Farmer's Perception on Climate Change and Adaptation Related to Drought-The Case of Northern Part of Bangladesh

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FARMER'S PERCEPTION ON CLIMATE CHANGE AND ADAPTATION RELATED TO DROUGHT-THE CASE OF NORTHERN PART OF BANGLADESH

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Executive Summary

This perception based study was conducted in the northern part of Bangladesh with the view to know farmer's perception related to climate change and drought adaptation practices. The study was conducted during the period of September 2015 to November 2016. Six villages from six Unions (Each Union from each Upazila and two Upazila from each district covering three districts) were selected for this study. The study sites were selected purposively based on drought severity ranking study (Khan and Islam, 2013). Several data collection tools were applied for the study including household interview, Key Informants Interview (KIIs), In-depth interview, case studies and Focus Group Discussion (FGDs). Total 295 respondents were selected for the study following PPS sampling method for household interview. Among the respondents 30% female quota sampling were followed for this study to get female perception and insight it. The highest number of respondents (122) was in between 30 to 40 years and only 39 respondents were over 65 years. Niskinpur demonstrated maximum average number of family members and minimum number in Rudrapur. This study found that agriculture remains as the main occupation of the study area. However, 8.87 percent respondents mentioned that they run business as secondary occupation. Among the study population, 64.7% respondents were married and only 0.3% respondents were split-up. The maximum percentage of respondents (29.8%) was mentioned that they have primary education only. The common housing pattern in the study area was clay wall with CI sheet (62.71%). 99.7% respondents have had their own land as they mentioned during the study. Average maximum land holdings were recorded in Niskinpur and minimum in Panihar village. Most of the respondents have had their own cows and hens to lead their livelihoods. As the agricultural activities, field works (planting, harvesting, ploughing etc) were performed by the men and poultry and cow rearing has been performed by the women. Non agricultural activities mostly dominated by women including cooking, cleaning and clothing. On the other hand, house repairing and marketing/shopping has been performed by the men.78.71% respondents were used tube well water and having own source (59%) in the study area. The study found maximum income and expenditure were recorded in Niskinpur from Naogaon with minimum expenditure in Panihar village and the lowest income in Rudrapur village. As the drought prone area low rainfall were recorded in the study area compared to other part of the country. In 2014, the maximum annual rainfall (1507mm) were recorded in Tanore and minimum rainfall (852.5mm) in Porsha among study locations. Drought is the common attributes in the study area. One extreme and four severe droughts were identified using 3 month SPI (April-June) for the period of 1976-2014. Using 3 month SPI (July –September), one extreme and seven severe droughts were reported for this study. Only 3 severe droughts were identified using 3 month SPI (October-December). The study sites experienced average temperature (25.22°C) during the period of 1976-2014 with the average maximum and minimum temperature of 30.1°and 16.6°. Analyzing the daily temperature data for the period of 1976 to 2014, 113 days were found as the hot days in 2010 followed by 108 days in 2014, 107 days in 2012, 98 days in 2009, 97 days in 2013 and 85 days in 1979 (Considering temperature range 30^0C-40^0C).Average humidity of the study area was recorded 76.96% with the range of average maximum (87.5%) and minimum humidity (59.6%) during the period of 1976-2014. The highest humidity was 80.7% in 1990 followed by 80.3% in 1998 and the lowest humidity was 70.4% in 1976 followed by 71.1% in 1979. The maximum humidity percentage was recorded in 1990. It was observed that the highest soil moisture was found 24.87% in 2003 followed by 21.43% in 2004 and the lowest soil moisture was found 11.88% in 2010 followed by 16.11% in 2009.The farmers perceived weather as a day to day status of several parameters including temperature, rainfall, natural disaster and more moisture in the sunshine. There is no firm definition and clear understanding of climate change as perceived by the respondents. They only understand climate change means the changes of average weather for long time.

Respondents mentioned few numbers of weather and climate change indicators including temperature, rainfall, soil fertility, ground water level, soil rupture, drought and flood. Variation in temperature and rainfall were observed over times. The respondents mentioned that the temperature is increasing day by day but the rate of rainfall is decreasing. The respondents think that the ground water level is going down because they face shortage of irrigation and drinking water during the summer. According to farmers' perception, ground water table goes down during dry season and for this reason the top layer of soil become dry. This situation creates cracks on the ground. As a result, soil fertility decreased which made the lands unsuitable for cultivation and yield become low. As perceived by the local people, increase of temperature during summer means, more sunshine during the day which leads soil rupture, less rainfall, less soil moisture. In this context low water level, shortage of irrigation water, decreased soil fertility and destruction of crops have been considered as drought. Respondents mentioned that drought has frequently increased due to climate change. Based on the qualitative data analysis it is found that, local droughts occur regularly and affect the crop production, livelihoods, health and society. Several drought symptoms or indicators were identified by the respondents including soil crack, decrease in the soil fertility, burning of crops and changes in cultivation period. This study found that farmers has changed the cropping time either prior to the beginning of the cultivation time or later period of the cultivation season to reduce drought impact. Maximum number of respondents has changed cropping time 11 to 15 days prior to actual cultivation time as a drought adaptation measure due to climate change. They have been suffering from diarrhea, fever, dysentery, dizziness, headache, skin disease, blood pressure, jaundice, fluxes, cough, cholera and dehydration. It was mentioned that the people of the study area have taken some of the measures to reduce the harmful effects of drought on agriculture and their livelihoods. The measures included optimum choice of land use, selection of suitable crops for cultivation during and after the drought, land plowing before the drought and use of compost manure to improve the physical properties of soil and pond digging as a water reservoir for irrigation during the drought. They take different measures to keep trees alive and try to stop brick field to minimize the harmful environment impacts. To mitigate the economical and social impacts due to drought the people of the study area elaborate themselves to Government and private agencies for investments, available funds, loan and subsidies. They also create awareness about the ways to mitigate drought. They migrate to other region for earning money to minimize the economic loss. They recover drought loss by taking loan from NGOs, cattle rearing, loan from others, fish cultivation, changing professions, small business, small trading and selling of their own property (poultry, cattle land). The highest percentage of respondents mentioned that wheat grows well in the drought prone areas followed by Mustard, corn, lentil, potato, linseed, masakalai, paddy, and sugarcane. Respondents were also reported that organic fertilizer prevents soil aridity and hence it increase the moisture content of the soil and the use of organic fertilizer has no negative impact on the health and environment. Farmers those have diverse livelihood opportunities can manage better their livelihood during drought. They received support including seed, fertilizers (From Government) and loan and relief from NGOs to mitigate drought impact. Subsequently the respondents reported that the support was not adequate for the mitigation of drought impact. To ensure better management of drought impact, respondents were suggested for tree plantation, digging pond (both khas and private), installation of tube well, loan provision from NGOs, use of organic manure for farming, relief from government, subsidy provision from government (seeds and fertilizers) and creating mass awareness related to climate change and drought.

Chapter One: Introduction

1.1. Introduction

There is often confusion between weather and climate but they are quite different. Climate is the "average" weather for a given place or a region, which means the statistical information, a synthesis of weather variation focusing on a specific area for a specified interval. Climate is usually based on the weather in one locality averaged for at least 30 years (ADPC and FAO, 2007). The most firmly, weather is the existing atmospheric state in a specified place, which means the day-to-day state of the atmosphere and its immediate (from hours to a few weeks) variations likely temperature, humidity, precipitation, cloudiness, visibility or wind. Therefore, climate change refers to change in the emblematic or average weather of a region or city. This could be a change in a region's average annual rainfall or average temperature for a given month or season. Climate change is also a change in Earth's overall climate. It could be a change in Earth's typical precipitation patterns (NASA, 2011).The global climate is changing and it is likely to change further over in coming decades due to increasing concentrations of 'greenhouse gases' in the earth's atmosphere caused largely by human activities. This will result in greater variations in weather patterns, a greater frequency of extreme weather events such as floods, droughts and tropical storms, and gradual rises in average temperatures and sea-levels. The change is no longer something to happen in the future, it is here and now. Like Bangladesh is among the countries that are expected to be worst affected by climate change (MoEF-GoB, 2009).Bangladesh is enormously exposed to climate change impacts because of its geographical settings and locations, high population density, high levels of poverty, and the reliance of many livelihoods on climate sensitive sectors, particularly rural agriculture and fisheries. Climate change therefore warns both earlier triumphs and potentials to condense poverty in Bangladesh to date, particularly by reducing water and food security and damage to essential infrastructure during more frequent disaster events. Several natural disasters are the common feature in Bangladesh including floods, cyclones, tornados, earthquakes, and landslides and many more. The dilemma of natural disasters in Bangladesh is very widespread due to climate change. Sidr, Nargis, Bizli, Aila are just a few recent cyclones that have hit Bangladesh's coast, killing thousands of people and wrecking havoc to crops and assets due to climate change. Among all natural disasters, drought is the gradual and most unpredictable disaster. The record during the period 1866 to 1990s has proven to be the warmest decade in human history. Climate change due to global warming is a reality for this country, as it is for the planet itself. In Bangladesh, the northwestern districts are severely affected by drought as compared to other districts. The northwest regions are affected by drought due to high inconsistency of rainfall (Shahid and Behrawan, 2008). Scarcity of surface water and climatic variability cause drought episodes in the northwestern part of Bangladesh (Habiba et al.2011a, 2011b). As mentioned in the report of Habiba et al. (2012) climate change is not only the cause also human provoked activities promote drought in Bangladesh. Most droughts in Bangladesh are seasonal and can desolate crops, causing privation to poor agricultural laborers and others who cannot locate work. In these areas, *monga* (unemployment leading to seasonal hunger) is often a problem, especially in the months of November-December in advent to rice harvest. If the crop entirely fails because of drought, the circumstances for poor people can become decisive. Droughts most commonly affect the northwestern region, which generally has lower rainfall than the rest of the country (MoEF-GoB, 2009). It necessitates to respond and acclimatize to climate change has become widely recognized, and people will have to deal with its impacts, with or without the help of government. The roles and activities of women and men are socially constructed, and gender-differentiated. In order to identify positive solutions for climate adaptation

and mitigation strategies, the different realities of women and men needs to be appreciated. Rampant step towards achieving sustainable development, Bangladesh's potential to sustain its development is faced with significant challenges posed by climate change (Ahmed and Haque, 2002). IPCC reported that South Asia is the most vulnerable region of the world to climate change impacts (McCarthy et al., 2001). According to the World Bank's Global Risk Analysis report Bangladesh exists in a list of 60 countries which visage two or more hazards every year. It affirms that 32.9% of the total populations are exposed to four types of hazard. The UNDP disaster vulnerability index, published in 2004, places Bangladesh among the most vulnerable to disasters. Adaptation is a practice by which strategies to restrained and deal with the consequences of climate change, together with climate variability, can be enhanced, developed and implemented (UNDP, 2004).

1.2. Background

Climate change pretenses significant risks for Bangladesh, yet the core rudiments of its vulnerability are primarily contextual. The societal confession to such risks is further enhanced by high population and density. Many climate induced factors (sea level rise, higher temperatures, evapo-transpiration losses, reduced precipitation, and drought intensity) would in fact reinforce many of these that already impede development of Bangladesh. Bangladesh suffers from many climate dependent natural hazards, such as: riverine and coastal floods, riverbank erosion, tropical cyclones and droughts. High population density implies that more people live in areas vulnerable to climate change, and therefore could limit the capacity of people to move in response to climate change. UNDP (2004) reported that Bangladesh lost 516,239 men, women, and children during the period of 1970 to 2005 in 171 disasters. The economic costs associated with such disasters continue to grow at national level, while the impact on livelihoods at household level remains unmeasured. Development research tells us that the success and the sustainability of interventions at the community level depend, among a number of factors, on the availability of relevant local culture, knowledge and indigenous practices that can combine with new ideas to generate innovation. Human development itself is the most secure foundation for coping with disaster risk reduction. Farmers are the backbone of national economy of Bangladesh. Mostly they are facing the negative impacts due to climate change and adopting innovative coping mechanisms and adaptation measures to reduce climate change risks. There is urgent need to know farmer's perception on climate change and adaptation for documentation. Several research results reported that drought poses highest risk to the northern and northwestern part of Bangladesh. Series of studies have been pointed the impact of droughts on agriculture (Karim et al, 1990; Jabbar 1990; Jabbar et al, 1982; Mazid et al, 2005), food production (Ahmed and Bernard 1989; Erickson et al, 1993), land degradation (Rasheed 1998).

1.3. Problem statement

Drought, the result of regional climatic variability is one of the dominant threats to environment (Dey *et al*., 2011). Bangladesh is one of the most seriously affected countries suffering from various meteorological disasters such as droughts and tropical cyclones in the pre- and post-monsoon seasons and floods in the summer monsoon season (Rafiuddin *et al*., 2011). The study of Tanner *et al*., (2007) revealed that around 2.7 million hectare land in Bangladesh are vulnerable to annual drought. According to Ministry of Environment and Forest (2009) depicted that about 83% of 12.49 million hectare of T-aman cultivable land and 9.32 million hectare of rabi crop lands are affected by drought during pre karif season and rabi season respectively. Apart from agriculture, the group with low income is affected by drought, lost their occupation during severe drought especially the small farmers group. Wage laborers and farming communities are affected mostly

by drought. Drought impact increases the risk to food security, illness, reduces the sources of water (both drinking and domestic) causes migration and loss of livestock. Coping with drought and minimizing the risk, several options are exist for their survival. There is a gap between options exist and applicability of the options at community level. There is urgent need to mapping out the options exist and applicability at the community level related to drought and its adaptation. Consequently, this research intends to investigate the effects of climate change due to drought at the grassroots' also, the community peoples' perception and adaptation to changing in climate. This will help to have a better understanding of the communities' perception on climate change and existing adaptation strategies. Records showed that 19 drought periods occurred in Bangladesh between 1960 and 1991. This means a drought every 1.6 years. In the decade between 1985 and 1998 the temperatures in Bangladesh increased by 1°C in the month of May and 0.5°C in the month of November. This change in temperature is relatively high compared to the IPPC projection of 0.2 degrees Celsius per decade. Despite this increased warming in Bangladesh, extreme lower temperatures have been observed e.g. the lowest winter temperature in 38 years was recorded in 2007 reading 5°C (Huq & Ayers, 2008).

1.4. Objectives of the study

i) Broad

The broad objective of this study is to explore perception related to climate change and the best suited adaptation measures by the farmer to climate change risk.

ii) Specific

The specific objectives are to:

- determine what factors are related with weather and climate change
- find out the functional relationship between drought and climate change
- explore local adaptation measures related to drought.
- appreciate farmer's knowledge on drought and climate change adaptation

1.5. Research questions:

How do the farmers perceive climate change and drought in the context of the study?

How do they manage climate change and drought risks by adopting appropriate adaptation measures?

