

## Impacts of Climate Change on Agricultural Production and Food Security at Sreeramkati Union of Pirojpur District

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### Abstract

The purpose of the study is to assess current climate change scenarios at Sreeramkati union of Nazirpur Upazila under Pirojpur district in Bangladesh, analyze the relationship between climate change scenarios and agricultural production, fisheries and livestock sector and then prescribe adaptive measures against climate change. Necessary data has been collected through both primary (household questionnaire survey, direct observation and key informant interview) and secondary (book, journals, articles, upazila office etc.) data sources. Food Security Index (FSI) have been used to estimate the food security. Climate change in Sreeramkati union has resulted in significant decline in agricultural production (45%), fisheries (36%) and livestock sector (19%). People (43%) are well informed about climate change but most of the respondents (66%) cannot understand about shifting season. The temperature is rising to almost 32°C & timely rainfall is not available. The lessons show that people (77%) are aware of climate change and its impacts on food security (82%). But, deficit of knowledge is the main cause to adapt these changes. Lack of training and infrastructure are also responsible for less production. Day by day, hybrid crops like Boro fields (66%) are increasing instead of local varieties and fish culture (68%) is adopted in the lieu of fish catching (32%). About 81% respondents agreed that their present condition is bad. The impacts of climate change cause less production (56%), high cost of food, less affordability, low utilization and availability of food which cause food insecurity. Regarding food insecurity, people are suffering from mal-nutrition and different diseases which decreases the livelihood status and socio-economic development. The findings of the study could be beneficial to government and policy makers during different decision making for food security in Bangladesh.

**Keywords:** Agricultural Production, Climate Change, Food Security, Adaptation

### 1. INTRODUCTION

Food is the basic need for all living organisms to continue their life cycles. Food security achievement is the key development priority for all developing countries such as Bangladesh [1]. Food security is a global concern for every individual; one in nine people around the world (805 million) go hungry every day [2]. Moreover, the hidden type of hunger that is caused by deficiencies in micronutrients such as iron, Vitamin A, and Zinc affects two billion people worldwide [2]. Bangladesh is an agrarian country where more than half of the population are engaged directly in agriculture for survival. Besides, a lion share of the national economy comes from the agriculture sector [3].

Bangladesh has nearly achieved self-sufficiency in food production [4], especially in the case of rice. The staple food of most people in Bangladesh is rice and more than 70 percent of their daily calories comes from rice [5]. Hence, food security is considered synonymously with self-sufficiency in rice production [6]. In addition, Bangladesh has made remarkable progress in producing wheat, potatoes, and vegetables [6], [7]. It is also worth mentioning that Bangladesh has made tremendous improvement in ensuring the food availability. However, about 32 percent of people live below the poverty line and do not have sufficient access to food [8].

The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as: “a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods”. Since all elements of food security directly or indirectly are affected by anthropogenic climate change. “Food security depends on more socio-economic conditions than on agro climatic zones and on access to food rather than the production or physical availability of food” [9].

Geographically, Nazirpur upazila is vulnerable to natural hazards as this upazila is located just beside the Kaligonga River. Climate change scenario makes the situation more critical. Due the nearness of the Kaligonga river and extreme weather event, its population often faces various types of natural disaster. Though the Nazirpur

upazila is in a vulnerable condition, Sreeramkati Union is worst affected because of its location near the Kaligonga river which disrupts the food security and nutrition level. For this reason, this area is selected for the empirical part of this research.

A recent study in this field [10] found that Climate-induced disaster like a cyclone, flood, drought, excessive rainfall, thunderstorm, tornado, sea level rise, salinity intrusion, etc. have a serious problem to the coastal area of Bangladesh. Recent evidence show that climate change is responsible for the frequency of natural disasters and climatic events in coastal Bangladesh. Another study [11] said that the impact of climate change will be felt by different parts of the world and by different people; poor countries like Bangladesh are going to be worst hit. Rapidly changing unstable weather patterns affect their living patterns. The ocean surface temperature and rising sea levels are likely to intensify cyclonic storm surges and further increase the depth and extent of storm surge induced coastal inundation. With the rise in temperature, sea level will rise because of thermal expansion and ice melt. It is very likely that mean sea level will contribute to upward trends in extreme coastal high-water levels in the future and adverse effect on coastal zones [12]. Some related studies in this field determine the impact of climate change on Food security but these studies do not focus on whole FS rather than some portion of FS [9]. There are some studies calculate the value of food security [13] but these studies are not enough in number. As there are a few pieces of research which calculated the value of food security and measure impacts of climate change on total food security system, so this research topic is very important.

This study tries to estimate the current status of food security, determine the climatic change scenarios for Nazirpur Upazila, estimate the changes in agricultural production output under changing climatic conditions, assess farmer's perceptions on climate change and how it is affecting food security in this area and suggest possible adaptation techniques for the farmers in the area.

## 2. METHODOLOGY

### 2.1 Study Area

This study is conducted at Sreeramkati Union of Nazirpur Upazila under Pirojpur District. This is located at southern part Bangladesh which is seriously affected by climate change, with increased severity of extreme weather events directly affecting the food security of the area and damaging the agricultural crop, livestock and fisheries sector that they rely on for everyday survival. Sreeramkati Union occupies an area of 6343 acre or 25.67 sq.km and it is located in between 22°42'1.001" north latitudes and in between 89°58' 39.000" east longitudes. It is bounded by Kaligonga river in the north, Sikdermollik under Pirojpur thana and Durgapur Union in the south, in the east Kaligonga river and Sekhmattia Union in the west [14].

This union consists of 9 mauzas (Noiltola, Joypur, Kailani, Dumuria, Modurabad, Vimkati, Sreeramkati, Bolibabla and Jibogram) and 27 villages. There are two local markets (North Sreeramkati and South Sreeramkati).

The total population of this union is 27705 of which 1300 are males and 12705 are females. The male and female ratio is almost 50:49. A number of children under 18 years are 5470 of which 2645 are girls and 2825 are boys [14]. A total number of households of this union is 4630. The average household size is 3.86 person.

The density of population is 730 per sq.km [14].

There are 23 primary schools, 4 secondary school, and 4 madrassas.

The literacy rate of this Union is 64.3%. There are 1770 school going students (855 girls and 915 boys). School attendance rate of students is 95% [14].

