis is show the yield year from the year of 2014 to 2021. Here we can see that Aus rice production was almost stable up to 2016-17 year and in falling trend the following years. Aman rice production was in increasing trend up to 2017-18 year, after that it’s production has been reduced significantly year after year. Boro rice crops production was also in stable production stage till 2018-19 year and later on falling production trend. As we see here, all rice crops production is in falling production trend, so our government should take proper steps to find out the factors that are causing production fall and find out appropriate path to solve this alarming issue.

**Table 19:** Total area and production of wheat from 2014-15 to 2020-21

Year	Area (Hectors)	Production (M. Ton)
2014 -15	6082	15893
2015 -16	6665	17338
2016 -17	6002	16703
2017 -18	6069	18350
2018 -19	4200	12169
2019 -20	4446	11642
2020 -21	4850	13813

Source: bbs.gov.bd

Table-19, shows that the cultivable land and production of Wheat in Tangail district from 2014- 15 to 2020- 21 has been reduced gradually.

**Table 20:** Total area and production of jute from 2014-15 to 2020-21

Year	Area (Hectors)	Production (M. Ton)
2014 -15	20724	221236
2015 -16	19956	199718
2016 -17	19566	197752
2017 -18	19655	209762
2018 -19	18077	197888
2019 -20	13887	135209
2020 -21	14566	151530

Source: bbs.gov.bd

Above table shows that that the cultivable land and production of Jute in Tangail district has been reduced significantly.

**Findings**

From our study we found that climate change has becoming a major threat for Bangladesh because here most of the peoples live and livelihood depends on agriculture. From the survey 93.33% peoples main occupation is agriculture. This paper studies that because of climate change vulnerabilities yield of rice has been reducing every year. Aus, Aman and Buro all rice crops is in falling in production trend. It also found that production of wheat, jute, potato, vegetables are being hampered. From study we found only 4.67% farmer used modern technology, which is very alarming. Ground water use increased, quality of crops also reduced, excessive use of fertilizer reduced the fertility and quality of land. We found that education level of the present generation of farmers is increasing and the perceptions that the temperature is rising, timely rainfall is not available and crop production seasons are shifting. If the local people follow the adaptation measures they can fight against climate change problem.

**Recommendation**

In order to create an inclusive and truly comprehensive mitigation scheme Bangladesh should emphasis on development of research, capacity building and disaster management, institutional and infrastructure strengthening, and low carbon technologies. For climate change adaptation government should develop national action plans and to allocate fixed proportion of national budgets to check on the effects of climate. Debate on the constructive issues of technology and production transfer should be encouraged. To mitigate worst climatic impacts urgent action is needed to build buoyancy through economic development. It is necessary for Bangladesh to identify all present vulnerabilities and future opportunities, adjusting priorities and trade policies in the agricultural sector while promoting training and education throughout the masses in all possible spheres. Some other recommendations are –

- Pesticides use should be reduced.
- Instead of chemical fertilizer organic fertilizer should be used in agricultural land.
- Crop pattern that is adapted in climate change should be innovated.
- For facing the challenges of climate change appropriate adaptation techniques should be developed.
- For agricultural production use of ground water should be reduced and arrangements be made for increasing use of rain water.
- Instead of artificial crops, vegetables and fishes' native species should be innovated by digging more channel and ponds water storage has to be increased.
- Shorter maturity variety of crops should be innovated and their availability should be increased.
- Agricultural loan facility should be increased.
- For long run remedy one need to start multidisciplinary human capacity development planning and implementation for climate and environmental management.
- Awareness of people about favorable climate should be increased.

### Conclusion

Climate change which is the result of burning fossil fuels and excessive use of natural resources, is affecting the earth's temperature and hydrological cycles and its impacts heavily on Bangladesh. This situation should be seen an urgent vigorous action and take immediate step to mitigate this danger, climate change is no longer a myth but it is a scientific observation. The World Bank (2013) shows that the World Bank is now 0.8 °C warmer than pre-industrial levels, and it also predicts that a scenario in which the world is 2 °C warmer. It is predicted that Bangladesh drought-prone areas are warmer and drier than 50 years ago, and current projection suggest that Bangladesh will become hotter and will face frequent drought due to increased rainfall variability. The main climate induced natural events, adaptation practices in terms of cropping pattern, choice of seed, management of irrigation, intensification of crops and selection of suitable date for transplantation have been suggested to farmers adapt to climate change. There is no doubt that because of climate change agriculture is badly affected and loss of agriculture would increase many social problems and force to import food, which will require spending currency. So the government, the people of BD and international bodies will be having to work united to face the climate change problem.

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### Conflict of interest

The authors declare no conflict of interest.

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