Chapter Two: Literature Review

2. Climate and weather

2.1 Seasons

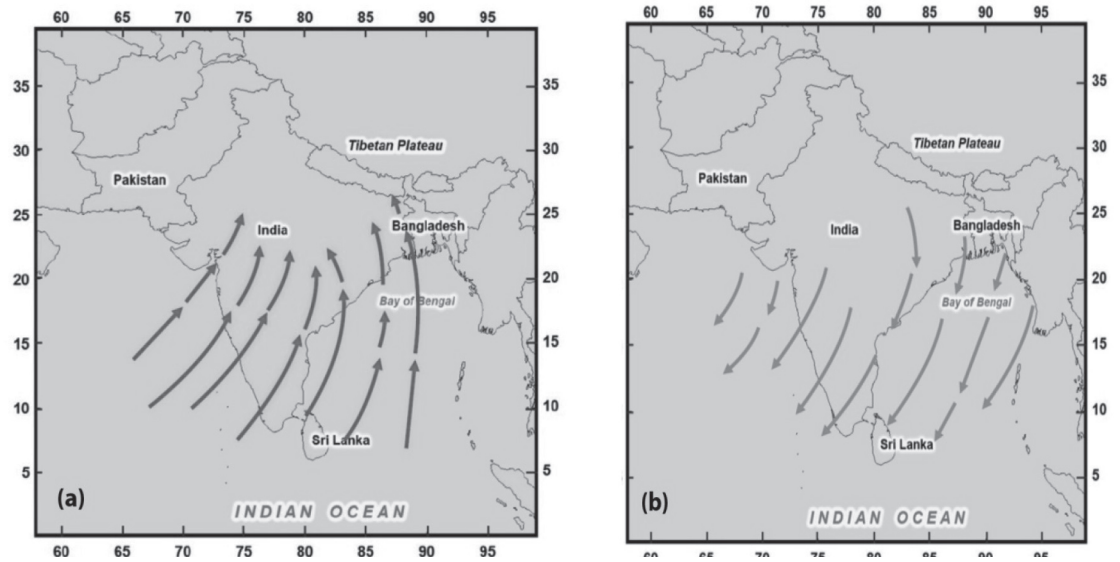
Bangladesh enjoys a sub-tropical monsoon climate and characterized by wide seasonal variations in rainfall, temperatures, and humidity. Bangladesh climate is generally sub-tropical in the north to hot humid in the south. Bangladesh is the land of six seasons. Seasonal dissimilarity occurs due to changes in the characteristics of the air flow patterns and temperature regimes. In practice, the seasons are: Summer (mid April to mid June), rainy season (mid June to mid August), autumn (mid August to mid October), late autumn (mid October to mid December), winter (mid December to mid February) and spring (mid February to mid April).

Although each season comprises two months, but few seasons stream other, while few become shorter. In agriculture, the country has experienced distinct three seasons: the pre-monsoon or hot season from March through May *(pre-kharif or kharif-1)*, rainy monsoon season *(kharif1 or kharif-2)* which lasts from June through October, and a cool dry winter season *(rabi)* from November through February. Besides, March may be considered as the spring season, and the period from mid-October to mid-November may be called the autumn (DoE, 2015).

There are four distinct seasons have been recognized in Bangladesh from climatic point of view: the dry winter season from December to February; the pre-monsoon hot summer season from March to May; the rainy monsoon season from June to September, and the post-monsoon autumn season which lasts from October to November.

In summer, the Asian continent develops low pressure as a consequence of heating and the airflow from Indian Ocean to inland. As the *southwest monsoon,* controls Bangladesh climate (Figure 2.1a). Moisture-laden air from the ocean is brought inland where it rises over the terrain and produces extremely large amounts of rainfall. Moreover monsoon, the easterly trade winds are also active, providing warm and relatively drier circulation.

The large Continent of Asia gets extremely cold and the Siberian high pressure develops and the air flow reverses in winter. The *northeast monsoon* coming from the Siberian High, a massive collection of cold to very cold dry air that accumulates on the northeastern part of Eurasian terrain is dry and cold. It conserves its inherent chilliness as it blows over Bangladesh (Figure 2.1b). The effects of continental air are felt even in the estuarine and coastal areas along the Bay of Bengal. However the coldness in the coastal region is slightly reduced because of the presence of such large water bodies (DoE, 2015).



Source: (re-drawn from Wang et al., 2003).

Figure 2.1. Wind direction during summer monsoon (a) and winter monsoon (b)

2.2 Temperature

In Bangladesh, the highest temperatures are recorded in April to May, decrease slightly during the monsoon and rise slightly in September or October when the rain ends. Mean daily maximum and minimum temperatures were recorded over the period 1984-2013, ranging from 34 to 38 and 10°C-15°C, respectively. During this period, maximum temperature ≥40°C was recorded in Rajshahi, Ishurdi and Jessore in the month of April and May. The highest temperature of 44°C was recorded on 21st April 1989 in Bogra. During the same period the highest number of days with minimum temperature ≤5°C was recorded in Ishurdi, Sreemangal and Dinajpur in the month of January. The lowest temperature was recorded 3°C in January 10, 2013 at Saidpur. Winter in Bangladesh is coolest from November to February, when the average minimum and maximum daily temperatures are about 9.7 and 26.6°C, respectively. Study areas experienced annual mean temperature 25.26°C with minimum 16.2°C and maximum 30.6°C in the year 2014 (Source raw data from Department of Meteorology, 2015)

2.3 Rainfall

Mean annual rainfall was observed in the study area 102.05 inches with the minimum mean 71.1 inches and maximum mean 125.6 inches in 2014 (Source raw data from Bangladesh Water Development Board, 2015). Average 1500 mm rainfall per year was recorded in the study area and usually rain starts in March-April and end in October. The Southwest monsoon influences the climate during June to October, and during the winter the climate is controlled by the northeast monsoon from November to March.

2.4 Humidity

An average relative humidity of the country ranges from 71 to 87% throughout the year. Low humidity is found in the month of January to April and reaches to peak during June to October. Annual mean humidity

percentage in the study area was 78.17% with the maximum 86% and minimum 63% in the year 2014 (Source raw data from Department of Meteorology 2015).

2.5 Soil Moisture

The study area demonstrated average 19.57 percent soil moisture in 2013 with the minimum 11 percentage and maximum 22.90 percent at different depth of the soil (Source raw data from Department of Meteorology 2015)

2.6 Climate change:

Climate change has emerged as one of the greatest environmental challenges facing the world today (IPCC, 2007; Anik and Khan, 2012). Developing countries, like Bangladesh, will continue to be affected by extreme weather variability such as temperature, severe water shortage, and flood-inducing rainfall events in coming decades (IPCC, 2007; Nizam, 2013). Weather inconsistency and sea-level rise are the most burning predicted consequences of climate change with a 0.6 °C global temperature change, 2% to 3% precipitation increase of the tropical latitudes and 3% precipitation decrease in subtropical areas within the 20th century. Global temperature could increase between 1.4°C and 5.8°C by the end of the 21st century (IPCC, 2001a). About 10 to 25 millimeters of sea-level rise was observed over the 20th century and models predict continued rise in a range of anywhere from 20 to 90 centimeters within the 21st century (IPCC, 2013). In the 20th century, roughly 2.7 million ha of land in Bangladesh alone were vulnerable to annual drought with a 10% probability that 41%–50% of the country experiencing drought in a given year and those figures are forecast to increase in both geographic scope and event intensity (IPCC, 2013.; IPCC, 2001b). The predicted climatic changes have the potential impacts on agrarian livelihoods people, resulting in food shortages, among other consequences. As who depend on farming activities will require a variety of adaptation strategies to mitigate the negative effects of climate change and maintain the livelihoods of farming families. Diverse fresh technologies have been developed and introduced at the farm level in order to attain target measures of the Millennium Development Goals (Rosegrant *et al*., 2008).

2.6.1 Impacts of climate change in Bangladesh

Bangladesh is a low lying deltaic country having huge rural population mass and a predominantly agrarian economy. Climate change consequences in Bangladesh is being felt in the increasing intensity, frequency and magnitudes of hazards (MoEF-GoB, 2009). Weather parameters changes are having, and will continue to have, a severe impact on production systems; particularly in agriculture and water resources (MoEF-GoB, 2009). It is mentioned that the impacts and implications of climate changes in the occurrence, prevalence and variability of the hazards will depend on the resilience of ecosystems, of the economy and of society (GED, 2014).

Climate change events affected local resource bases that people are reliant on to realize their livelihoods. It also impacts the capital assets of households, including the health and safety of the people. This is likely to affect urban slum dwellers the most. The rural poor livelihoods are shaky to climate change. Increased hazards related to climate change are spreading across time and space and have the effect of limiting livelihoods and welfare. Climate change effects are reaching nearly all means of economic activities, including crops, fisheries, livestock and cottage industries directly and may affect on the roads and high ways, flood protection infrastructure, growth centers, and transportation (MoEF-

GoB, 2012) indirectly. As poor people living in marginalized lands are exposed to hazards and a state of incremental degradation that makes their livelihood more challenging. People in rural settings are more dependent on natural resources and have limited livelihood diversity options and are thus, vulnerable to climatic variation. In response to climate change, drainage congestion is worsening and the millions of city slum dwellers are facing an increasing state of misery. Shelter, production system, livelihoods and the health and safety of people are being increasingly impacted by climate change (GED, 2014).

2.6.2 Climate Change Impacts on Agriculture:

South Asia, especially the Indian monsoon is projected to intensify, but it could also become more variable, possibly leading to a higher incidence of flooding in flood prone areas and persistence of drought in semi-arid areas. Temperature rise is expected to cause reductions in both yield and area of suitability of the region's two main cereal crops, wheat and rice, and long-term changes to the region's water resources caused by the loss of glacier melt-water. Sea-level rise is a threat to rice production in low-lying coastal zones and river deltas (Padgham, 2009).

Food production will be particularly sensitive to climate change, because crop yields depend directly on climatic conditions (temperature and rainfall patterns). Tropical regions, even small amounts of warming will lead to declines in the amount of crops harvested. In cold areas, crop harvests may increase at first for moderate increases in temperature but then fall. Higher temperatures will lead to large declines in cereal (e.g. rice, wheat) production around the world (Stern, 2006). Indirect effects on crops include increased amounts of Carbon dioxide (a greenhouse gas) in the air; this can help plants to grow (photosynthesis) and to reduce the amount of moisture lost from leaves. But like warmth it will only benefit agriculture in the short term, as other indirect effects on crops such as drought, flooding, less moisture in soils and an increase in pests and diseases will soon lead to less food being produced from farmland (Stern, 2006). Added heat stress, changing monsoon patterns, and drier soils may reduce yields by as much as a third in the tropics and subtropics, where crops are already near their maximum heat tolerance. Further to these effects forestry due to drier and hotter conditions will face increased risk of fire damage (Williams, 2002).

2.7 Drought perception

Drought is to be marked as the most complex but least understood of all natural hazards, affecting more people than any other hazards (Wilhite, 2005). It has been defined as a temporary meteorological event, which stems from a deficiency of precipitation over an extended period of time compared to long-term average conditions (Eriyagama *et al*., 2009), being one of the prime abiotic stresses in crops in the world (Cao and Limniranku, 2014). It is clear that there is no firm definition of drought; it varies from region to region based on the context. Over the time, scientist tried to define this occurrence, but still there is no clear characterization. Based on earlier observations, its perception is dependent on water deficit, (Nguyen, 2006). According to, Kapoi, K. J., & Alabi, O. (2002) drought as a relative word to normal conditions while water shortage is utter term for water demand.

2.7.1 Impacts of drought:

The extent and intensity of drought impact is determined by existing economic conditions, the structure of the agricultural sector, management of water resources, cereal reserves, internal and external conflicts, etc. (Benson and Clay, 1998). Micro level impact is largely on the entitlement to produce and procure food.

The impact varies depending upon the social structure (class, caste) and village and household resource endowments. The direct impacts of drought can be classified under four broad categories, likely physical, social, economic and environmental. The initial direct physical effects of drought on the production sectors are similar regardless of the type of economy, although the relative and absolute magnitudes of each impact will depend on specific country characteristics. Drought entails a loss of assets in the form of crop, livestock and productive capital damage as a direct consequence of water shortage or related power cuts. The industrial segment, agro-based industries are the ones directly affected, as the lower domestic production of agro-processing inputs reduces non-agricultural production. Water resources availability is also restricted. Later, this aspect has implications for health and household activities, including the time required for collecting water. As water becomes scarce, competition among and within sectors may increase. Droughts have significant impacts in both developed and developing countries. The countries still suffer from droughts the most (Wilhite, 2005) and Bangladesh is one of those countries. The northern part of Bangladesh experiences droughts regularly. Drought in Bangladesh are recurring can wreck crops, causing poverty to poor agricultural labourers and others to who cannot locate work. The common word '*Monga'* in these areas, (unemployment leading seasonal hunger) is often a problem, especially in the months leading up to November-December during rice harvest. If the crop totally fails because of drought, the situation of poor people can become critical. Drought most commonly affects the Northwestern region, which generally has lower rainfall than the rest of the country (MoEF, 2009). In the last three to four decades when climate change reported to be observed in the northern Bangladesh, the situation has gradually decreased (Habiba *et al*., 2012). In Bangladesh, the agricultural activities are mainly rain-fed and heavily depend on rainfall (Mbugua, 2011). This dependence makes this northern region particularly vulnerable to the adverse impacts of climate change. It has been reviewed in the literature that the scope (geographic coverage), frequency and magnitude of climatic changes and environmental degradation such as deforestation, water level decreasing and soil erosion have been gradually increasing in this region (Brammer, 2012). The potential adverse effects of climate change on this region's agricultural sector are of a major concern because of this dependence.

2.7.2 Drought adaptation

The word 'adaptation' has derived from the term 'adapt', which means "making things/conditions/situations better by changing" (Ahmed, 2006). Adaption makes the community to have a better way of living and communities will need to adapt to the already inevitable effects of a changing climate. Adaptation to climate change is therefore the process through which people reduce the negative effects of climate on their health and well-being and adjust their lifestyles to the new situation around them (Pender, 2008). 'In a nutshell adaptation is being better prepared or adapting to climate change, not fighting it, but learning to live with it" (Rahman, 2008).

Chapter Three: Study area and Methodology

3.1. Research Framework

This exploratory study was conducted over a period of twelve months starting from January, 2016 and ended by December 2016 to elicit farmer's perception on climate change and adaptation measures related to drought and reduce negative impacts to the rural poor.

The study was carried out following participatory rural appraisal (PRA) method because it facilitates two-way interaction between researcher and the participants. Therefore, a favorable environment was created through PRA which is important for conducting social research especially in core village. Several tools of PRA including personal observation, semi-structured questionnaire, In-depth interview, Key Informant's Interview and Focus Group Discussion were used for data collection.

All the work has been carried out in three phases. The first phase of field work has been covered the introduction with the areas and followed by field work including site selection, respondent selection, and sample selection, preparation of questionnaire and field test of the questionnaire with respondents (both male & female) and data collection (on socio-economic survey, exploratory survey, discussion with respondent and group discussion with local farmers local/indigenous knowledge). The 2nd phase has been focused on data management and analysis. Data were interpreted both quantitatively and qualitatively. And finally report is prepared based on finding from data.

3.2. Selection of the study area

Depending on the research objectives the study was concentrated in northern part of Bangladesh. In selecting of the study locations multistage sampling were followed. This sampling allows individuals to be selected in geographic batches.

In first step; the three districts viz. Rajshahi, Chapai Nawabganj and Naogoan from the Barind Tract were purposively selected based on report of Khan and Islam (2013).

In the second step; According to the drought severity ranking, a total six (06) upazila of which two (02) upazila from each district namely Godagari and Tanore under Rajshahi district, Nachole and Shibganj under Chapai Nawabganj district, Niamatpur and Porsha upazila under Naogoan district has been selected purposefully for the study.