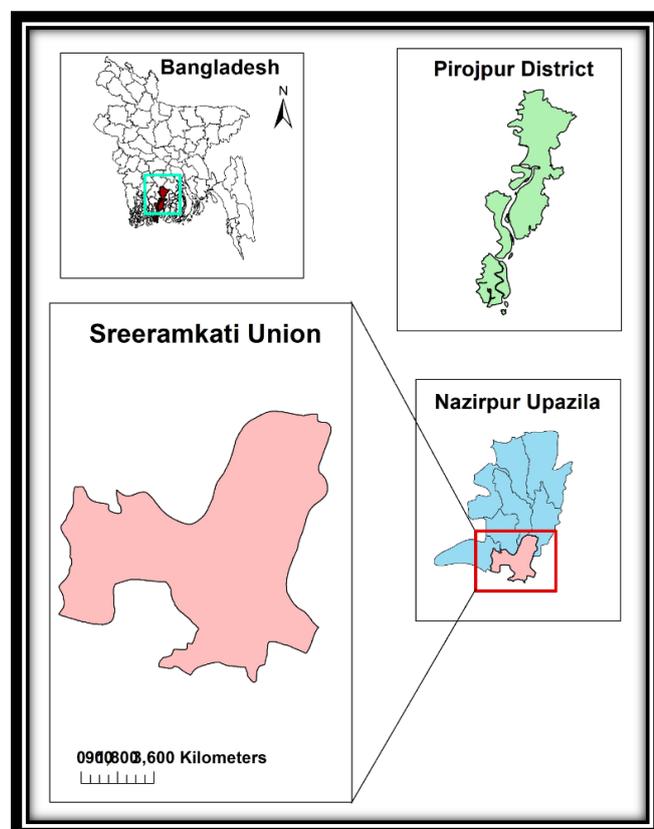
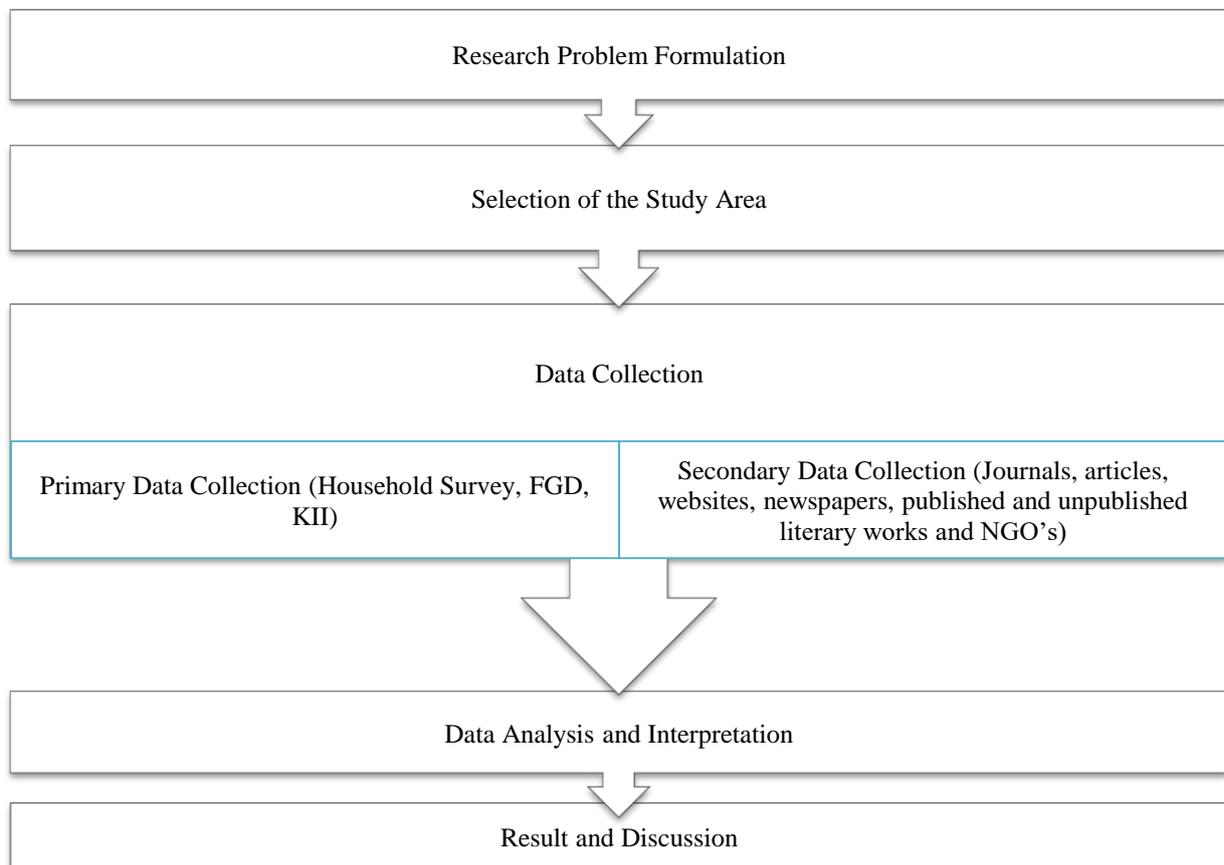


Figure 1: Study Area Map

### 2.3 Methodology of Research

Methodology is the combination of methods to conduct any research work. Despite this methodology is the sum of many methods. The main methodology adopted in this study is shown in figure 2.



**Figure 2:** Flowchart of Research Methodology

Firstly, author went through a literature review which gave information about food security in the study area. Primary data from direct observation, household questionnaire survey, Key Informant Interview (KII) gave clear information about farmers' perception of existing food production available with the importance of food security to their everyday life. Food Security Index (FSI) is used to qualify the food security in this area. Crop yield data for areas in Nazirpur Upazila obtained from Bangladesh Bureau of Statistics [14], Census of Agriculture Zilla Series, Pirojpur, Year book of agricultural statistics and Agricultural Ministry of Bangladesh. For the estimation of impacts of climate change on food security, the rainfall and temperature data were Bangladesh Meteorological Department (BMD) and Bangladesh Bureau of Statistics (BBS). The rainfall and temperature data were used to determine climatic variability and climatic scenarios for Nazirpur in Pirojpur district (Districts Statistics, 2011). The questionnaire survey was carried out after a pilot studies were carried out in each area. The target population was mainly the oldest people of a selected community because they were considered to be able to give a pattern of weather changes over a longer period of time which was considered a more reliable picture of changes in climate.

### 2.4 Measurement of Food Security

This study adopted the food self-sufficiency ratio, which is defined as the share of domestic food grain production in the total domestic consumption [15] and is called the food security index (FSI) in this study. It is presented in the equation below:

$$FSI = \frac{\sum_{i=1}^n GP_i}{\sum_{i=1}^n Food_i + Feed_i + Other_i} TGC$$

Where TGP is the total domestic grain production, i.e., the summation of rice, wheat, maize, and pulses (denoted separately as  $GP_i$ ) in rice equivalent. TGC is the total grain consumption, i.e., the summation of the grain types

consumed for food (Foodi ) and feed (Feedi ), as well as the part used for seeds, and losses during processing and storage (denoted as Otheri ).

**2.5 Determination of Sample Size**

For determination of sample size Cochran, (1963) equation was used. In the case of the 95% confidence level and 10% margin of error, the sample size was 90. Each of the village individual sample size was 30. The sample size was calculated through the following equation:

Sample size = n

Total targeted population, N =3580 [14]

Confidence level = 95%

Margin of error, e = 10%

Chi-square at 95%level of significance, Z = 1.96

The estimated proportion of successes, Standard Deviation, p=0.5 (Male and Female base)

Estimated proportion of failures, q = (1-p) = (1-0.5) = 0.5

Sample Size,

$$n_o = \frac{Z^2 * p * q}{e^2} \dots \dots \dots \text{Eq.1 (Cochran, 1963)}$$

$$= \frac{(1.96)^2 * 0.5 * 0.5}{(0.10)^2}$$

$$= 96.04$$

Then Adjusted Sample Size,  $n = \frac{n_o}{1 + (\frac{n_o - 1}{N})} \dots \dots \dots \text{Eq.2 (Cochran, 1963)}$

$$= \frac{96.06}{1 + (\frac{96.04 - 1}{3580})}$$

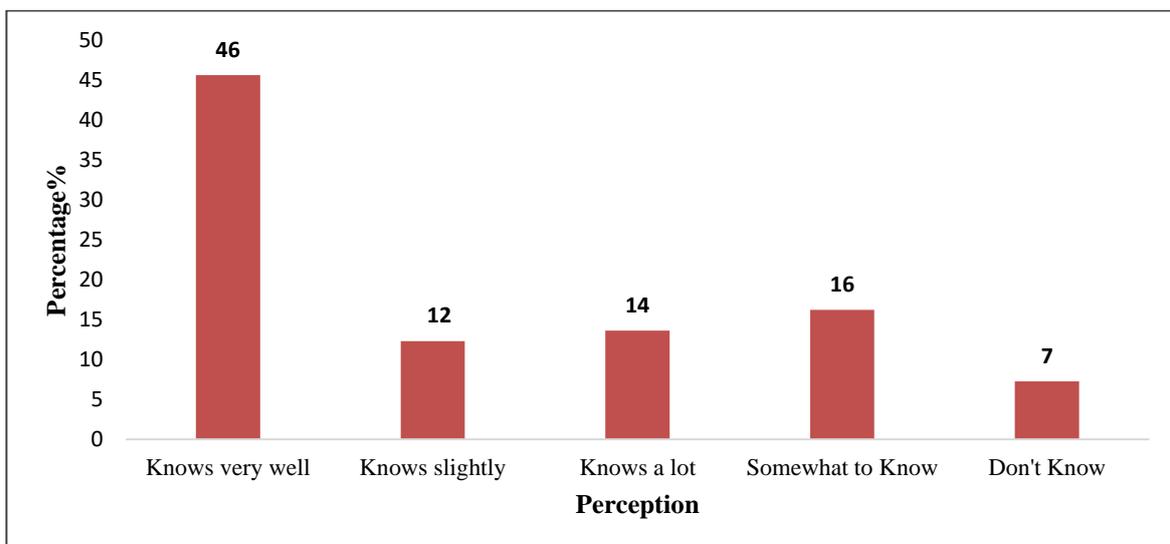
$$= 93.15$$

The determine sample size from the total population was: 93.15; for conservative measure sample was 90.