Third steps, by using 'basket and paper' method a total six unions were randomly selected (one union selected from each upazila) namely Godagari, Kamargaon, Nizampur, Chatrajitpur, Bhabicha and Ghatnagar union selected from Godagari, Tanore, Nachole, Shibganj, Niamatpur and Porsha upazila respectively.
Similarly six baskets were taken and the name of total union under each upazila has been written separately on the piece of paper and put into the baskets. Then the basket was shaken by the hand and pickup a name of union from each basket.

And finally followed by the same method, a total six villages were randomly selected from the six upazila (one village from each upazila) for this study. The selected villages were Panihar, Batashpur, Barenda, Kanthalia para, Rudrapur and Nishkinpur.

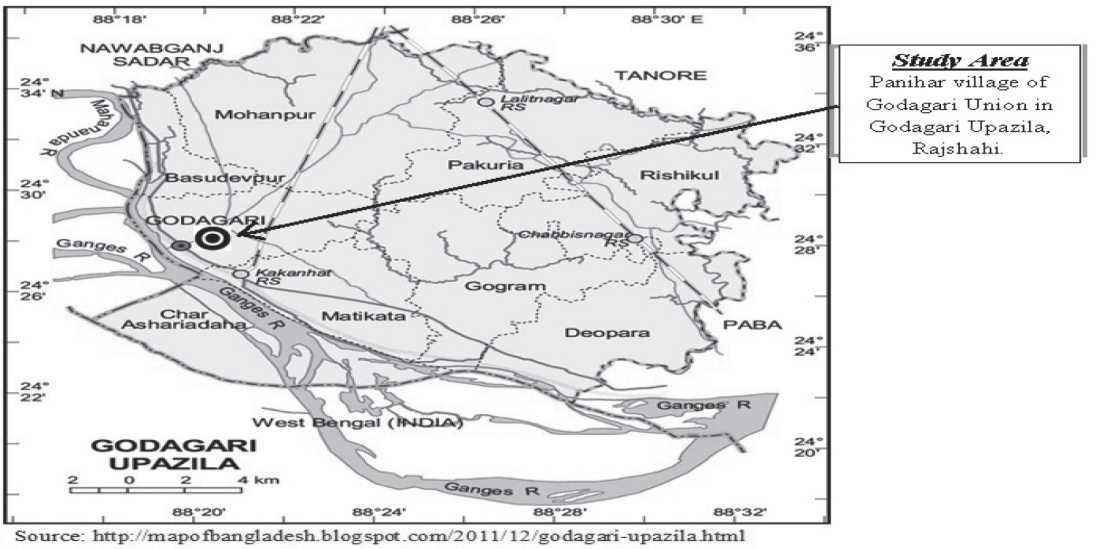
3.2.1 Description of the study area

3.2.1.1 General information of Rajshahi District

Rajshahi district was established in 1772. It lies between 24°07′ to 24°43′ north latitudes and between 88°17′to 88°58′ east longitudes. The total area of the District is 2,425.37square kilometers. The district is bounded by Naogaon district on the north, West Bengal of India, the Padma and Kushtia district on the south, Natore district on the east and Chapai Nawabganj district on the west. The region consists of Barind tract, Diara and Char lands. The district consists one City Corporation including 4 metropoliton thana, 30 wards, 170 mahallah & 9 upazilas, 71 unions, 1678 mauzas, 1727 villages, 14 paurashavas and 126 wards. According to the Population Census 2011, total number of households of Rajshahi district was 6,33,758 and total enumerated population was 25,95,197.The annual average temperature of this district varies from maximum 37.8°C to minimum 11.2°C and annual average rainfall is 1862 mm. The Padma (Ganges), Mahananda, Baral and Barnai are the main rivers of the district (BBS, 2014).

3.2.1.2 General information of Godagari Upazila

Godagari came into existence in 1865. The upazila covers an area of 475.26 square kilometers including 0.28 square kilometers forest. It is located between 24°21' and 24°36' north latitudes and between 88°17' and 88°33' east longitudes. The upazila is bounded on the north by Tanore upazila, on the east by Paba and Boalia, on the south by the river Padma and on the west by Nawabganj sadar upazila (Figure 3.1). According to Population and Housing Census 2011, the total population of the upazila is 330924 of which 166260 are males and 164664 are females. The sex ratio of the upazila is 101. The population density is 696 person per square kilometer. The upazila consists of 9 unions, 316 populated mauzas and 396 villages. In the upazila, there are 72,186 households. The average household size (General) for the upazila is 4.57 persons. the literacy rate of the upazila is 46.3 % for both sex, 46% for male and 46.6% for female. Paddy, wheat, jute, sugarcane, turmeric, oil seed, onion, garlic, potato, and betel leaf and mulberry plant are the main crops. Extinct or nearly extinct crops are Linseed, sesame, indigo, mustard seed, sweet potato, kaun, bajra, arahar and aus paddy. Main fruits are mango, jackfruit, banana, lichi, black berry, coconut, palm and papaya. (BBS, 2011).

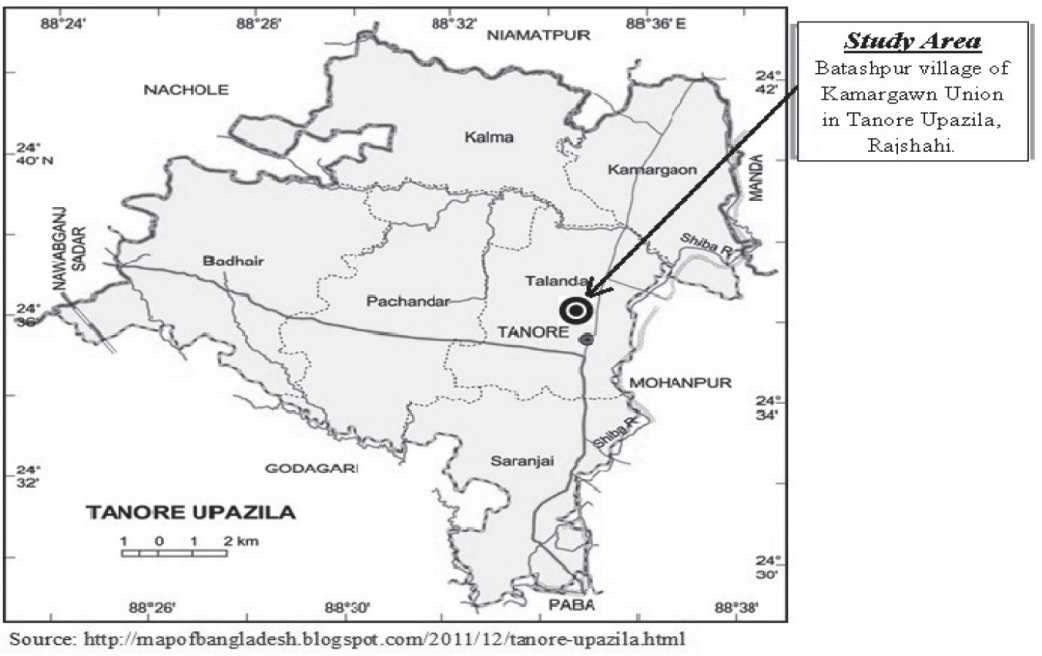


Source: http://mapofbangladesh.blogspot.com/2011/12/godagari-upazila.html

Figure 3.1 Upazila Map (Godagari)

3.2.1.3 General information of Tanore Upazila

The upazila occupies an area of 295.40 square kilometers. It is located between 24°29' and 24°43' north latitudes and between 88°24' and 88°38' east longitudes. The upazila is bounded on the north by Niamatpur and Manda upazilas of Noagaon district, on the south by Paba and Godagari upazilas, on the east by Manda upazila of Naogaon district and on the west by Nachole upazila and Nawabganj sadar upazilas of Nawabganj district (Figure 3.2).



Source: http://mapofbangladesh.blogspot.com/2011/12/tanore-upazila.html

Figure 3.2 Upazila Map (Tanore)

According to Population and Housing Census 2011, the total population of the upazila is 191330 of which 94041 are males and 97289 are females. The sex ratio of the upazila is 97. The population density is 648 person per sq. km. The upazila consists of 7 unions, 157 populated mauzas and 169 villages. In the upazila, there are 47425 households. The average household size (General) for the upazila is 4.03 persons. the literacy rate of the upazila is 48.8% for both sex (51.1% for male and 46.7% for female). Main crops are paddy, wheat, jute, sugarcane, turmeric, oil seed, onion, garlic, potato, betel leaf and mulberry plant. Extinct or nearly extinct crops are Linseed, sesame, indigo, mustard seed, sweet potato, kaun, bajra, arahar and aus paddy. Main fruits are mango, jackfruit, banana, lichi, black berry, coconut, palm and papaya.

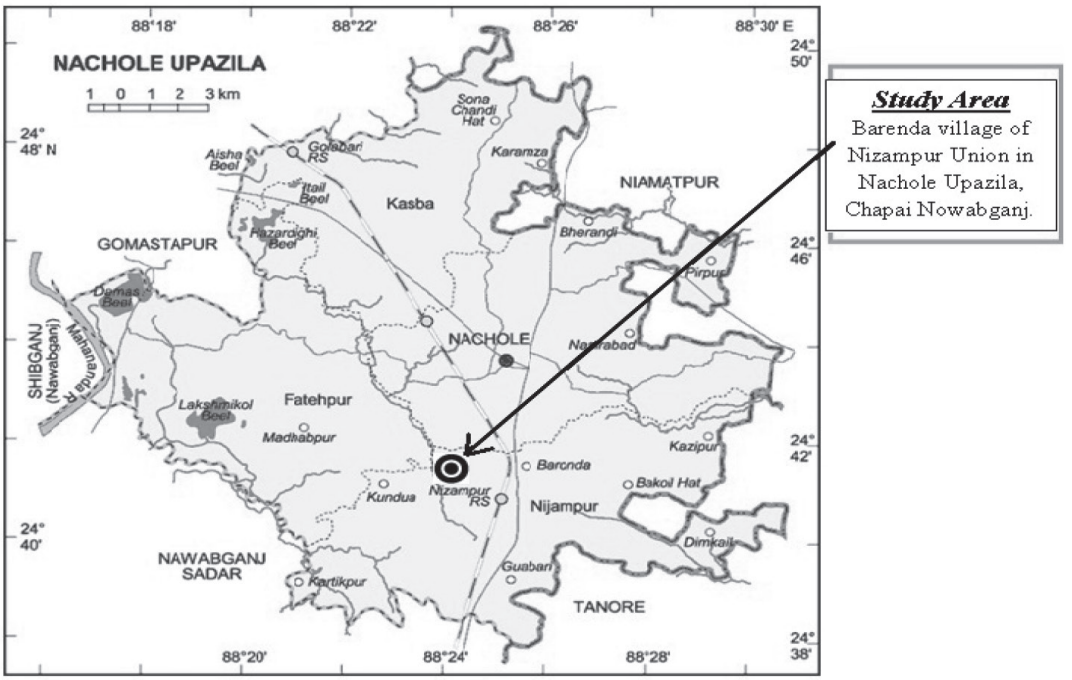
3.2.2.1 General information of Chapai Nawabganj district

Chapai Nawabganj is a district in northern Bangladesh. It is a part of the Rajshahi division. The district is bounded on the north by India, on the east by Naogaon and Rajshahi districts, on the south and west by India. The total area of the district is 1702.54 square kilometers (657.35 sq.miles). The district lies between 24˚25´and 24˚58´ north latitudes and between 88˚01´ and 88˚30´ east longitudes. The annual average

temperature of this district varies from maximum 37.8°C to minimum 11.2°C and annual average rainfall is 1862 mm. The Ganges, Mahananda, Pagla, Moraganga and Punarbhaba are the main rivers of this district. Chapai Nawabganj district consists of 5 upazilas, 45 unions, 785 mauzas, 1135 villages, 4 paurashavas, 42 wards and 156 mahallas. The upazilas are Bholahat, Gomastapur, Nachole, Chapai Nawabganj Sadar and Shibganj (BBS, 2014 and Banglapedia, 2015).

3.2.2.2 General information of Nachole Upazila

Nachole upazila occupies an area of 283.67 square. kilometers. It is located between 24°38' and 24°51' north latitudes and between 88°15' and 88°21' east longitudes. The upazila is bounded on the north by Gomastapur and Niamatpur upazilas of Naogaon districts and Tanore upazila of Rajshahi district, on the south by Tanore upazila of Rajshahi district and Nawabganj Sadar upazila and on the west by Gomastapur, Nawabganj Sadar and Shibganj upazilas (Figure 3.3).



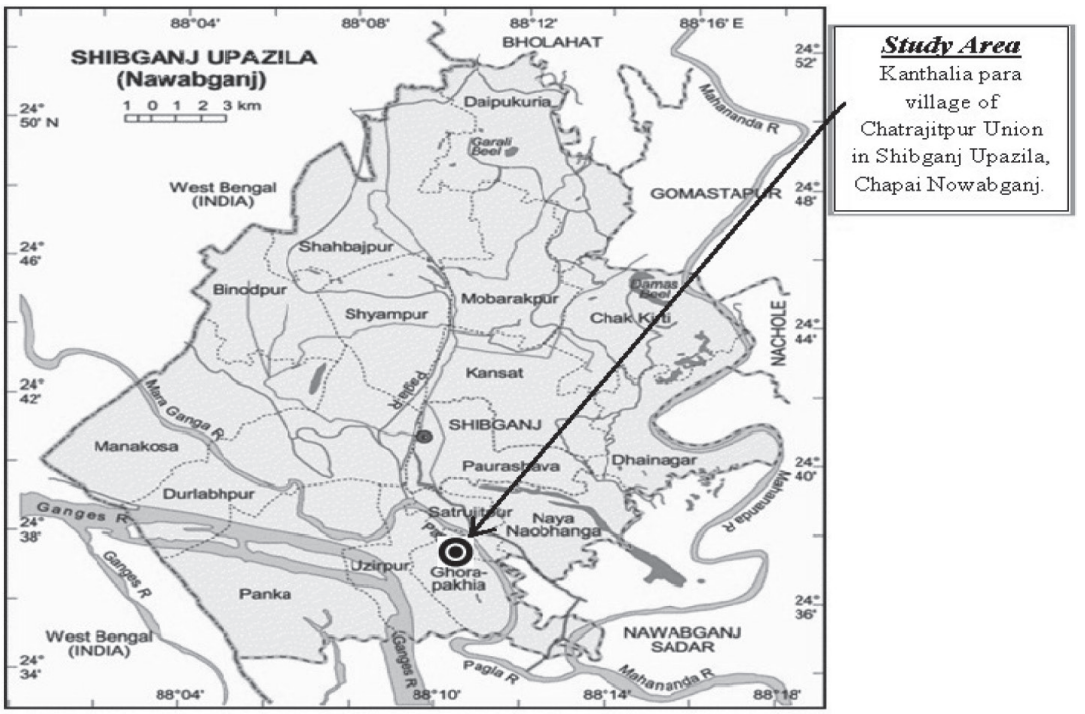
Source: http://www.hellobangladesh.biz/Bangladesh/District-Map/Thana_Upazila_Map/nachole_upazila.gif

Figure 3.3 Upazila Map (Nachole)

Nachole upazila consists of 4 Union and 191 villages. Total Population of the upazila is 1, 46,627 of which 72,895 are male and the rest 73,732 are female. Population density of this upazila is 517 persons per square km. The number of total households of the upazila is 32,922 and the average household size is 4.45. Literacy rate is 45.5%, among them 44.9% male and 46% are female. Annual Average Temperature lies between maximum 37.8°C to minimum 11.2°C; annual rainfall 1862 mm. Main crops of the area are paddy, jute, sugarcane, wheat, betel leaf, oil seeds and pulses. Extinct and nearly extinct crops Indigo, koda, maara (one kind of pulse), china (common millet). Main fruits of the area are Mango, jackfruit, litchi, black berry, palm, coconut, watermelon and boroi.