**3. RESULTS AND DISCUSSION**

**3.1 Concept about Climate Change of people**

The river side areas are much more susceptible to the recent anthropogenic climate change. Whatever the educational background of the people, most of the people about 46% of Sreeramkati are aware about the climate change (Figure 3) and 7% have no idea about climate change.



**Figure 3:** Concept about Climate Change of People

**3.1.1 Indicator of Climate Change**

According to farmer’s view the main indicators of the climate change are temperature rising 30%, erratic rainfall 20% and natural disaster activities 20%. And also shifting season is one of the indicators which is 15%. Respectively increase the tidal wave is 15% and others 10%. In figure 4 indicate the climate change indicator. Temperature and erratic rainfall are increasing in the district as well as Union according to BMD report.

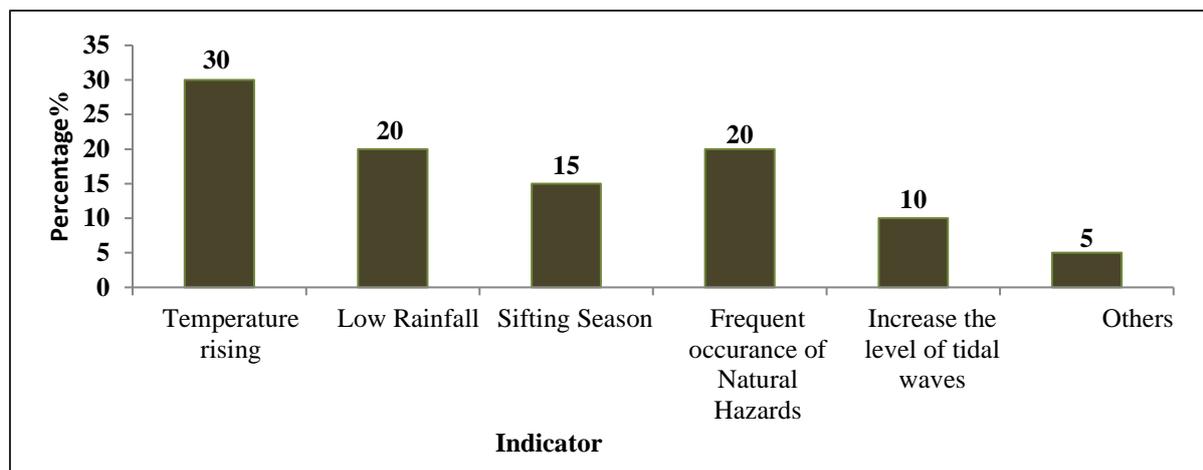


Figure 4: Indicators of Climate Change

### 3.1.2 Temperature variation in Pirojpur District

In figure 5, shows that the minimum and maximum temperature in Pirojpur District. The average annual temperature of Barisal Division 25.9°C and 30°C in May (According to BMD) which is relative to the Pirojpur District temperature rate.

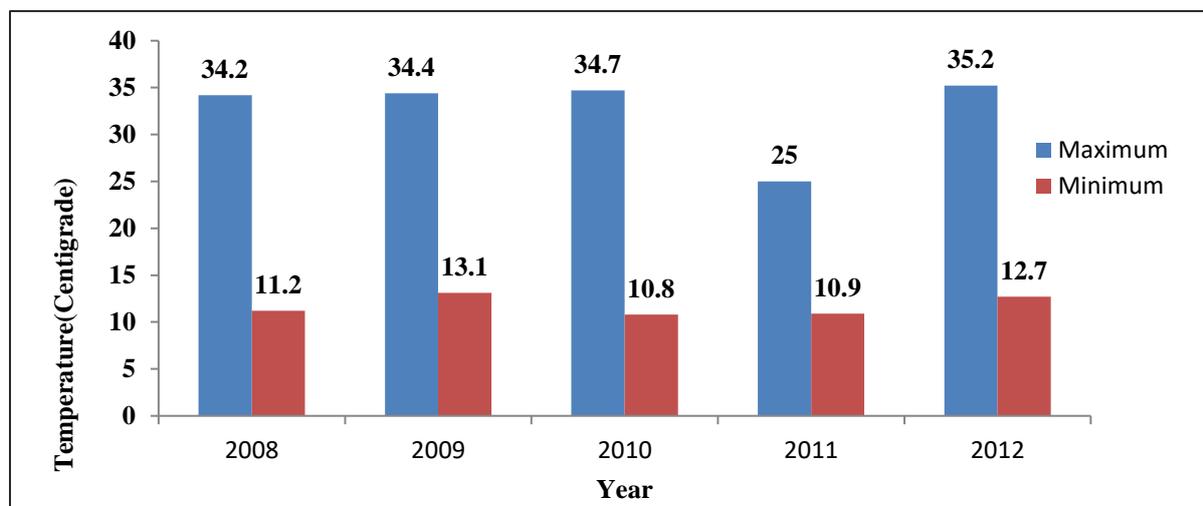


Figure 5: Maximum and Minimum Temperature in Pirojpur District between 2008-2012 (Source: BMD)

It is shown that the temperature is continuously rising. Also, it is transparent from analyzing temperature data of 2008 to 2012 that the gap between maximum and minimum is extended. Large gap shows the abrupt climatic situation.

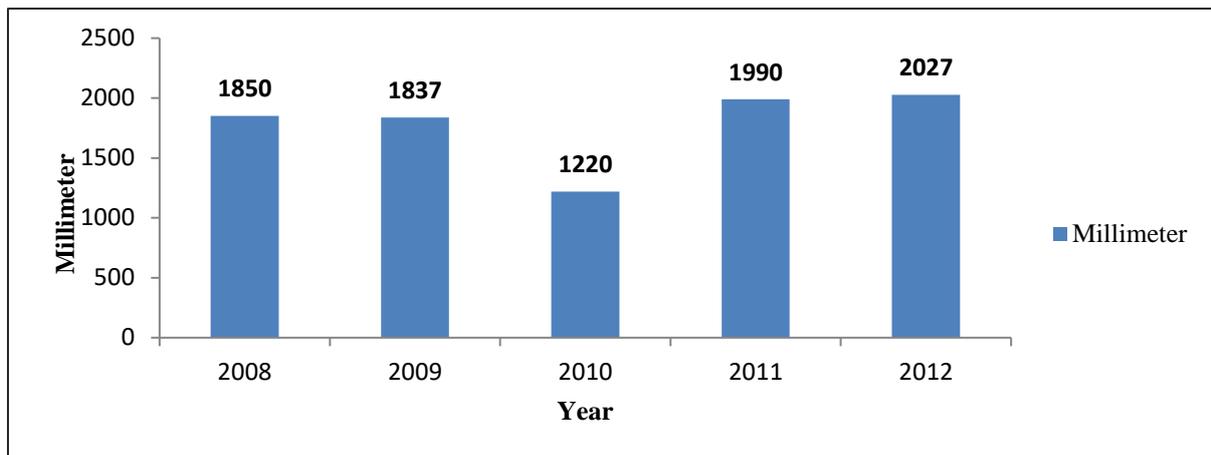
### 3.1.3 Rainfall Variation in Pirojpur District

Due to climate change the rainfall pattern expected to be dramatically changed throughout the globe. The rainfall is decreasing than the average. They also expressed that, during the summer season they experienced insufficient rainfall in recent times (Figure 6). Average rainfall of Barisal Division is 2184 mm which is nearly similar to Pirojpur District [14].