3.2.2.3 General information Shibganj Upazila

The upazila covers an area of 525.42 square. kilometers. It is located between 24°34' and 24°54' north latitudes and between 88°1' and 88°18' east longitudes. The upazila is bounded on the north Bholahat upazila and India, on the east by Gomastapur, Nachole and Nawabganj Sadar upazilas, on the south by Nawabganj Sadar upazila and India and on the west by India (Figure 3.4). Shibganj upazila consists of 15 Union and 407 villages. Total Population of the upazila is 591178 of which 295338 are male and the rest 295840 are female. Population density of this upazila is 1125 persons per sq. km. The number of total households of the upazila is 124899 and the average household size is 4.73. Literacy rate is 39.4%, among them 38% male and 40.8% are female. Annual Average Temperature of this area varies maximum 37.8°C to minimum 11.2°C; annual rainfall 1862 mm. Main crops of the area are paddy, jute, sugarcane, wheat, betel leaf, oil seeds and pulses. Extinct and nearly extinct crops Indigo, koda, maara (one kind of pulse), china (common millet). Main fruits of the area are Mango, jackfruit, litchi, black berry, palm, coconut, watermelon and boroi.



Source: http://wikimapia.org/16598558/Shibganj-Upazila-HQ

Figure 3.4 Upazila Map (Shibganj)

3.2.3.1 General information of Naogoan

Naogaon was one of the sub-divisions of former Rajshahi district. It was established in 1877 and was up-graded to district on 1 March, 1984. The district is bounded on the north by West Bengal State of India, east by Joypurhat and Bogra districts, south by Natore and Rajshahi districts and on the west by Chapai Nawabganj district and West Bengal State of India. It lies between 24º32' and 25º13' north latitudes and between 28º23' and 89º10' east longitudes. The total area of the district is 3435.65 square kilometers (1326.00 sq.miles) of which 9.09 square kilometers (3.51) sq. miles) is reverine and 19.45 square kilometers (7.51

sq. miles) is under forest. Naogaon Subdivision, under Rajshahi district, was established in 1877 and was turned into a district in 1984. The district consists of 11 upazilas, 99 unions, 2497 mauzas, 2780 villages, 3 paurashavas, 27 wards and 92 mahallas. The upazilas are Naogaon Sadar, Atrai, Badalgachhi, Dhamoirhat, Manda, Mahadebpur, Niamatpur, Patnitala, Porsha, Raninagar and Sapahar. The annual average temperature of the zila varies maximum 37.8°C to minimum 11.2°C and the average annual rainfall of the zila is recorded 1862 mm. Atrai, Punarbhaba, Little Jamuna, Nagar, Chiri and Tulsi Ganga are the main rivers of this zila (BBS 2011).

3.2.3.2 General information Niamatpur Upazila

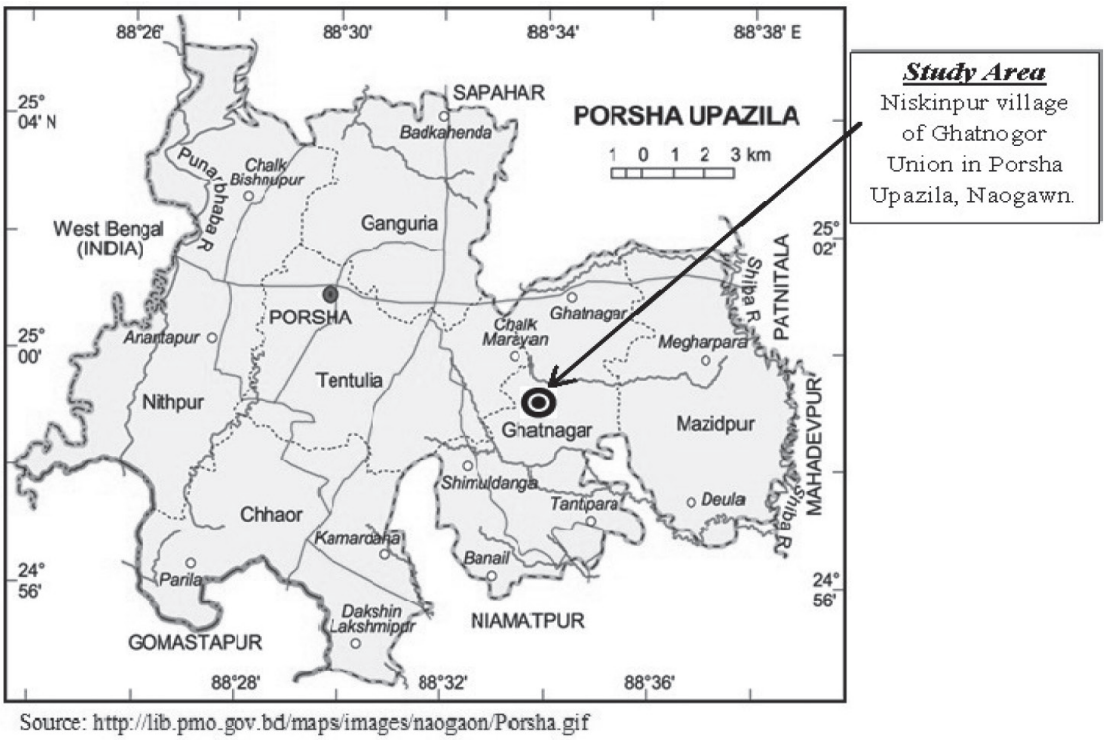
Niamatpur is the biggest upazila of Naogaon district in respect of area. This upazila covers an area of 449.09 square kilometers. It is located between 24041' and 24059' north latitudes and between 88023' and 88040' east longitudes. The upazila is bounded on the north by Porsha Upazila, east by Manda Upazila and Mahadebpur Upazila, south by Tanore Upazila of Rajshahi district and west by Gomostapur Upazila and Nachole Upazila of Chapai Nawabganj district(Figure 3.5) . According to Population and Housing Census 2011, the total population of the upazila is 248351 of which 122578 males and 125773 females. The upazila consists of 8 unions, 321 populated mauzas and 344 villages. In the upazila, there are 61811 households. The average household size (General) for the upazila is 4.0 persons. The literacy rate of the upazila in 2011 is 44.7% for both sex (male 46.5% and female 42.9%). The annual average temperature of the this area varies from maximum 37.8°C to minimum 11.2°C and the average annual rainfall is recorded 1862 mm. The major agricultural products comprise of aus, aman, boro, jute and wheat. Rice covers 85.25% of the gross cropped area of this district. Rabi (summer) includes mustard, khesari, masur, mash, potato, sesame, fram, spices, barly, maize, tobacco, sugarcane, etc. Tal (palms) are abundant in the Barind portion of the district. Besides, the cultivation of hemp plant (Cannabas sativa) is a speciality of this area. The plant yields three narcotic products called ganja, charas and bhang. The homestead flora represents different species of commonly planted trees. These are mango (Mangifera indica), jackfruit (Artocarpus heterophyllus), black berry (Syzygium cumini), betel nut (Areca catechu), coconut (Cocos nucifera), palm tree (Borassus flabellifer), guava (Psidium guajava) and lime (Citrus grandis).

Source: http://mynaogaon.blogspot.com/2009/02/niamatpur-upazila-naogaon.html

Figure 3.5 Upazila Map (Niamatpur)

3.2.3.3 General information of Porsha Upazila

Porsha Upazila is the second smallest upazila of Naogaon district in respect of population. The upazila occupies an area of 252.83 square kilometers including 0.5 square kilometers river area. It is located between 24°54' and 25°05' north latitudes and between 88°24' and 88°39' east longitudes. The upazila is bounded on the north by Sapahar Upazila, east by Patnitala Upazila and Mahadebpur Upazila, south by Gomastapur Upazila of Chapai Nawabganj district and Nimatpur Upazila and west by West Bengal State of India (Figure 3.6). The total population of the upazila is 132095 of which 66299 are males and 65796 are females (BBS, 2011). The upazila consists of 6 unions, 155mauzas and 246 villages. The average size of population of each union, mauza and village are 22016, 852 and 537 respectively. In the upazila, there are 30773 households. The average household size for the upazila is 4.2 persons. the literacy rate of the upazila in 2011 is 42.5% for both sex (male 43.2% and female 41.9%).



Source: http://lib.pmo.gov.bd/maps/images/naogaon/Porsha.gif

Figure 3.6 Upazila Map (Porsha)

The annual average temperature of this area varies from maximum 37.8°C to minimum 11.2°C and the average annual rainfall is recorded 1862 mm. The major agricultural products comprise of aus, aman, boro, jute and wheat. Among rice crops, aman covers by far the largest area followed by boro and aus. The common planted fruit trees are mango (Mangifera indica), jackfruit (Artocarpus heterophyllus), black berry (Syzygium cumini), betel nut (Areca catechu), coconut (Cocos nucifera), palm tree (Borassus flabellifer), guava (Psidium guajava) and lime (Citrus grandis).

3.3 Floral diversity of the study area

In the farm lands, varieties of crops namely rice, jute, vegetables, spices, pulses, oil seeds, beans etc. are produced. Sugar cane and mango are the major cash crops. Among rice crops, aman covers the largest area followed by aus and boro. Minor crops include barley, potato, motor and arhar etc. litchi, melon, water melon and other fruits are also cultivated. In the villages bamboo *(Bambusa spp.)* and tree growths are numerous. In the barind, palm (*Borassus flabellifer*) is grown widely.

Tree and fruit tree species: Common trees found in this area include babla (*Acacia nilotica*), shet khoiyer (*Acacia suma*), chakua koroi (*Albizzia chinnensis*), shiris (*Abizzia lebbeck*), bilati siris (*Samanea saman*), batul (*Trewia nudiflora*), akashmoni (*Acacia auriculiformis*), catechu (*Acacia catechu*), raktachandhan (*Pterocarpus santalinus*), wood apple (*Aegle marmelos*), motor koroi (*Albizia lucidior*), ata (*Anona squamosa*), kadam (*Anthocephalus cadamba*), pitraj (*Aphanamixls polystachia*), betel-nut (*Areca catechu*), jackfruit (*Artocarpus heterophyllus*), kamranga (*Averrho karambola*), margosa (*Azarachta indica*), hijal (*Barringtonia acutangula*), lotkan (*Baccaurea ramiflora*), cotton (*Bombax ceiba*), bastard–teak (*Butea*

monosperma), papaya (*Carica papaya*), sonalu (*Cassia fistula*), jambura (Citrus decumana), coconut (Cocos nucifera), barun (Crataeva magna), krishnochura (*Delonix regia*), tamal (*Diospyros montana*), gab (*Diospyros precatorius*), olive (Elaeocarpus tectorius), mandar (Erythrina variegata), kodbel (Limonia acidissima), bot (*Ficus benghalensis*), dumur (*Ficus spp.*), ashatha (*Ficus religlosa*), chila (*Holoptelea integrifolia*), jarul (*Legerstroemia speciosa*), bhadia (*Lannea coromandelica*), mendi (*Lawsonia inermis*), neem (*Azadirachta indica*) pitali (*Mallotus albus*), mango (*Mangifera indica*), nageswar (*Mesua nagassarium*), sajna (*Moringa obifera*), tut (*Morus alba*), debdaru (*Polyalathia longifolia*), guava (*Psidium guajava*), dalim (*Punica granatun*), herenda (*Ricenus communis*), boroi (*Zizyphus mauritiana*), katbadam (*Terminalia catappa*), arjun (*Terminalia arjuna*), tatul (*Tamariandus indica*), starapple (*Syzygium samarengense*), black berry (*Syzygium cumini*), bara mehogoni (*Swietenia macrophylla*), talla bans (*Bambusa tulda*), beora bans (*Bambusa tulda*), choibans (*Bambusa multiplex*) etc. Some plants are grown at the homesteads mainly for aesthetic purposes. These are china box (*Murraya paniculata*), gardenia (*Gadenia augusta*), night queen (*Cestrum nocturnum*), dolon champa (*Hedychium coronarium*), beli (*Jasminun scandens*) etc. Besides, the floating macrophytes like water hyacinth (*Eichhorina crassipes*), topa pana (*Pistiastratiotes lemna spirodela*) etc. are commonly seen in the village ponds. In shallower ponds and beels are found species of lotus (*Nelumbo nucifera*), water lily (*Nymphaea pubescens*), bind weed (*Ipomoea aquatic*), helencha (*Tilanthera philoxcroides*) and the like.

Main crops: Various types of Paddy (*Oryza sativa*), jute (*Corchorus spp.*), sugarcane (*Saccharum officinarum*), wheat (*Triticum spp.*), betel leaf (*Piper betle*), various types of oil seeds and pulses. Extinct and nearly extinct crops Indigo (*Indigofera spp*.), koda, maara (one kind of pulse), china (common millet). Common vegetables are Potato (*Solanum tuberosum*), cucumber (*Cucumis sativus*), spinach (*Lactuca sativa*), carrot (*Daucus sativus*), tomato (*Solanum lycopersicum*), brinjal (*Solanum melongena*), radish (*Raphanus sativus*), Lady's finger (*Abelmoschus esculentus*) etc. Common spices are Onion (*Allium cepa*), Garlic (*Allium sativum*), capsicum (*Capsicum annuum*), black pepper (*Piper nigrum*), Nigella seed (Nigella sativa)

3.4 Fauna of the study area

Mammals: The char areas of the Rajshahi district are covered with thick reeds, bushes, tarmerisk bushes and heavy jungles which serve as a natural habitat for wild animals. Once wild buffaloes (*Bubalus bubalis)* and maya horin (*Muntiacus muntjak)* used to be seen in the thatching grass, but they now totally disappeared. In the Barind, tigers, leopards (*Panthera pardus)* used to follow the deer (*Muntiacus muntjak)* and hog to the valley. But they are no more seen. However, the common mammals are found in the jungles both in the chars and the Barind as well as homestead forests of these districts include wild cat (*Felis chaus*), fox (*Canis aureus*), mongoose (*Herpestes edwardsi*), cola badur (*Pteropus giganteus*), tikkell's bat (*Herperoptenus tickelli*), indian pipistrelle (*Pipistrellus coromandra*), dura kathbirail (*Funumbalus pennant*), bhondar (*Lutra perspicillata*), idur (*Bandicota bengalensis*), metho Idur (*Mus booduga*), common house rat (*Rathus rattus*), nengti idur (*Mus musculus*) etc.