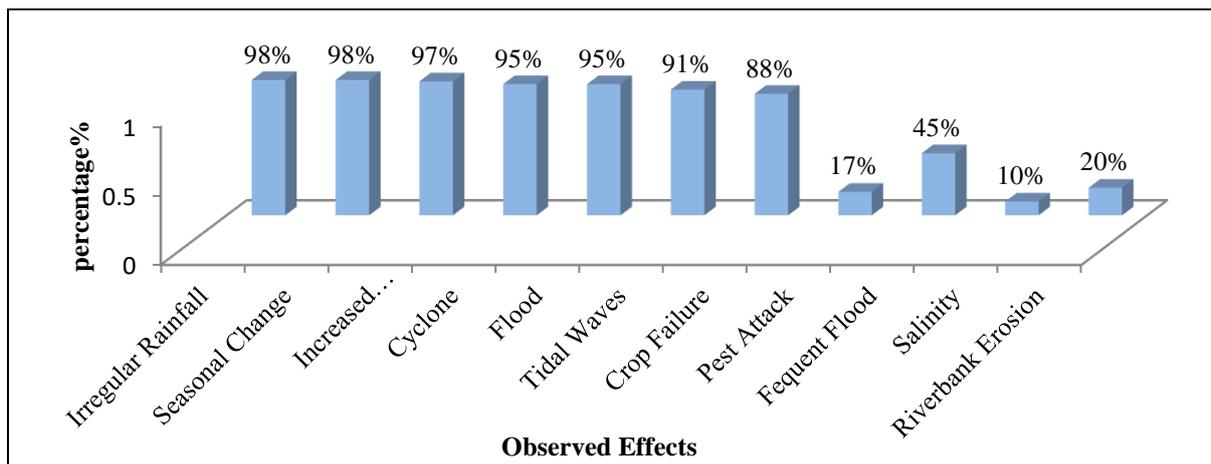
### 3.1.4 Observed Effects of Climate Change

Due to the climate change the natural hazards are also increasing. In the study area respondents experienced a wide variety of the hazards which are occurring frequently. Among these hazards, cyclone, flood, flash flood, seasonal change etc. are prominent. Despite these people also experienced that a higher river water rising during tides compared with the past. Most of the farmers can not identified the salinity intrusion which cause major damage in crop production. On the other hand, fishing sector and livestock are seriously disrupted during the flood. In figure 7, shows the effects of climate change in the study area according to the perception of respondents.

In this figure, most of the respondents (98%) claimed that irregular rainfall pattern and seasonal change occurs as the result of climate change. 97% respondents observed increase in the temperature, 95% observed cyclone and flood, 91% increase the level of tidal waves, 88% crop failure, 45% observed frequent flood.



**Figure 6:** Total Yearly Rainfall in Pirojpur between 2008-2012(Source: BMD)



**Figure 7:** Observed Effects of Climate Change

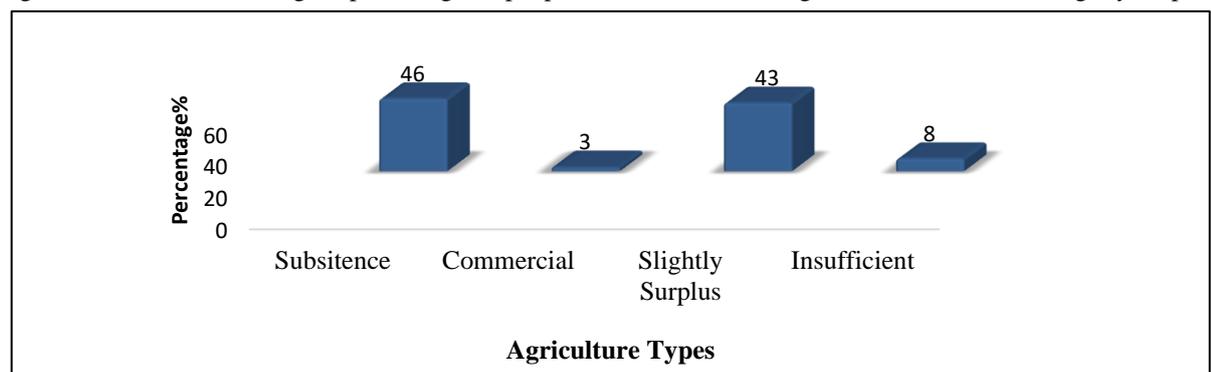
### 3.1.5 Concept about Shifting season

Shifting season is a good indication for climate change. About 66% people and 34% people are given both negative and positive views about shifting seasons respectively. From the respondents about 34%, it can be known that the people are not able to identify the seasons like the past which creates dilemma in sowing and cultivating of crops. In the present times people can identify only 3 seasons. Duration of the winter season are decreased on the other hand; the nature of the rainy season is also changed.

### 3.3 Food Security Measurement

#### 3.3.1 Types of Agriculture

The agriculture of study area has different types. Most of the people about 46% are dependent on subsistence agriculture. There are a higher percentage of people about 43% whom agriculture is under the slightly surplus

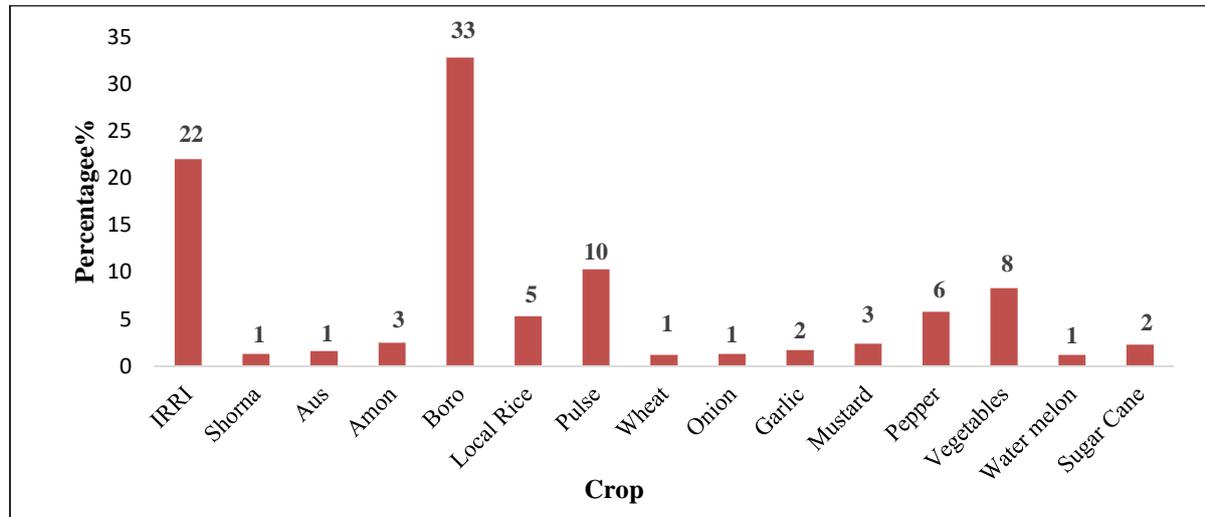


**Figure 8:** Agricultural Types

condition. There is seen the lower percentage for insufficient production. So, this situation is occurring due to blessing of modern technology in agriculture than the past times (Figure 8).

**3.3.1.1 Types of Crops**

According to the respondent’s different types of crops are cultivated in the study area. But Boro (33%) is prominent in this area.

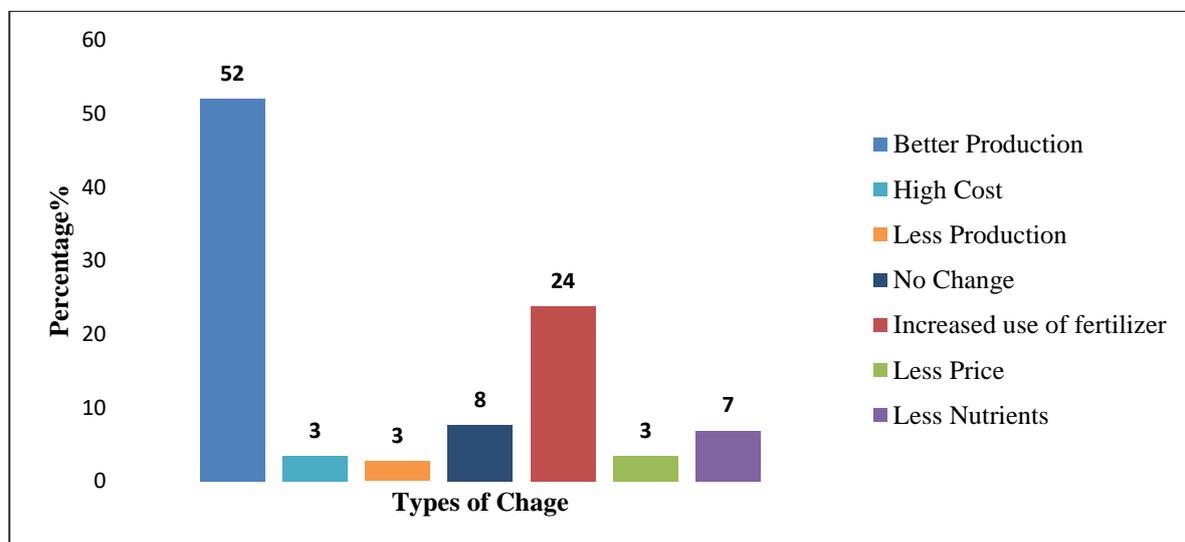


**Figure 9:** Types of Crops

Onion, watermelon, wheat, sugarcane, garlic are less cultivated because the cropping area is short. It cannot fulfill the demand the food intake. Maximum people are affording food for consumption. Different types of crops are included (Figure 9) which is cultivated in this area. According to BBS 2011, Different types of crops like, wheat, jute, sugarcane, radish, amon, boro, pumkin, cabbage etc. are grown in Pirojpur District but in Sreeramkati the availability of different seasonal crops are decreased due to lack of interest and space.

**3.3.1.4 Changes in the Crop Production**

For the time being crop production rate is rapidly changing. The people of the study area are expressing the various concepts about the changing pattern of the crop production. The maximum people about 52% expressed that they experienced higher production in their agricultural field than past times. This situation is seen due to the green revolution. Despite these the agricultural extension is taking different initiatives to increase the crop production. Some people about 3% also told that they experienced low production of agricultural products. Whatever, the situation but it can be certainly told that, the cost of the agricultural activities is also increasing for using the modern technology. (Figure 10).



**Figure 10:** Types of the changes in the crop production in Sreeramkati

### 3.3.2 Comparison between Present and Past Fish Production

As the study area is a river side area so there is seen two types of the fishing like cultured fishing (70%) and captured fishing (30%). From the view of respondents, it can be said that in the present times there is seen the prominence of the culture fishing rather than the capture fishing. In past times people were reluctant about the culture fishing in their homestead ponds. But recent times the people are much interested about the culture fishing. Decreasing trends of the capture fishing but increasing in the culture fishing is experienced in study area. Due to climate change the production of capture fishing is decreasing and for this reason people are giving more emphasis on the culture fishing for fulfillment their protein demand (Figure 11).

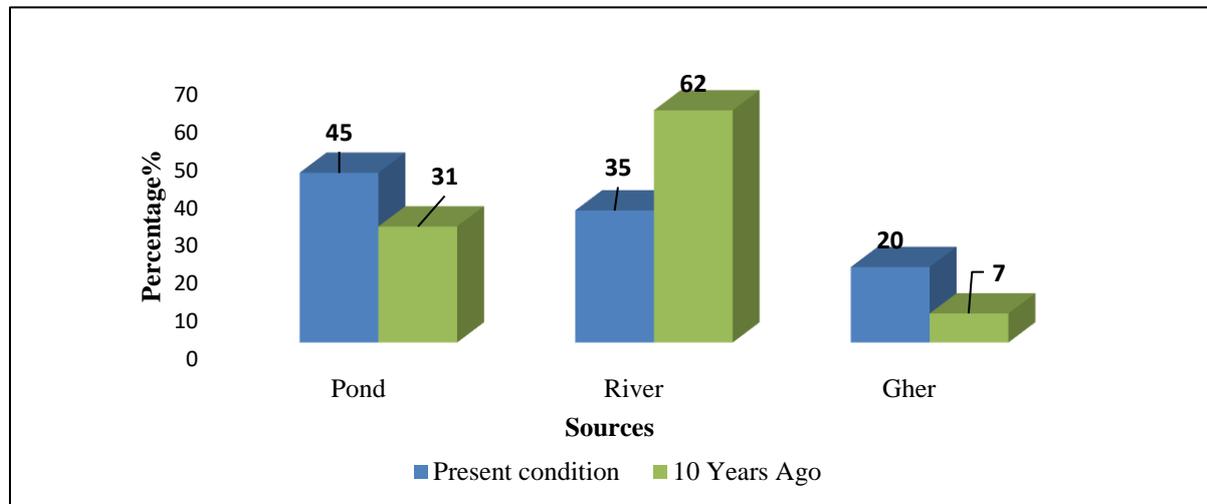


Figure 11: Comparison of fish production between present and past

#### 3.3.2.1 Changes in Fishing

Due to climate change, a great variety of changing is observing by the people in fisheries sector. Maximum respondents about 42% supposed that their fish production is decreasing in the recent times regarding to flood water. This may happen due to peoples more consciousness about the culture fishing rather than the capture fishing. On the other hand, the people are also trying to use different types of modern technologies for the culture fishing. Extinction of marine and river fish species are observing. Breeding is also hampered due to low rainfall (Figure 12).