Birds: The resident birds those are usually found in these districts are crow (*Corvus splendens*), raven (*Corvus macrohynchus*), machranga/kingfisher (*Alcedo atthis*), wood-pecker (*Picus myrmecophoneus*), bhat

shalik (*Acridotheres tristis*), jhuti shalik (*Acredotheres fuscus*), choto fingey (*Dicurus macrocercus*), halde pakhi (*Oriolus xanthornus)*, doyel (*Copsychus saularis), s*parrow (*Passer domesticus*), cuckoo (*Cuculus microplerus*), tila ghugu (*Streptopelia chinensis*), water hen (*Oriolus xanthornus)*, swallow (*Ploceus philippinus*), bulbuli (*Picnonotus cafer*), kali pencha (*Glaucidium radiatum*), loxme pacha (*Tyto alba*) etc. besides, various species of migratory birds like greenleg goose (*Anser anser*), raj hash (*Anser indicus*), pitail (*Anas acuta*), geria hash (*Anas querquedula*), kadakhucha (*Gallinago gallinago*), chokachoki (*Tadorna ferrugeniea*), khanjon (*Motacilla cinerea*) etc. are seen in water bodies of the district during winter season.

Fishes: With large water area the district is well stocked with fish. Some of the commonly available fishes are ruhi (*Lebeo rohita*), mrigel (*Cirrhinus mrigala*), kalboush (*Labeo calbasu)*, katla (*Catla catla*) etc. Shoil fish (*Channa striatus)*, magur (*Amblyceps mangois)*, Shing (*Hetropneustes fossilis)* are also found in large quantity in beels and khals. Many other spieces of river and fresh water fishes are also found in the district. Of these the principal varieties are airh *(Mystus aor),* pangas *(Pangasius pangasius),* chitol *(Notopterus chitala*), koi *(Anabas testudineus),* gozar *(Channa marulius) etc.* However, some of these varieties, especially those which inhabit the marshes and tanks, are dwindling due to over catching and other reasons such as use of insecticides and pesticides for crop production etc. In addition, some exotic varieties of fish such as telapia (*Oreochromis mossambicus)*, nilotica (*Oreochromis niloticus)*, silver carp (*Hypophthalmicthys molitrix)*, and grass carp (*Cteropharyngodon idella)* are also cultivated in the district and they are also becoming very popular. Moreover, a small number of hilsa fish (*Hilsa ilisa)* is caught in the Padma River. It has a wide reputation for its excellent flavor and test.

Reptiles: These three districts contain in its area few species of reptiles. The reptiles include different species snakes, lizard (*Hemidactylus brooki)*, and tortoises (*Kachuga tecta),* iguana, python (*Python molurus)*, cobra (*Naja naja)* and other varieties of poisonous snakes are found almost all over the district. The commonest poisonous snakes are kal-keotey (*Bungarus fasciatus)*, the raj ghokra (*Ophiophagus hannah*) and the shankhini snake (*Bungarus cacruleus).* The chandrabora snake is also common. Of non-poisonous snakes, the largest is the darash *(Ptyas mucous).* Other common snakes are dhora shap *(Xenoclrophis piscator)* and ghargini shap *(Lycodon jara).*

Amphibians: Among the amphibians the most common are kotkoti bang (*Rana cyanophlyctis*), jhijhi bang (*Rana limnocharis*), bhawa bang (*Rana tigerina*), kuno bang (*Bufo melanostictus*) etc.

3.5 Determination of sample size

The total number of household in the study area is 1263. Among them 295 respondent household were selected as a sample size by using determinants (Appendix 1). And then by using calculations, the specific numbers of respondent households in village wise were fixed up from the total number of sample size. These numbers of respondent households are 33 for Panihar village, 55 for Batashpur village, 59 for Barenda village, 32 for Kanthalia para village, 56 for Rudrapur village and 60 for Nishkinpur village. Among them by considering women empowerment a total of 30% selected respondents (n=90) were female and another 70% respondents (n=205) were male.

3.6 Selection of respondents' for household survey

3.6.1 Selection of respondents in Panihar village

By using 'Basket and Paper' method the name of total 33 respondent's household were selected for the questionnaire survey from the Panihar village.

The number of living household in Panihar village is 142. First of all, the names of all household owners in entire village were collected from the Union parishod. Then the basket was taken and the names of total household owner separately write down in a piece of paper and put down in the basket. After that the basket was shaken by the hand and randomly picked up 33 names from the basket.

During the survey 10 female respondents (30%) were randomly taken from the total respondents while the remaining 23 respondents (70%) were male.

3.6.2 Selection of respondents in Batashpur village

In Batashpur village, the total numbers of living household are 236. Among them 55 respondent households were selected for household survey and the name of these household were find out by using "basket and paper" method. Firstly, the names of all household owners in entire village were collected from the Union parishod and separately write down on a piece of paper and then put down in a basket. After that the basket was shaken by the hand and randomly picked up 55 names from the basket. When the survey was carried out then the 17 female respondents (30%) were randomly taken from the selected respondents.

3.6.3 Selection of respondents in Barenda village

In this village, the total numbers of living household are 251. Among them 59 respondent households were selected for household survey and the selection procedure was "basket and paper" method.

In this process, a basket was taken and then the collected names of all household owners in entire village from the Union parishod were separately write down on a piece of paper and put down in the basket. Finally the basket was shaken by the hand and randomly picked up 59 names from the basket.

During the household survey, Among 59 selected respondents in Barenda village there were 41 male (70%) and 18 female (30%) respondents were selected for survey.

3.6.4 Selection of respondents in Kanthalia para village

By using 'Basket and Paper' method a of total 32 respondent household were selected for the questionnaire survey from the Kanthalia para village, while the number of living household in Kanthalia para village is 136.

In the process of selection, at first the list of all household owners in entire village was collected from the Union parishod. Then the basket was taken and the names of total household owner separately write down

on a piece of paper and put down in the basket. After that the basket was shaken by the hand and randomly 32 household names picked up from the basket.

When the survey was held on, then the 10 female respondents (30%) were randomly taken from the total respondents while the remaining 22 respondents (70%) were male.

3.6.5 Selection of respondents in Rudrapur village

In Rudrapur village, applying the "basket and paper" method a total 56 respondent were selected from 240 living household.

The name of 240 household owners were collected from the Union parishad and separately list down on a piece of paper. Then a basket was taken and all the pieces of paper put down in the basket. After that the basket was shaken by the hand and randomly 56 household names picked up from the basket.

Among 56 household respondents about 17 female respondents (30%) and 39 male respondents (70%) were randomly selected when the survey was conducted.

3.6.6 Selection of respondents in Nishkinpur village

In this village, the total numbers of living household are 258. Among them 60 respondent households were selected for household survey and the selection procedure was "basket and paper" method.

In this process, a basket was taken and then the collected names of all household owners in entire village from the Union parishod were separately write down on a piece of paper and put down in the basket. Finally the basket was shaken by the hand and randomly picked up 60 names from the basket.

During the household survey, Among 60 selected respondents in Barenda village there were 42 male (70%) and 18 female (30%) respondents were selected for survey.

3.7 Secondary data collection

To supplement the collected data and information were also collected from different secondary sources like published books, journals, leaflets, bulletins and officials records from Bangladesh Meteorological Department, Department of Environment, Department of Agriculture and Bangladesh Bureau of Statistics and various NGOs and Library from Universities of Bangladesh.

Very recent and updated information and literature were also collected from internet sources.

3.8 Primary data collection

3.8.1 Reconnaissance survey

The study has been conducted using a combination of quantitative and qualitative methods. The study area was first visited before conducting the survey. Gross information was collected from local people, local

meteorological office and local NGO's informally. Some questions were tested and deficiencies were filled by reconstructing the questionnaires after the field visit.

3.8.2 Preparation of questionnaire

With the objectives in view, the questionnaire (Appendix 3) was designed to collect relevant information covering socio-economic characteristics of the respondent such as age, education, family members, land resources and its utilization, source of income, livestock, agricultural practice, source of water, local knowledge on climate change and drought adaptation measures.

3.8.3 Household survey

Household survey was conducted with a pre-structured questionnaire (Appendix 3). Total 295 respondent households were randomly surveyed. Among them 33 respondent households (23 male & 10 female) were surveyed in Panihar village, 55 respondent households (38 male & 17 female) were surveyed in Batashpur village, 59 respondent households (41 male & 18 female) were surveyed in Barenda village, 32 respondent households (22 male & 10 female) were surveyed in Kanthalia para village, 56 respondent households (39 male & 17 female) were surveyed in Rudrapur village and 60 respondent households (42 male & 18 female) were surveyed in Nishkinpur village.

3.8.4 Data collection using PRA tools

Primary data were collected from the study area by using four PRA tools viz. In-depth interview, Key Informants Interview, Focus Group Discussions and Case Study because it facilitates two-way interaction between researcher and the participants.

3.8.4.1 In-depth Interview

In-depth interviews are useful in qualitative research technique that helps to know the detailed information about a person's thoughts, observations and behaviors. To explore the particular idea or situation about climate change and adaptation related to drought there were a total thirty In-depth interviews were conducted of which 5 interviews from each upazila. These interviews were taken from one Sub Assistant Agriculture Officer, one self reliant farmer, one tenant farmer, one fisherman and one from Union Parishad (Chairman/ Member) from each Upazila.

3.8.4.2 Key Informant's Interview

Key Informant's Interviews is a low-cost way to gather qualitative data; the only resources needed are interviewer and respondent time, and minimal costs for conducting the interview. A total twelve Key Informant's Interviews were conducted to get qualitative data. Two Key Informant's Interview (KIIs) was carried out from each Upazila. One official from Department of Agricultural Extension (DAE) and another official from Barind Multipurpose Development Authority (BMDA) were carried out.

3.8.4.3 Focus Group Discussions

A total twelve Focused Group Discussions (FGDs) were carried out for qualitative data in which two FDGs were conducted from each of the village. Whereas one FGD was carried out with the female participants from each study site and another one was carried out with the male participants to get more information on climate change related issues and adaptation related to drought. About 6-8 respondents were randomly gathered for conducting a session based on their similar characteristics such as age, gender, occupation, socio-economic status and land holdings.

3.8.4.4 Case Study

A total 6 case studies were conducted to learn about the precise impact of climate change and adaptation related to drought, in which single case study was conducted in each selected village.

3.9 Data compilation and analysis

The collected data were compiled daily in the field at the end of the survey. Important data in the form of text were sorted manually and information found in the field was documented in the notes which were presented in the form of text. Empirical data were analyzed with the help of MS-Excel and SPSS (Statistical Package for Social Survey version.20). Eventually rainfall data was calculated using standard formula of Standardized Precipitation Index (SPI).

Chapter Four. Results and Discussions

4.1. Demographic features of the study area

Demographic feature means the socioeconomic characteristics of a population expressed in statistically such as age, sex, education level, income level and employment, marital status, occupation, average size of a family, among others. Demographics are used by government organizations, corporations and non-government organizations to learn more about a population's characteristics for many purposes including policy development, economic market research and academic research.

4.1.1 Age and sex of the respondent

The study was conducted on a total 295 respondents and these respondents were distributed in six villages. The result of the household survey showed that the maximum number of respondent's (n=122) belong to the age category of ≥30<45 years, among them 26.44% respondent (n=78) were male and 14.92% respondent (n=44) were female. The second largest age category was ≥45<60 years and there were 92 respondents in this category where the 22.03% were male (n=65) and the 9.15% were female (n=27). There were 41 respondents found in the ≥15<30 years age category in which 10.17% respondent (n=30) were male and 3.73% respondent (n=11) were female. There were also 39 respondents were found those age has above the 60 years among them 10.85% respondent (n=32) were male and 2.37% respondent (n=7) were female. On the other hand only one male respondent (0.34%) was found in <15 age category (Table 4.1).

Table 4.1 Age and sex of the respondent

Age category	Sex	Study location and sex distribution						Total N=295
		Rajshahi		Chapai Nawabganj		Naogaon		
		Panihar	Batashpur	Barenda	Kanthalia para	Rudrapur	Nishkinpur	
		N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
<15 (N=1)	Male	0	0	0	0	0	0	0
	Female	0	0	0	0	1 (100)	0	1 (0.34)
≥15<30 (N=41)	Male	9 (30)	7 (23.33)	5 (16.67)	1 (3.33)	6 (20)	2 (6.67)	30 (10.17)
	Female	2 (18.18)	4 (36.36)	2 (18.18)	0	3 (27.27)	0	11 (3.73)
≥30<45 (N=122)	Male	10 (12.82)	16 (20.51)	17 (21.79)	7 (8.97)	15 (19.23)	13 (16.67)	78 (26.44)
	Female	4 (9.09)	11 (25)	11 (25)	6 (13.64)	3 (6.82)	9 (20.45)	44 (14.92)
≥45<60 (N=92)	Male	3 (4.62)	7 (10.77)	14 (21.54)	10 (15.38)	12 (18.46)	19 (29.23)	65 (22.03)
	Female	4 (14.81)	1 (3.7)	4 (14.81)	4 (14.81)	5 (18.52)	9 (33.33)	27 (9.15)
≥60 (N=39)	Male	1 (3.13)	8 (25)	5 (15.63)	4 (12.5)	6 (18.75)	8 (25)	32 (10.85)
	Female	0	1 (14.29)	1 (14.29)	0	5 (71.43)	0	7 (2.37)

Source: Field survey, 2015

4.1.2 Household members and family

This part depicts the information related to the distribution of household members. The table 4.2 represents that the highest average family members live in Nishkinpur (4.27) followed by Barenda (3.98), Kanthalia para (3.81), Panihar (3.67), Batashpur (3.56) and Rudrapr (3.20). The maximum family members were lived in Niskinpur (9) followed by Batashpur (7), Barenda (7), Kanthaliapara (7), Panihar (6) and Rudrapur (6). And the minimum numbers of peoples lived in Batashpur and Rudrapur (1) followed by other four villages (2). According to the BBS (2011), the average household size (General) for the Godagari, Tanore, Nachole, Shibganj, Niamatpur, and Porsha upazila was 4.57, 4.03, 4.45, 4.73, 4.0 and 4.2 persons respectively.

Table 4.2 Family member of the respondents

Household Members	Village					
	Panihar n=33	Batashpur n=55	Barenda n=59	Kanthalia n=32	Rudrapur n=56	Nishkinpur n=60
Average	3.67	3.56	3.98	3.81	3.20	4.27
Minimum	2.00	1.00	2.00	2.00	1.00	2.00
Maximum	6.00	7.00	7.00	7.00	6.00	9.00

Source: Field survey 2015

4.1.3 Occupation both primary and secondary

Analysis of the respondents' (n=295) occupation showed that 55.59% respondents were primarily engaged in agriculture as a primary occupation followed by housewife (24.75%), business (9.15%), day labour (2.71%), Van/ rickshaw puller (1.69%), auto/nosimon driver (0.68%) and fisherman (0.68%). On the other hand, only 16.95% respondents (n=99) were reported that they have secondary occupation like business (8.47%), agriculture (4.41%), small trader (1.02%) and auto/nosimon driver (1.02%) etc (Table 4.3). BBS (2011) stated that the main occupation is agriculture likely Rajshahi (56%), Chapai Nawabganj(48.9%) and Naogaon (63.83%). Pisciculture and rearing of livestock and poultry adds an additional income to the rural households. Fish of different varieties abound in the district. Moreover, varieties of fish are caught from rivers, tributary channels, even from paddy field during rainy season. Corresponding figure, the maximum percentage of agriculture were found in Panihar (87.88%) as the primary occupation. Among the secondary occupation the business is the top rank occupation as mentioned by the respondents.