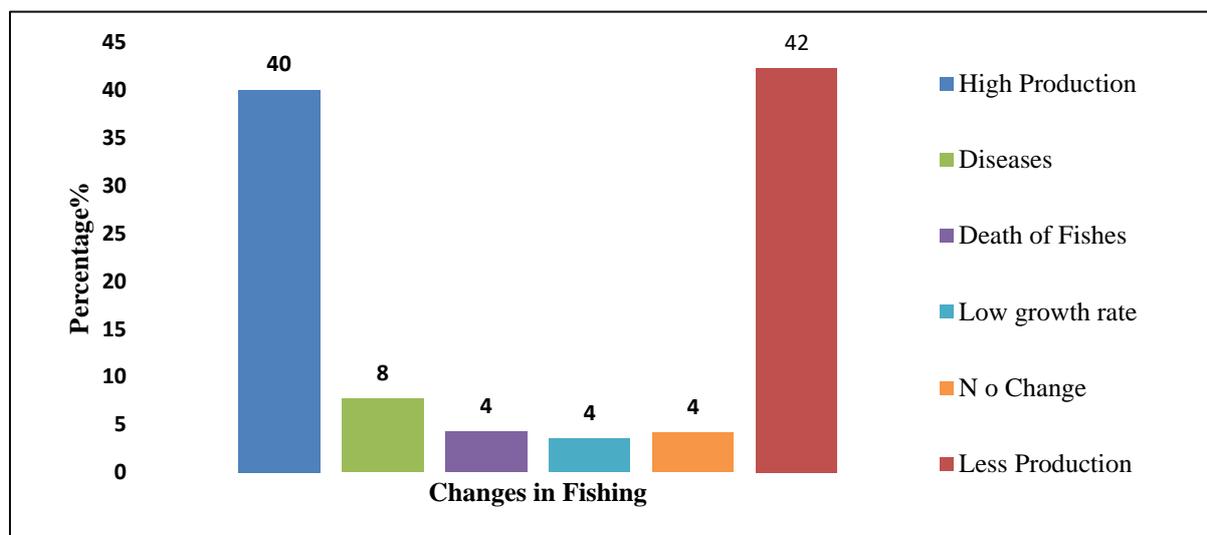
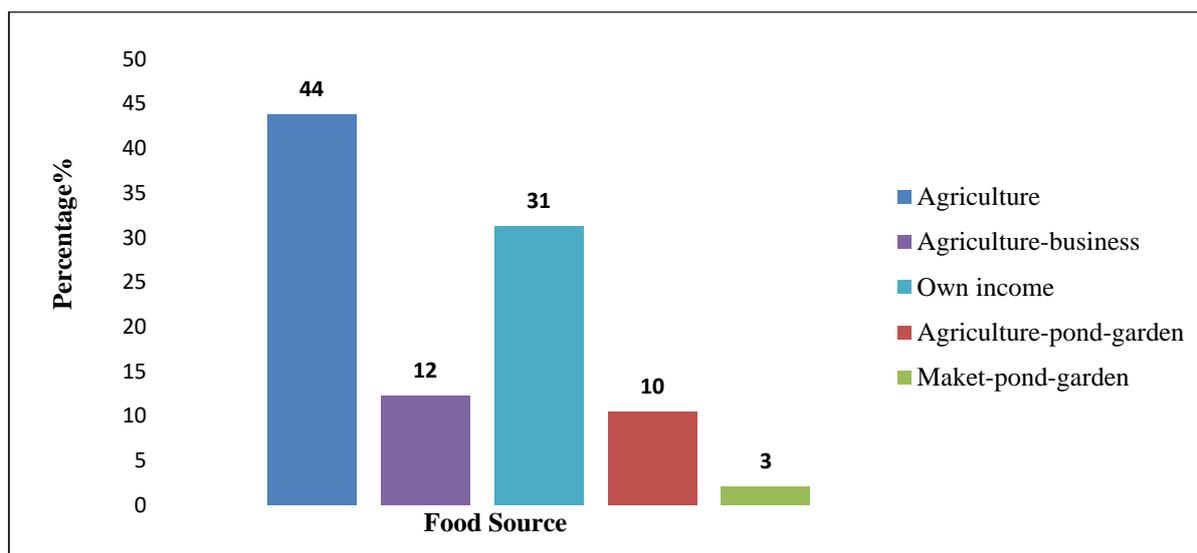


Figure 12: Types of Changes in the Fishing in Sreeramkati

#### 3.3.4.2 Sources of Food

Maximum people are dependent on agriculture (44%) for their livelihood. Despite these people are also dependent on the single source of income. So, it is very risky for future survival. As agriculture is the most susceptible sector to climate change so, the probability of food insecurity situation is increasing. On the other hand, one third of the

people (31%) is dependent on own income (day labor) so; it is also susceptible to climate change (frequent occurrence of hazards) (Figure 13)



**Figure 13:** Sources of food in Sreeramkati

### 3.3.4.3 Food Security Index (FSI)

Here, Total Domestic Grain Production=83411 metric ton= $8.3411 \times 10^{10}$  grams/yearly (District Statistics, 2011)

Total Population=166014

Daily Food consumption=468.9 grams/per day

Yearly consumption= $468.9 \times 365 \times 166014 = 2.84 \times 10^{10}$

Feedi= $1.24 \times 10^8$

Others= $0.34 \times 10^2$

$$\therefore \text{FSI} = \frac{8.3411 \times 10^{10}}{2.85340 \times 10^{10}}$$

$$= 2.92$$

Here, the Upazila domestic grain production was used because union data was not available. It shows that the Food Security Index is positive number. So, the production rate is average. According to **Global Food Security Index (GFSI)- 2019**, Bangladesh is the lowest among South Asian countries. Food Security Index of Nazirpur Upazila shows that same condition of GFSI Report-2019. Different climatic hazards cause serious damage to the crop production. So, they afford food from other sources for lack of quality & safety of food.

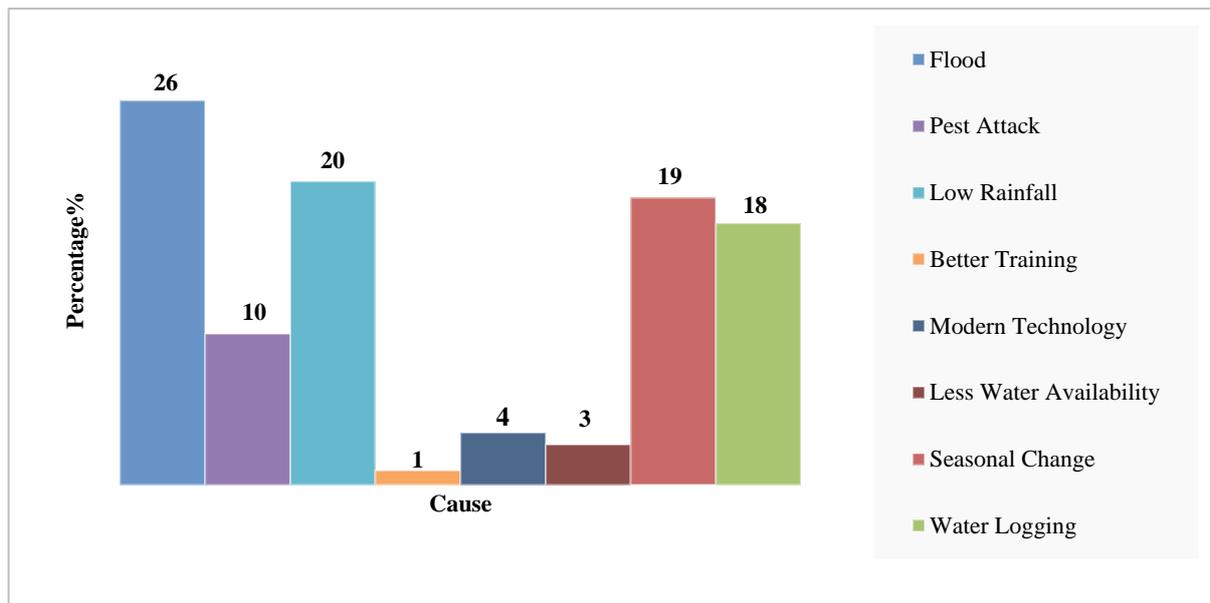
### 3.4 Impacts of Climate Change on Food Security

Agricultural in Bangladesh has been greatly influenced by seasonal characteristic and climatic variables such as temperature, rainfall, humidity, day length, etc. Crop agriculture is often constrained by different hazards and disasters such as floods, droughts, soil and water salinity, cyclones and storm surges. The Geophysical Fluid Dynamics Laboratory (GFDL) model predicted an approximate 17% decline in overall rice production for Bangladesh and as high as a 61 percent decline in wheat production under a 4o C change in temperature. The highest impact would therefore be on wheat followed by rice (Aus variety).

Climate change effects the agricultural, fisheries and livestock sector tremendously in this area. Due to climate change they apply different adaptation techniques to minimize the loss. On the other hand, they change their cultivating pattern.

#### 3.4.1 Causes of Production Change

Though there is seen the both higher and lower production of agricultural products but the farmers experienced different causes behind this change. In the study area the respondents said that their agricultural productions are changing due to the flood, salinity, pest attack, low rainfall, seasonal change, dense fog etc. (Figure 14). GFSI report-2019 shows same result for crop production. Impacts of changing climate, their susceptibility to natural resource risk & lack of adaptation are responsible for less food production as well as food insecurity.