Table 4.3 Occupation of the respondents

Occupation		Rajshahi		Chapai Nawabganj		Naogaon		Total 295
		Panihar 33	Batashpur 55	Barenda 59	Kanthalia para 32	Rudrapur 56	Nishkinpur 60	
		N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Primary occupation	Agriculture	29 (87.88)	32 (58.19)	33 (55.93)	7 (21.87)	30 (18.29)	33 (83.33)	164 (55.59)
	Business	1 (3.45)	3 (9.37)	1 (3.03)	8 (25)	7 (12.5)	7 (11.66)	27 (9.15)
	Small trade	0	0	0	0	0	1 (1.67)	1 (0.34)
	Labour	1 (3.45)	0	1 (3.03)	4 (12.5)	2 (25)	0	8 (2.71)
	Van/ rickshaw puller	0	0	0	4 (12.5)	1 (1.78)	0	5 (1.69)
	Auto/ nosimon driver	0	1 (3.12)	0	0	1 (1.78)	0	2 (0.68)
	Mechanics	0	0	1 (3.03)	0	0	0	1 (0.34)
	House wife	2 (6.06)	17 (53.12)	12 (20.34)	8 (25)	15 (26.78)	19 (31.67)	73 (24.75)
	Servant	0	0	1 (3.03)	0	0	0	1 (0.34)
	Fishing	0	1 (3.12)	0	1 (3.12)	0	0	2 (0.68)
	Student	0	0	10 (16.95)	0	0	0	10 (3.39)
	Teacher	0	1 (3.12)	0	0	0	0	1 (0.34)
Secondary occupation	Agriculture	0	0	5 (8.47)	0	4 (7.14)	4 (6.67)	13 (4.41)
	Business	0	0	1 (3.03)	0	1 (1.78)	23 (38.33)	25 (8.47)
	Small trade	1 (3.45)	0	0	1 (3.12)	1 (1.78)	0	3 (1.02)
	Labour	0	1 (3.12)	0	0	0	0	1 (0.34)
	Van/ rickshaw puller	0	0	1 (3.03)	0	0	0	1 (0.34)
	Auto/ nosimon driver	0	0	2 (6.06)	0	0	1 (1.67)	3 (1.02)
	Mechanics	0	0	0	0	0	1 (1.67)	1 (0.34)
	Fishing	0	2 (6.25)	0	0	0	0	2 (0.68)
	Job	1 (3.45)	0	0	0	0	0	1 (0.34)

Source: Field survey 2015

4.1.4 Marital status

The total population of the respondent's family was 975 individuals. Among them 64.7% were married and 32.9% were not married. Among the populations only 2.1% were widowed and the rest 0.3% were divorced (Table 4.4). The maximum married populations were recorded in between age of ≥30<45 years

and maximum single populations in between age of ≥15<30 years. The maximum numbers of female widow were reported at age more than 60 years and only three members were reported as divorced.

Table 4.4 marital status

Age class	Sex	Marital status			
		Unmarried	Married	Widow	Divorced
		N (%)	N (%)	N (%)	N (%)
<15	Male	80 (8.2)	2 (0.2)	0	0
	Female	81 (8.3)	5 (0.5)	0	0
≥15<30	Male	104 (10.7)	47 (4.8)	0	0
	Female	42 (4.3)	73 (7.5)	1 (0.1)	1 (0.1)
≥30<45	Male	5 (0.5)	127 (13)	0	1 (0.1)
	Female	1 (0.1)	134 (13.7)	4 (0.4)	1 (0.1)
≥45<60	Male	3 (0.3)	96 (9.8)	1 (0.1)	0
	Female	1 (0.1)	87 (8.9)	3 (0.3)	0
≥60	Male	3 (0.3)	47 (4.8)	1 (0.1)	0
	Female	1 (0.1)	13 (1.3)	10 (1)	0
Total		321 (32.9)	631 (64.7)	20 (2.1)	3 (0.3)

Source: Field survey 2015

4.1.5 Educational status

The respondents' education levels were calculated in terms of their achievement of certificate. The result showed that 75.6% respondents have recognized education and the rest 24.4% respondents have no formal education. Among the literate respondents 29.8% respondents took part in primary level, 25.1% respondents took part in secondary level, 10.8% respondents achieved Secondary School education, 7.8% respondents achieved Higher Secondary education and 2% respondents achieved Graduation (Table 4.5). Entire the respondents 13.9% male were illiterate while the percentage of illiterate women was 10.5%. On the other hand, 21.7% male respondents were took part in primary level followed by secondary level (17.3%) and then SSC (8.1%). And 8.1% female respondents were took part in primary level followed by secondary

level (7.8%), SSC (2.7%) and graduation 0.7%. Among the male respondents the maximum percentage of secondary education were reported in Panihar village(51,5%) . On the other hand, the maximum secondary education of female was reported in Niskinpur (18.3%) village.

Table 4.5 Educational status of the respondents

Educational level	Sex	Rajshahi		Chapai Nawabganj		Naogaon		Sub Total	Total N=295
		Panihar	Batashpur	Barenda	Kanthalia para	Rudrapur	Nishkinpur		
Illiterate	M	2 (6.1)	12 (21.8)	8 (13.6)	1 (3.1)	12 (21.4)	6 (10)	41 (13.9)	72 (24.4)
	F	5 (15.2)	5 (9.1)	5 (8.5)	3 (9.4)	12 (21.4)	1 (1.7)	31 (10.5)	
Primary	M	0	10 (18.2)	17 (28.8)	11 (34.4)	12 (21.4)	14 (23.3)	64 (21.7)	88 (29.8)
	F	0	7 (12.7)	8 (13.6)	1 (3.1)	4 (7.1)	4 (6.7)	24 (8.1)	
Secondary	M	17 (51.5)	6 (10.9)	7 (11.9)	5 (15.6)	9 (16.1)	7 (11.7)	51 (17.3)	74 (25.1)
	F	2 (6.1)	4 (7.3)	2 (3.4)	3 (9.4)	1 (1.8)	11 (18.3)	23 (7.8)	
SSC	M	2 (6.1)	7 (12.7)	4 (6.8)	5 (15.6)	3 (5.4)	3 (5)	24 (8.1)	32 (10.8)
	F	2 (6.1)	1 (1.8)	2 (3.4)	2 (6.3)	0	1 (1.7)	8 (2.7)	
HSC	M	2 (6.1)	1 (1..8)	5 (8.5)	0	2 (3.6)	10 (16.7)	20 (6.8)	23 (7.8)
	F	1 (3)	0	1 (1.7)	0	0	1 (1.7)	3 (1)	
Graduate	M	0	2 (3.6)	0	0	0	2 (3.3)	4 (1.4)	6 (2)
	F	0	0		1 (3.1)	1 (1.8)	0	2 (0.7)	

Source: Field survey 2015

According to Bangladesh Bureau of Statistics data (2011), in Rajshahi districts the literacy rate of Godagari upazila is 46.3% for both sex of which 46.0% for male and 46.6% for female and the literacy rate of Tanore upazila is 48.8% for both sex of which 51.1% for male and 46.7% for female. In Naogoan, the literacy rate of Niamatpur upazila in 2011 is 44.7% for both sex, 46.5% for male and 42.9% for female. And in Porsha upazila, it is found that 42.5% for both sex of which 43.2% for male and 41.9% for female. In Chapai Nawabganj, the literacy rate of Nachole upazila in 2011 is 45.5% for both sex, 44.9% for male and 46.0% for female. And the literacy rate of Shibganj upazila in 2011 is 39.4% for both sex, 38.0% for male and 40.8% for female.

4.1.6 Housing pattern of the respondents

Several housing patterns were observed in the study area including concrete, semi concrete, clay wall with CI sheet, thatched wall with CI roof and cottage. In Godagari upazila, 9.9% respondents were lived in pucca house, 17.1% in semi-pucca house, 69.0% in kutcha house and the remaining 4.0% in *jhupri* (Table 4.6). In case of Tanore upazila, 2.8% households were lived in pucca house, 4.0% in semi-pucca house, 92.4% in kutcha house and the remaining 0.8% in *jhupri.* 93.5% respondents of Niamatpur upazila were resided in kutcha houses followed by 2.9% in semi-pucca house, 2.4% in pucca house, and the remaining 1.2% in jhupri. Most of the respondents of Porsha were lived in kutcha houses and only few percentage were lived in pucca houses (2.5%), semi-pucca houses (5.4%) and the remaining 2.4% in *jhupri.* Only 4.1% respondent's residence types were jhupri followed by pucca houses (4.2%), semi-pucca (12%) and 79.7% kutcha houses in Nachole. Shibganj upazila represented 13.3% houses, 44.2% semi-pucca houses, 32.3% kutcha houses and the remaining 10.2% *jhupri.*

Table 4.6 Respondent's housing types

Residence type	Rajshahi				Chapai Nawabganj				Naogaon				Total N=295	
	Panihar (33)		Batashpur (55)		Barenda (59)		Kanthalia para (32)		Rudrapur (56)		Nishkinpur (60)			
	N	%	N	%	N	%	N	%	N	%	N	%		
Concrete	0	0.00	2	20.00	0	0.00	4	40.00	2	20.00	2	20.00	10	100.00
Semi concrete (tin roof)	5	7.35	14	20.59	5	7.35	25	36.76	4	5.88	15	22.06	68	100.00
Clay wall & tin roof	27	14.59	34	18.38	46	24.86	0	0.00	41	22.16	37	20.00	185	100.00
Thatched wall and roof with tin	0	0.00	1	8.33	3	25.00	3	25.00	1	8.33	4	33.33	12	100.00
Cottage	1	7.69	1	7.69	1	7.69	0	0.00	8	61.54	2	15.38	13	100.00

Source: Field survey 2015

4.1.7 Land holding types

This part depicts the information related to the land ownership type. The table 4.7 represented that all the respondents of Panihar, Batashpur, Barenda, Kanthalia para and Nishkinpur village has own land property

but in Rudrapur this percentage was 98.2%. It was also seen that 66.7% respondents of Panihar village has had leased property followed by Barenda (66.1%), Nishkinpur (13.3%), Kanthalia para (6.2%), Batashpur (3.6%) and Rudrapur (3.6%). Beside these 16.4% respondents of Batashpur village has mortgaged in property followed by Rudrapur (12.5%) and 12.7% respondents of Batashpur has mortgaged out property followed by Rudrapar (7.1%).

Table 4.7 Ownership types

Owner of land	Rajshahi		Chapai Nawabganj		Naogaon		Total N=295
	Panihar	Batashpur	Barenda	Kanthalia para	Rudrapur	Nishkinpur	
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Own land	33 (100)	55 (100)	59 (100)	32 (100)	55 (98.2)	60 (100)	294 (99.7)
Leased property	22 (66.7)	2 (3.6)	39 (66.1)	2 (6.2)	2 (3.6)	8 (13.3)	75 (25.4)
Mortgaged in property	0	9 (16.4)	1 (1.7)	0	7 (12.5)	6 (10)	23 (7.8)
Mortgaged out property	0	7 (12.7)	0	0	4 (7.1)	1 (1.7)	12 (4.1)

Source: Field survey 2015

4.1.8 Land holdings

This part depicts the information related to different types of land holdings. The highest mean own land was reported in Niskinpur followed by Batashpur, Rudrapur, Barenda, Kthalia and Panihar (Table 4.8). On an average 253.25 decimals own land area were operated by each family of Nishkinpur village followed by Batashpur (151.93 decimals), Rudrapur (92.29 decimals) and Panihar (47.71 decimals). It was seen that the respondents of Barenda operate highest average of lease land (115.9 decimals) compared to Kanthalia para (82.5 decimals), Panihar (80.18 decimals), and Batashpur (23 decimals). Respondents of Rudrapur village were also owned highest average mortgage in land (54.71 decimals) followed by Batashpur (40 decimals) while the respondents of Nishkinpur village were owned highest average of mortgage out land (66 decimals) followed by Rudrapur (53.5 decimals).It was also found that the maximum own land area were operated by each family in Rudrapur (1231 decimals) followed by Nishkinpur (1213 decimals) and the minimum land area operated by each family in Panihar and Rudrapur (2 decimals) followed by other villages (3 decimals).

Table 4.8 land holdings

Ownership type (in decimal)		Own	Leased	Mortgaged in	Mortgaged out
Panihar	Mean	47.71	80.18		
	Minimum	2	12		
	Maximum	212	300		
Batashpur	Mean	151.93	23	40	48.57
	Minimum	3	13	2	16
	Maximum	609.00	33	132	120
Barenda	Mean	85.69	115.9	33	
	Minimum	3	30	33	
	Maximum	577	338	33	
Kanthalia para	Mean	53.64	82.5		
	Minimum	3	33		
	Maximum	254	132		
Rudrapur	Mean	92.29	49.5	54.71	53.5
	Minimum	2	33	2	16
	Maximum	1231	66	100	99
Nishkinpur	Mean	253.25	70.13	44.5	66
	Minimum	3	33	33	66
	Maximum	1213	99	66	66

Source: Field Survey 2015

The maximum mortgage in land area was found in Batashpur (132 decimals) followed by Nishkinpur (66 decimals) while it was minimum in Batashpur and Rudrapur (2 decimals). The maximum mortgage out land was found in Batashpur (120 decimals) followed by Nishkinpur (66 decimals) while Panihar, Barenda, Kanthalia para and Rudrapur village it was not identified.

4.1.9 Other property (Moveable property)

The table 4.9 exhibited that all the respondents having more or less moveable properties. It was reported that 53.9% respondents (n=159) have television in their home followed by motor cycle (14.9%), sewing machine (11.5%), shallow (11.2%) and power titter (4.4%). Among the villages, it was found that 69.5% respondents of Barenda having the television followed by Batashpur (67.3%) and Panihar (66.7%). 33.3% respondents of Panihar village having the sewing machine followed by Rudrapur (14.3%) and Nishkinpur (13.3%). In Batashpur village 27.3% respondents have had shallow machine followed by Barenda (20.3%) and Rudrapur (5.4%). The small number of respondents of the study area have had power tiller.

Table 4.9 status of moveable property

Property	Rajshahi		Chapai Nawabganj		Naogaon		Total N=295
	Panihar	Batashpur	Barenda	Kanthalia para	Rudrapur	Nishkinpur	
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Shallow	1 (3)	15 (27.3)	12 (20.3)	1 (3.1)	3 (5.4)	1 (1.7)	33 (11.2)
Power tiller	1 (3)	0	3 (5.1)	0	5 (8.9)	4 (6.7)	13 (4.4)
Motor cycle	4 (12.1)	8 (14.5)	7 (11.9)	5 (15.6)	2 (3.6)	18 (30)	44 (14.9)
TV	22 (66.7)	37 (67.3)	41 (69.5)	10 (31.3)	10 (17.9)	39 (65)	159 (53.9)
Sew machine	11 (33.3)	1 (1.8)	5 (8.5)	1 (3.1)	8 (14.3)	8 (13.3)	34 (11.5)

Source: Field survey 2015

4.1.10 Status of livestock

Livestock rearing is an important income generating activity of the respondent's family. They usually do it for cash income as well as for their own consumption. The table 4.10a represented that on an average 80% of the respondents from the study area were found to rear cow followed by hen (76.3%), goat (63.4%), duck (58%), pigeon (20.3%), sheep(8.5%) and buffalo (3.45) . The highest percentage of cows was reported from Barenda (94.9%) and lowest from Kanthalia para (67.7%).