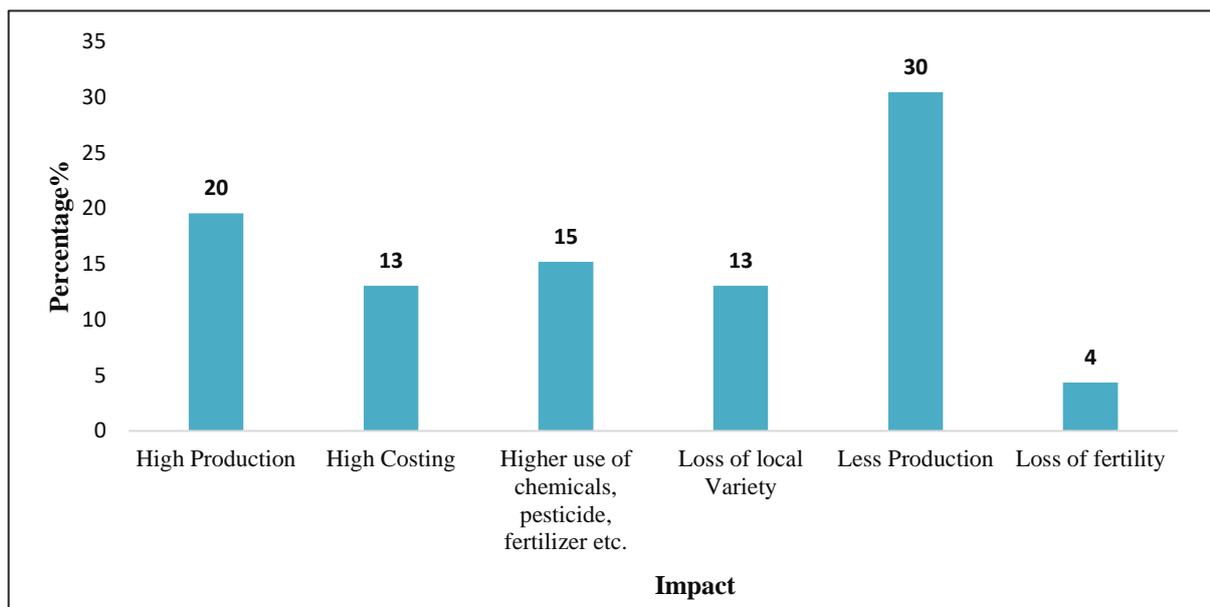


**Figure 14:** Causes of the Production Changing in Sreeramkati

According to the figure 14, flood (26%) is the major cause of production changing. In this area, training program do not get sufficiently. Salinity intrusion is low. Most of the farmers do not understand the seasonal pattern change.

**3.4.1.1 Impacts of Climate Change on Agriculture**

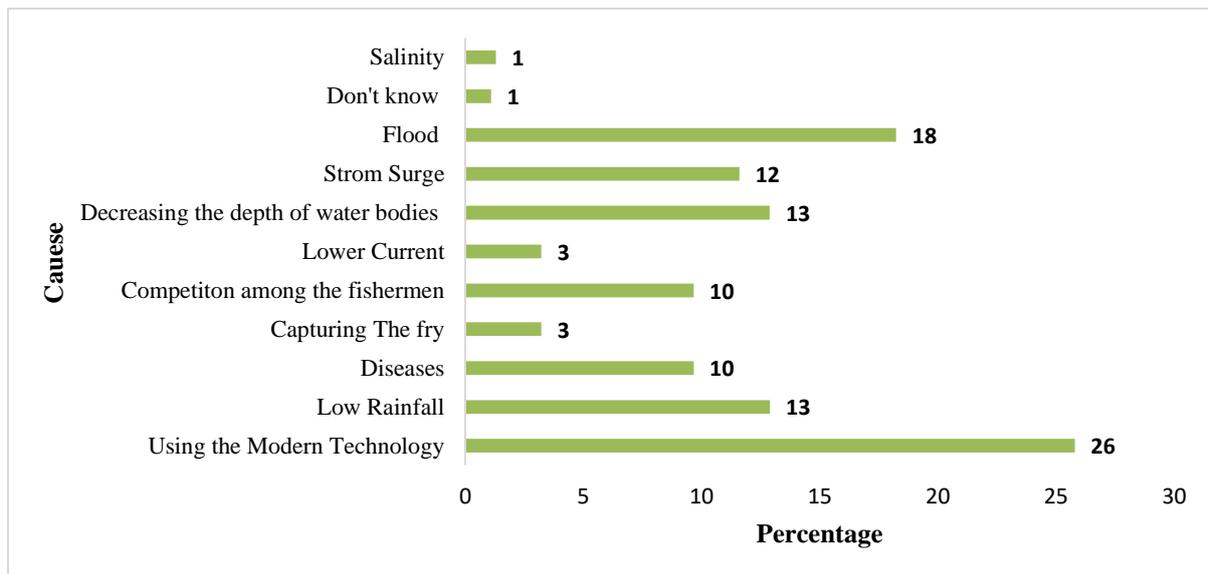
Agriculture of our country is not much modernized and also nature dependent, so, for slightly change of the climate can bring a great impact on agriculture. Though the production of rice is increasing but this production is hampered due to the occurrence of natural hazards. The normal system has changed due to climate change so this can be a cause for the low production. In the study area people are also trying to address the impacts of climate change. For this reason, they are trying to cultivate HYV rather than the local variety, so the local variety of the agricultural products are decreasing. On the other hand, due to the cultivation of HYV the costing of the production is rapidly increasing (Figure 15)



**Figure 15:** Impacts of Climate Change on Agriculture

**3.4.2 Causes of the Changes in the Fishing**

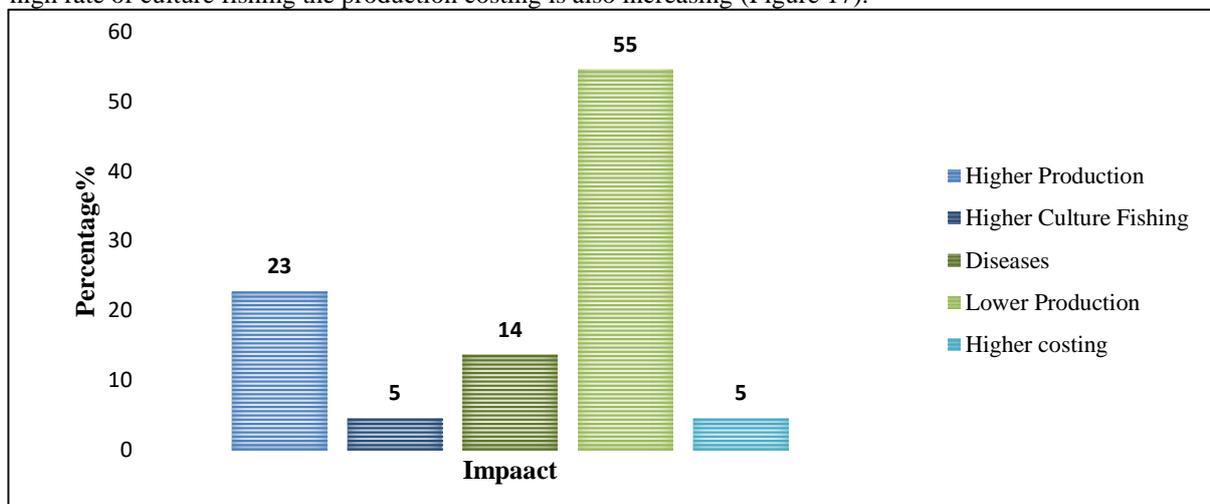
There are a lot of causes behind the changes in fisheries sector. One fourth of respondents supposed that the production of the culture fishing is increasing for using of modern technologies. One fifth of respondents experienced that the production is hampering due to low rainfall (13%) and diseases (10%). The production is also decreasing due to flood, the occurrences of the storm surge etc. (Figure 16).



**Figure 16: Causes of the Changes in Fishing**

**3.4.2.1 Impacts of Climate Change on Fishing Production**

Due to climate change fisheries sector is much susceptible. About 55% respondents believe that production of fishes is decreasing simultaneously. 23% are agreed that the production is increased. In the study area it was seen that the production of capture fish is decreasing on the other hand the production of capture fish is decreasing. For high rate of culture fishing the production costing is also increasing (Figure 17).



**Figure 17: Impacts of Climate Change on Fishing**

**3.4.4.2 Food Security in Previous Time**

As the price of commodities is increasing so food accessibility of people is facing a great threat. In this situation people of higher income range will be able to buy their commodities and low-income range people will face a great problem to fulfill their food demand. So, food security condition is becoming a great challenge to the people.

Most of the people about 70% of Sreeramkati are believed that they were in food secure condition in previous times. But in the present times food security condition is degrading for climate change and other reasons.

**3.5 Adaptation Techniques for Climate Change impacts on Food Production**

**3.5.1 Adaptation to Agriculture**

As agricultural sector is most vulnerable sector due to impacts of climate change so adaptive measures are essential to combat adverse situations. Govt. has taken many measures in agricultural sector. For these measures the impacts of climate change are not severely felt. In some parts, production of the crops is increasing for these adaptive measures. Most of the farmers about 44% are taking modern technology. 22% people are taking HYV seeds. Some parts of the people about 7% are taking flood tolerant variety etc. for the adaptation in agriculture. People are also taking the training about modern farming system to reduce the probable impacts of climate change (Figure 18).

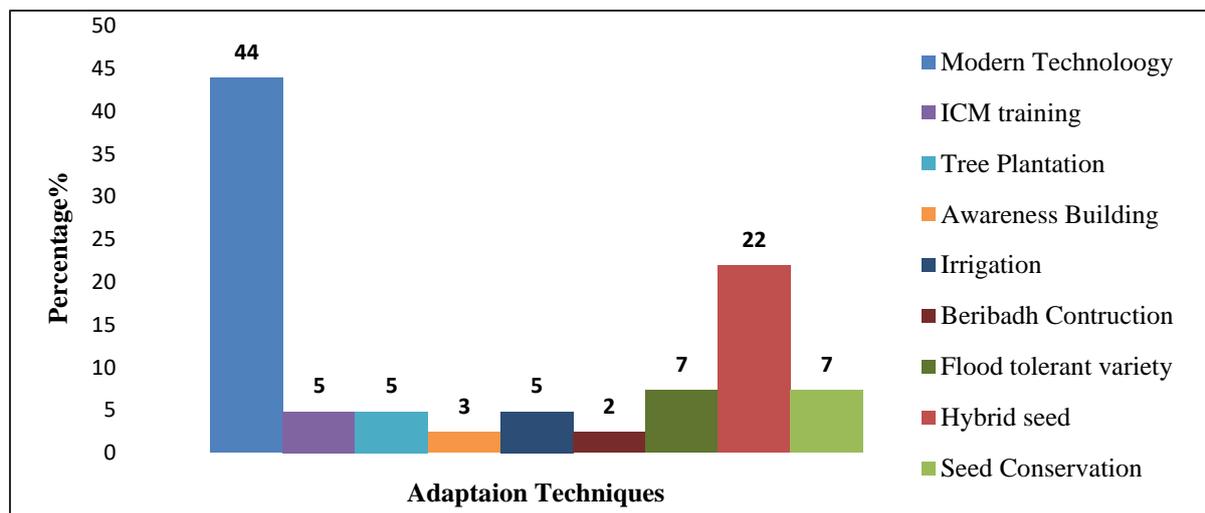


Figure 18: Adaptation to agriculture for Climate Change

### 3.5.2 Adaptation to Fisheries

The people of Sreeramkati are taking different types of adaptive measures to combat climate change. Limited assistance is given to the affected people by providing good fry and food (7%). In that area the fish training institute is not existed and a smaller number of hatcheries are seen. Different saline tolerant fishing procedures are taken by people. But fishermen do not take any appropriate training (3%) for good fish farming (Figure 19).

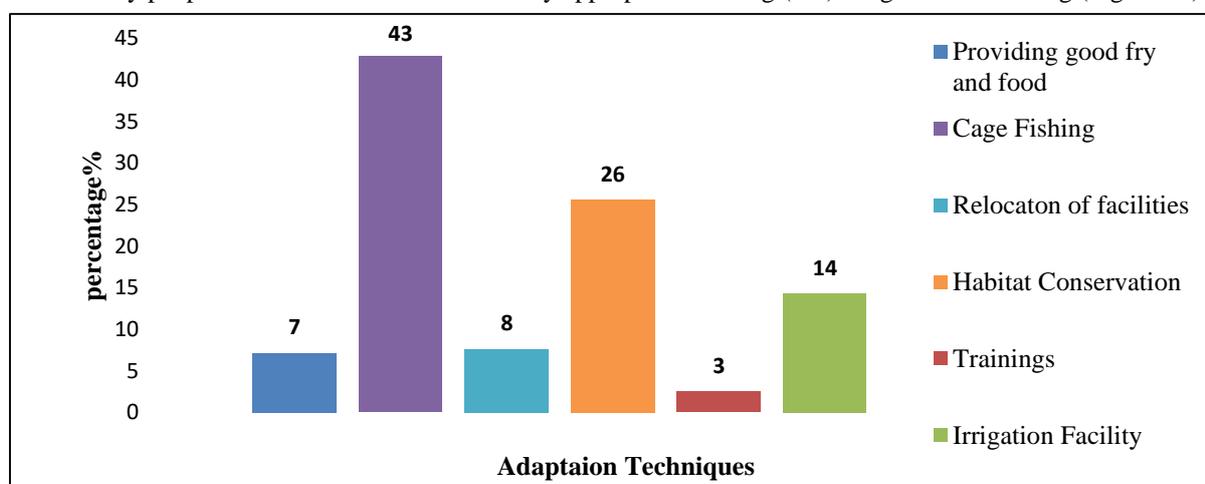


Figure 19: Adaptation to Fisheries for Climate Change

## 4. CONCLUSION

From this study it was seen the production of the different crops are increasing (40%) in Sreeramkati. In this area, local varieties are decreasing (5%) because they cultivate hybrid crops to adapt climate change. About 45% people are known very well about climate change. But most of the farmers (70%) cannot understand the changing pattern. So, they are not able to sow the seeds in time. For this why, the production rate is decreased and fall in food insecurity. According to Upazila statistics, the food security index was 2.94 which shows the positive ranking of food security. Upazila officer said that, the rate of production is increasing but different weather pattern decreases the rate. Comparison between the 2011 & 2020, haphazard weather pattern decreases the production of fish, livestock and agriculture sector. On the other hand, day by day population density is increasing. So, people built their house to spoil the cropping land and reducing the cropping area (18321 to 17020 hectare). In 2019, total surplus was 7240 metric ton and 2020, the amount is 4174.5. This data shows that unavailability of food and less quality & safety of food. Fishing culture concept is now in seasonal activities in this area. Day by day, the fish is decreased in the river. They culture different fish to adapt the climate effects. Among these techniques, culture fishing is prominent (70%). During any disaster, the fish is blown away in huge number which indicates the less production & suffer protein deficiency. The poorest people cannot afford food for high price regarding to less food availability. So, they suffer malnutrition and different diseases which hampers the socio-economic condition as well as sustainable development goals. Whatever the impacts of climate change on food security but people are at bay due to this climate change. Despite this the production rate of the crops is also increased. This is positive

news for us. Though the production of crops is increased, but the food security of the people is degraded due to less availability and quality of food. There are so many causes behind this reason. The higher production cost, higher commodity prices, higher number of populations, inflation of the money, frequent natural disasters etc. They are playing the negative roles to ensure the food security.

The findings of the research could be beneficial to government and planners during different decision-making process for food availability and food safety in Bangladesh by understanding the existing food security in Sreeramkati Union along with the utilization & quality of food and the impacts of changing climate on different crop production, livestock and fisheries.

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