Table 4.10 A livestock own by each category

Name of livestock	Rajshahi		Chapai Nawabganj		Naogaon		Total N=295
	Panihar	Batashpur	Barenda	Kanthalia	Rudrapur	Nishkinpur	
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Cow	30 (90.9)	40 (80)	56 (94.9)	21 (67.7)	39 (76.5)	50 (83.3)	236 (80)
Buffalo	2 (6.1)	0	3 (5.1)	0	1 (2)	4 (6.7)	10 (3.4)
Goat	22 (66.7)	19 (38)	48 (81.4)	28 (90.3)	30 (58.8)	40 (66.7)	187 (63.4)
Sheep	3 (9.1)	0	9 (15.3)	0	1 (2)	12 (20)	25 (8.5)
Duck	13 (39.4)	20 (40)	46 (78)	6 (19.4)	41 (80.4)	45 (75)	171 (58)
Hen	20 (60.6)	14 (28)	58 (98.3)	29 (93.5)	48 (94.1)	56 (93.3)	225 (76.3)
Pigeon	11 (33.3)	10 (20)	19 (32.2)	1 (3.2)	6 (11.8)	13 (21.7)	60 (20.3)

Source: Field survey 2015

On an average 43.53 pigeons were reported from Barenda followed by Nishkinpur (26.85) of which the maximum number was found in Barenda (200) and the minimum number was found in Panihar, Batashpur and Barenda (2). On an average 48.21 hen were reported in Batshpur with the minimum numbers 2 and maximum numbers 600 in a family (Table 4.10b). The maximum numbers of cows (20) were reported from Niskinpur with the minimum (1).

Table 4.10b Average number of livestock

List of livestock		Rajshahi		Chapai Nawabganj		Naogaon	
		Panihar	Batashpur	Barenda	Kanthalia para	Rudrapur	Nishkinpur
Cow	Mean	1.87	2.68	2.89	1.43	2.23	2.98
	Minimum	1	1	1	1	1	1
	Maximum	5	7	7	2	15	20
Buffalo	Mean	1.67	0	2	0	1.00	2.00
	Minimum	1	0	2	0	1	2
	Maximum	2	0	2	0	1	2
Goat	Mean	2.05	2.11	3.27	2.29	2.55	2.53
	Minimum	1	1	1	1	1	1
	Maximum	5	6	6	5	5	8
Sheep	Mean	10.50	0	1.78	0	2.00	4.08
	Minimum	1	0	1	0	2	2
	Maximum	20	0	2	0	2	10
Duck	Mean	11.69	4.95	8.43	4.67	6.12	5.49
	Minimum	2	1	1	3	1	2
	Maximum	25	16	22	6	15	17
Hen	Mean	18.45	48.21	12.43	4.76	9.94	8.09
	Minimum	1	2	2	1	1	2
	Maximum	25	600	50	12	40	20
Pigeon	Mean	14.73	11.00	43.53	10.00	8.17	26.85
	Minimum	2	2	2	10	4	4
	Maximum	40	30	200	10	14	100

Source: Field survey 2015

4.1.11 Agricultural activities

The respondents were asked to know about the agricultural activities of their family members. It was seen that all the members of the entire family are more or less involved in agricultural activities. The table represents that a total 14 types of activities were found of which 77.70% female members (n=230) were involved in raising poultry followed by pre-boiling the paddy (70.95%), cows and goats rearing (64.19%), cultivation of vegetables (17.23%), crop processing (3.38%), planting crops/seeds (2.36%) etc. In the study area 72.30% male members were involved in planting crops/seeds followed by weeding (67.91%), irrigation (67.57%), transplanting (53.72%), harvesting (53.72%), crop processing (47.30%) etc. It was seen that the child were also involved in various types of agricultural activities (Table 4.11). 23.65% male child were involved in planting crops/seeds and irrigation followed by weeding (22.30%), transplanting (13.85%), fish farming/ catching fish (11.15%) etc. and 6.76% female child were involved in raising poultry followed by pre-boiling the paddy (0.34%) and cows and goat rearing (0.34%).

Table 4.11 Agricultural activities performed by the family members

Agricultural activity	Women	Men	Son	Daughter
	N (%)	N (%)	N (%)	N (%)
Planting crops/seeds	7 (2.36)	214 (72.30)	70 (23.65)	0
Weeding	6 (2.03)	201 (67.91)	66 (22.30)	0
Irrigation	3 (1.01)	200 (67.57)	70 (23.65)	0
Composting	4 (1.35)	130 (43.92)	50 (16.89)	0
Transplanting	3 (1.01)	159 (53.72)	41 (13.85)	0
Mulching	0	60 (20.27)	4 (1.35)	0
Harvesting	6 (2.03)	159 (53.72)	22 (7.43)	0
Pre-boiling	210 (70.95)	19 (6.42)	1 (0.34)	1 (0.34)
Crop processing	10 (3.38)	140 (47.30)	23 (7.77)	0
Cultivation of vegetables	51 (17.23)	114 (38.51)	29 (9.80)	0
Homestead gardening	7 (2.36)	87 (29.39)	9 (3.04)	0
Fish farming/ catching fish	2 (0.68)	70 (23.65)	33 (11.15)	0
Keeping cows and goats	190 (64.19)	102 (34.46)	27 (9.12)	1 (0.34)
Raising Poultry	230 (77.70)	28 (9.46)	2 (0.68)	20 (6.76)

Source: Field survey 2015

4.1.12 Household activities

Member of the respondents family were involved in various types of household activities. It was found that 98.31% female members were involved in cooking for their family member followed by cleaning (97.97%) while the 85.47% male members were involved in marketing followed by house repairing (Table 4.12). On the other hand the children both male and female had a variety of works to assist their families. About 25.68% male child (Son) were engaged in marketing followed by house repair (14.54%) and 17.57% female child (Daughter) were engaged in cleaning followed by clothing (14.86%).

Table 4.12 Household activities performed by the family members

Household activity	Women	Men	Son	Daughter
	N (%)	N (%)	N (%)	N (%)
Cooking	291 **(98.31)**	1 (0.34)	0	41 (13.85)
Cleaning	290 (97.97)	1 (0.34)	0	52 **(17.57)**
Clothing	286 (96.62)	1 (0.34)	0	44 (14.86)
Handcrafts production	5 (1.69)	1 (0.34)	0	5 (1.69)
Sewing	26 (8.78)	3 (1.01)	0	6 (2.03)
House repair	34 (11.49)	184 (62.16)	46 (15.54)	1 (0.34)
Marketing	20 (6.76)	253 **(85.47)**	76 **(25.68)**	2 (0.68)

Source: Field survey 2015

4.1.13 Household Expenditure

The maximum monthly average expenditure were recorded from Niskinpur (BDT 9739) followed by Kanthalia para, Barenda, Batashpur, Rudrapur and Panihar (Table 4.13). The maximum and minimum monthly household expenditure were reported from Rudrapur. On the other hand, Monthly maximum educational expenditure was reported from Niskinpur (BDT 10000) and minimum (BDT 500). The maximum monthly other cost were recorded from Niskinpur and minimum from Barenda. Other cost was not reported by the respondent from Panihar village.

Table 4.13 Monthly family expenditure

Village		Household	Education	Other	Total
Panihar	Average	3783.3	1555.6		4631.8
	Minimum	2000.0	500.0		2000.0
	Maximum	7500.0	5000.0		10000.0
Batashpur	Average	4560.0	1958.1	1000.0	5681.8
	Minimum	2000.0	500.0	1000.0	2000.0
	Maximum	10000.0	7000.0	1000.0	13000.0
Barenda	Average	5288.1	2409.1	1428.6	8550.9
	Minimum	2000.0	500.0	500.0	3000.0
	Maximum	10000.0	15000.0	5000.0	65000.0
Kanthalia para	Average	5468.8	2182.6	1000.0	7068.8
	Minimum	2000.0	500.0	1000.0	2500.0
	Maximum	9000.0	15000.0	1000.0	20000.0
Rudrapur	Average	4057.1	1983.9	2000.0	5191.1
	Minimum	500.0	500.0	2000.0	500.0
	Maximum	15000.0	12000.0	2000.0	18000.0
Nishkinpur	Average	5242.9	3019.2	2314.3	9739.0
	Minimum	3000.0	500.0	1000.0	1500.0
	Maximum	12000.0	10000.0	10000.0	40000.0

Source: Field survey 2015

4.1.14 Household income

The highest monthly average income was recorded from Niskinpur followed by Barenda, Kanthalia para, Batashpur, Rudrapur and Panihar (Table 4.14). On an average monthly income BDT 12364.4 were mentioned by respondents of Niskinpur with minimum BDT 2000 and Maximum BDT 40000. The lowest monthly average income was reported from Panihar village ranging from BDT 2000 to BDT 15000. The higher monthly average income for male was reported from Niskinpur (BDT13829.30) ranging from BDT2000 to-BDT40000 and lowest from Panihar (BDT5908.7) with the range of BDT 20000 to BDT 15000. On the other hand, the lowest monthly average income for female respondents was reported from Panihar with the range of BDT 2000 to BDT 10000. Again the highest monthly average income for female was reported from Niskinpur with the minimum BDT 4500 and Maximum BDT 16000.

Table 4.14 Monthly Household incomes

Village:		Total	Male	Female
Panihar	Average	5578.8	5908.7	4820.0
	Minimum	2000.0	2000.0	2000.0
	Maximum	15000.0	15000.0	10000.0
Batashpur	Average	7463.6	8364.9	5611.1
	Minimum	3000.0	3000.0	3000.0
	Maximum	45000.0	45000.0	14000.0
Barenda	Average	11442.4	12525.6	8531.3
	Minimum	2000.0	4000.0	2000.0
	Maximum	85000.0	85000.0	20000.0
Kanthalia para	Average	7796.9	7934.8	7444.4
	Minimum	3000.0	5000.0	3000.0
	Maximum	14000.0	14000.0	13000.0
Rudrapur	Average	5780.4	6587.5	3762.5
	Minimum	1000.0	2500.0	1000.0
	Maximum	16000.0	16000.0	7500.0
Nishkinpur	Average	12364.4	13829.3	9027.8
	Minimum	2000.0	2000.0	4500.0
	Maximum	40000.0	40000.0	16000.0

Source: Field survey 2015

4.1.15 Sources of drinking water

The respondents were asked to know about the source of their drinking water. 78.31% respondents mentioned that their sources of drinking water from tube well while 21.02% respondents said that supply water (tap water/pipeline) was their sources of drinking water (Table 4.15). Among the villages, it was observed that tube well was the source of drinking water from Panihar, Batashpur and Kanthalia para but in Barenda 91.5% respondents used tap water/pipeline water as the sources of drinking water followed by Nishkinpur (11.9%). According to BBS (2011) it was mentioned that in Godagari Upazila of Rajshahi district, 82.7% households were availed the facility of drinking water from tube-well, 13.5% from tap and the remaining 3.8% household from other sources and in Tanore Upazila, 75.1% households got the facility of drinking water from tube-well, 20.6% from tap and the remaining 4.3% household got water from other sources. In Niamatpur Upazila 89.7% general household got the facility of drinking water from tube-well, 7.7% from tap and 2.6% households from other sources. Among all respondents 78.31 % respondents were availed tube well water and 21.02% from supply as the source of drinking water. Only 0.68% respondents were mentioned other sources for their drinking water.

Table 4.15 Sources of household drinking water

Sources	Rajshahi		Chapai Nawabganj		Naogaon		Total N=295
	Panihar	Batashpur	Barenda	Kanthalia para	Rudrapur	Nishkinpur	
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Tube well	33 (100)	54 (98.18)	5 (8.5)	32 (100)	55 (98.2)	52 (88.1)	231 (78.31)
Tap water/ pipeline			54 (91.5)		1 (1.8)	7 (11.9)	62 (21.02)
Others		1 (1.81)				1 (1.78)	2 (0.68)

Source: Field survey 2015

4.1.16 Own sources of drinking water

The results showed that a total 59% respondents of the study area having own sources of drinking water and another 41% respondent's have no own source of drinking water (Table 4.16). They were heavily relied on other sources likely neighbor's tube well, tap water or pipeline. Among the villages, all the respondents of Kanthalia para having their own sources of drinking water followed by Niskinpur (85%), Barenda (73%), Batashpur (55%), Rudrapur (25%) and Panihar (9%).

Table 4.16 Own source

	Rajshahi		Chapai Nawabganj		Naogaon		Total N=295
	Panihar	Batashpur	Barenda	Kanthalia para	Rudrapur	Nishkinpur	
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Yes	3 (9)	30 (55)	43 (73)	32 (100)	14 (25)	51 (85)	173 (59)
No	30 (91)	25 (45)	16 (27)	0	42 (75)	9 (15)	122 (41)

Source: Field survey 2015

4.1.17 Distance of drinking water from source

The respondents those have no own sources of drinking water they need to collect it either from short distance or long distance. The respondents were asked to know about the distance of drinking water source from their houses. 64.75% respondents of the study area mentioned that the source of drinking water less than 100 meter away from their homestead (Table 4.17). On the other hand 34.43% respondents of the study

area were claimed that the distance between 100 to 500 meters and only 0.82% respondents reported that more than 500 meter away from their homestead.

Table 4.17 Distance of the source

Distance	Rajshahi		Chapai Nawabganj		Naogaon		Total N=295
	Panihar	Batashpur	Barenda	Kanthalia para	Rudrapur	Nishkinpur	
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Less than 100 meter	20 (25.32)	18 (22.78)	5 (6.33)	0	29 (36.71)	7 (8.86)	79 (64.75)
100-500 meter	10 (23.81)	6 (14.29)	11 (26.19)	0	13 (30.95)	2 (4.76)	42 (34.43)
More than 500 meter	0	1 (100)	0	0	0	0	1 (0.82)
Total	30 (24.59)	25 (20.49)	16 (13.11)	0	42 (34.43)	9 (7.38)	122 (100)

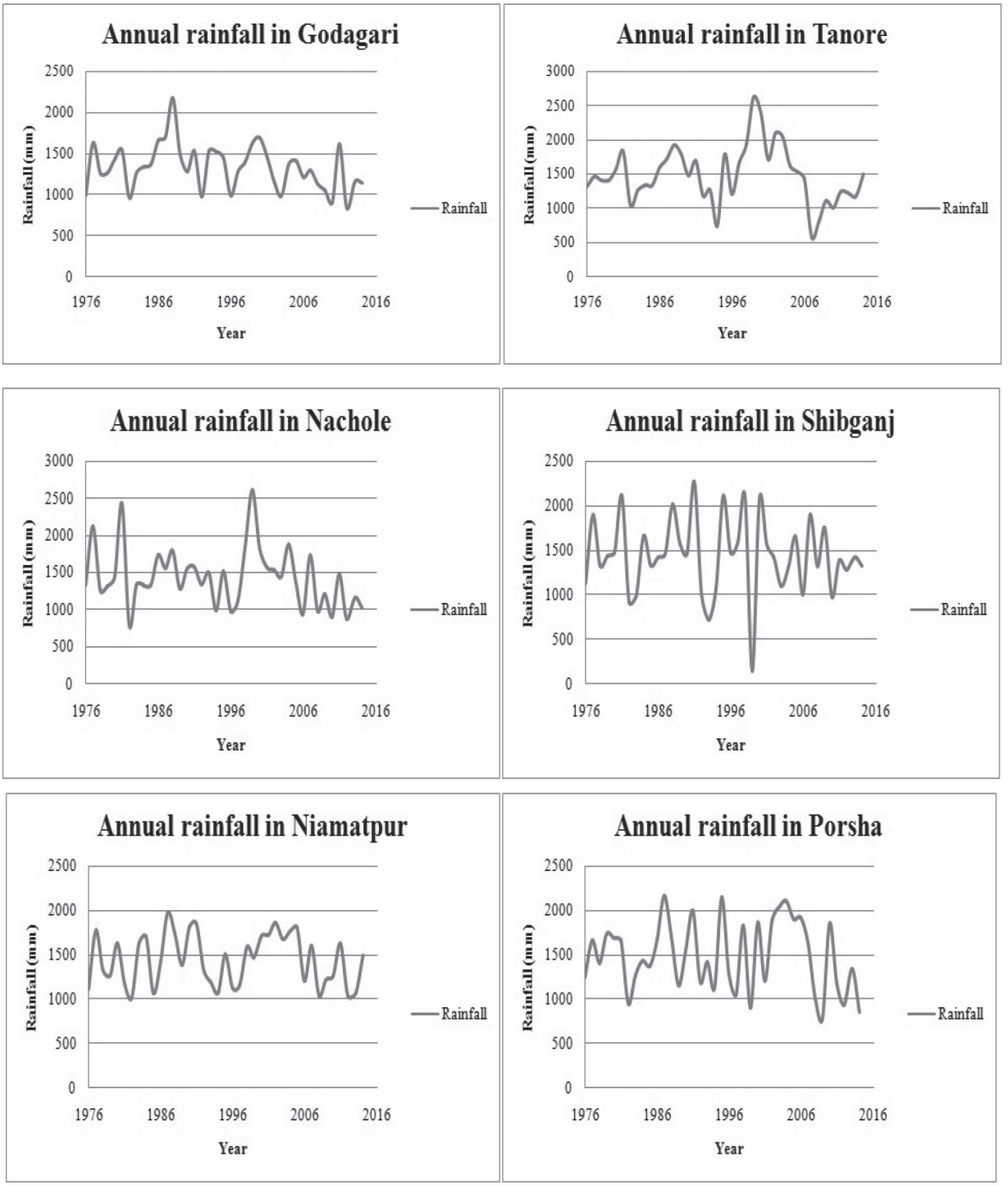
Source: Field survey 2015

4.2 Climate scenario in the study area

4.2.1. Rainfall

4.2.1.1. Annual rainfall of the study area

Metrological data showed that the annual rainfalls in the study area were not uniform and it varies from month to month, year to year and locations to locations (Appendix 2). The rainfall data of the study was collected from six different meteorological stations. Analysis of the available data from 1976 to 2014, in Godagari station it was seen that the highest amount of rainfall were found in the year of 1988 (Annual rainfall 2180mm) and the lowest rainfall 834.5mm was recorded in the year of 2012. Alike in Tanore, Nachole, Shibganj, Niamatpur and Porsha the highest annual rainfall (2624.5mm) was recorded in 1999, 2615.4mm in 1999, 2276mm in 1991, 1977.7mm in 1987 and 2162.3mm in 1987 respectively (Fig 4.1). On the other hand the lowest rainfall (582.7) was reported in 2007, 796.2mm in 1982, 148.1mm in 1999, 1017.4mm in 1982 and 782.9mm in 2009 respectively.



Source: Bangladesh Meteorological Department, 2016.

Figure: 4.1 Annual rainfalls in the study area

4.2.1.2. Scenario of rainfall using 3 months SPI value

The Standardized Precipitation Index (SPI) was used for analysis of wet or dry condition based on long term rainfall data. This wet or dry condition could be monitored by using SPI on a variety of time scales from sub-seasonal to inter-annual scales. The SPI is expressed as standard deviations that the observed precipitation

would deviate from the long-term mean, for a normal distribution and fitted probability distribution for the actual precipitation record. Since precipitation is not normally distributed, a transformation is first applied, followed by fitting to a normal distribution (GMAO, 2016). McKee and others (1993) used the classification system shown in the SPI value (Table 4.18) to define drought intensities resulting from the SPI. They also defined the criteria for a drought event for any of the timescales. A drought event occurs any time the SPI is continuously negative and reaches an intensity of -1.0 or less. The event ends when the SPI becomes positive. Each drought event, therefore, has a duration defined by its beginning and end, and intensity for each month that the event continues. The positive sum of the SPI for all the months within a drought event can be termed the drought's "magnitude".

Table 4.18 SPI Values

SPI values	Reminds
2.0+	extremely wet
1.5 to 1.99	very wet
1.0 to 1.49	moderately wet
-.99 to .99	near normal
-1.0 to -1.49	moderately dry
-1.5 to -1.99	severely dry
-2 and less	extremely dry

This interpretation was made by using 3 months SPI values for Godagari upazila. The lowest SPI value (-1.07) were found in the year of 1989 and 1999 using January to March time series data, which indicated moderate dryness of the area. From April to June the lowest SPI value was found (-1.34) in the year of 1997, which indicated moderate dryness of the area. The severe dryness was taken place during July to September in 2008 and 1982 by demonstrating SPI value (-1.61) and (-1.58) respectively. The severe dryness was observed during October to December in the year of 1996, 2011 and 1987 by representing SPI value (-1.68), (-1.58) and (-1.53) respectively (Fig 4.2).

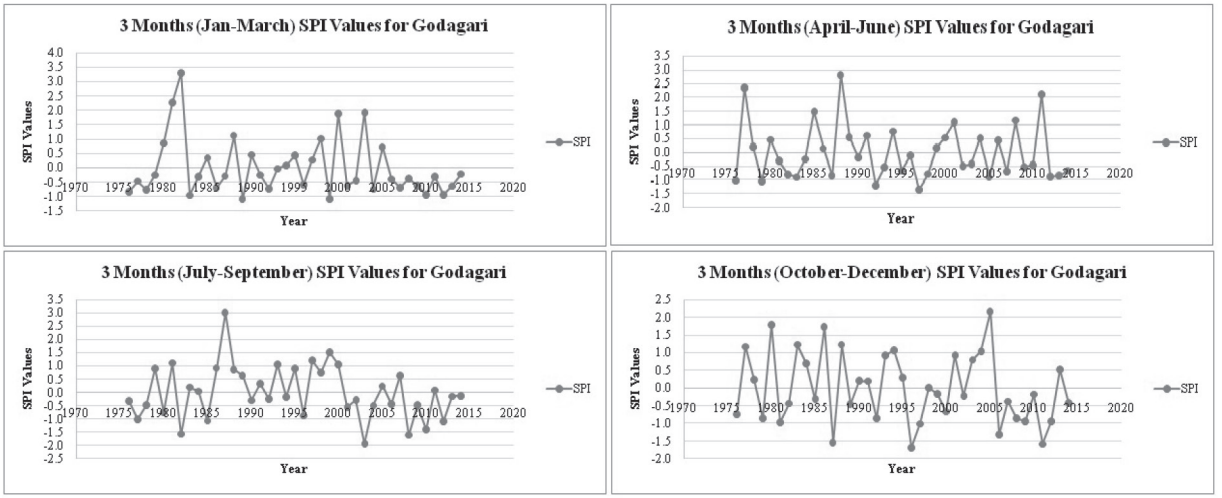


Figure: 4.2 3 Months SPI Value for Godagari

The mild dryness was taken place during the month of January to March in the year of 1999, 2007 and 2010 in Tanore Upazila (Fig 4.3). The severe dryness was noticed during the month of April to June in the year of 1998 and 2007 demonstrating SPI value (-1.72) and (-1.55) respectively. From July to September the severe dryness was occurred in 1994, 2008 and 2007. During severe dryness, the SPI values were (-1.89), (-1.61) and (-1.54) respectively and from October to December mild dryness were appear in 2011 and 1981.

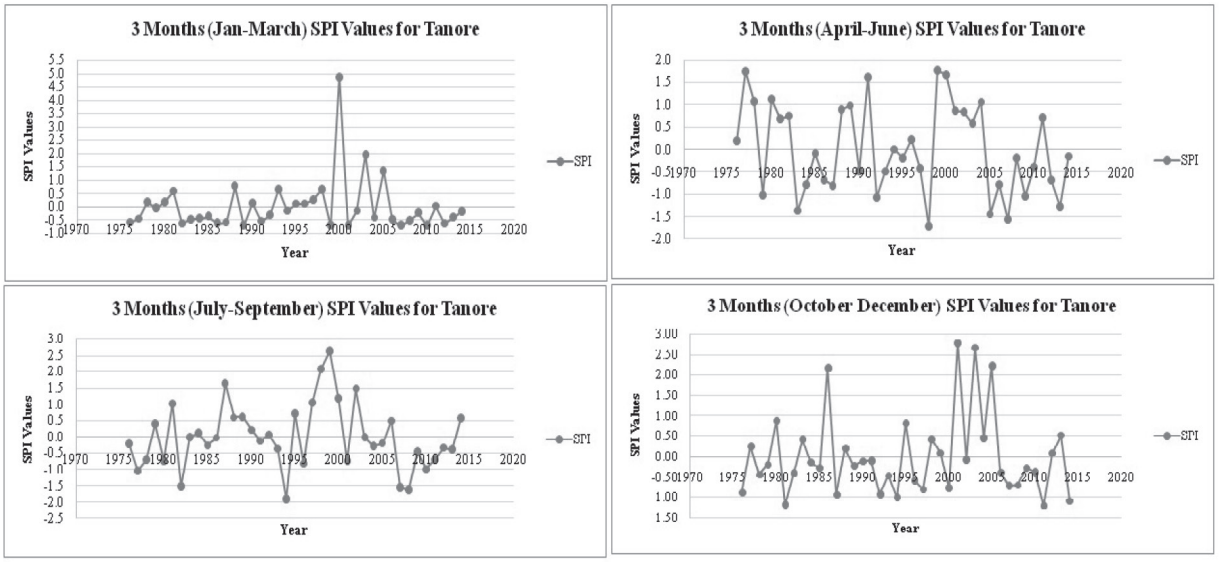


Figure: 4.3 3 Months SPI Value for Tanore

The mild dryness was noticed during the month January to March in 1977, 1986 and 2001 in Nachole Upazila. Severe dryness was occurred in 2005 during the period of April to June by demonstrating SPI value (-1.52). The moderate dryness was recorded in the year of 1982, 1994, 2008, 2012 and 2013. From October to December there was only mild dryness prevail in the of 1996 in Nachole (Fig 4.4).

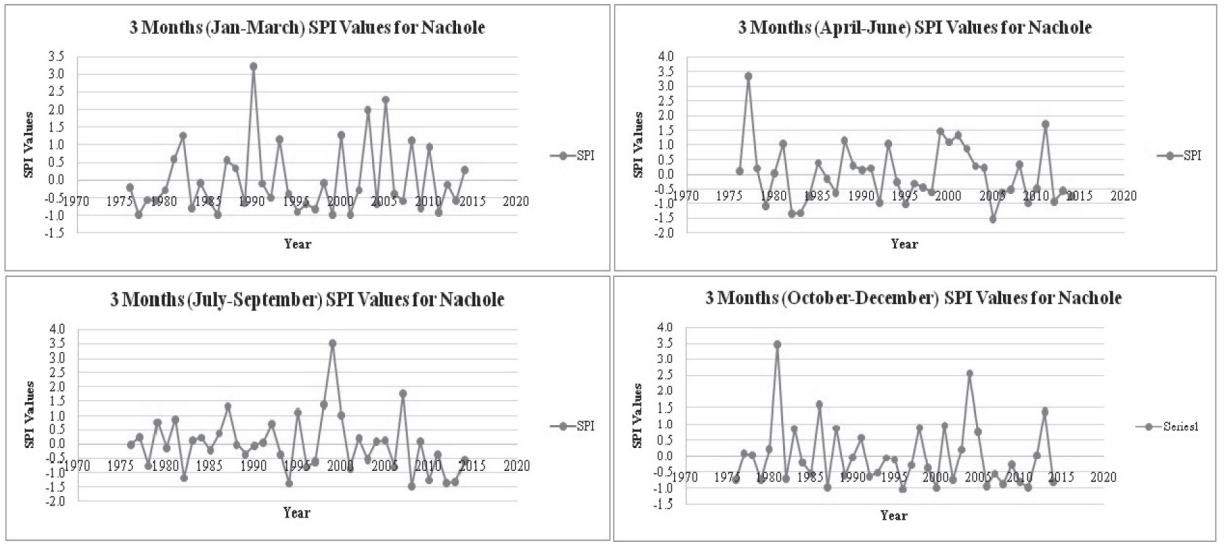


Figure: 4.4 3 Months SPI Values for Nachole

No extreme and severe dryness were recorded in Shibganj during the month of January to March in the year of 1976 to 2014 (Fig 4.5). In this area the upmost dryness from January to March was recorded as the category of moderate dryness and the SPI value (-1.18) for the year 1976, 1986, 1999 and 2011 respectively. The SPI value indicated that the area experienced an extreme dryness during April to June and July to September in 1999 with the SPI value (-2.13) and (-2.26) respectively. From October to December two moderate dryness were recorded in 1987 and 2011.

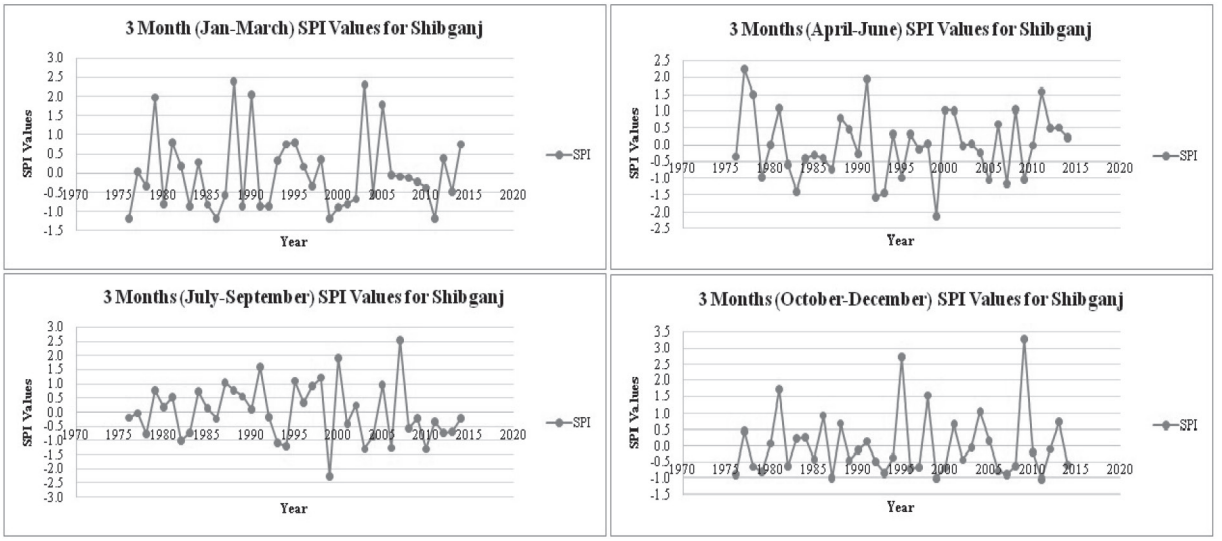


Figure: 4.5 3 Months SPI Value for Shibganj

No extreme and severe dryness was recorded during the month of January to March in the year of 1976 to 2014 in Niamatpur Upazila (Fig 4.6). Moderate dryness with the SPI value (-1.08) was recorded in 1999 and 2001 respectively. The study site also passed moderate dryness as upmost dryness during April to June, July to September and October to December.

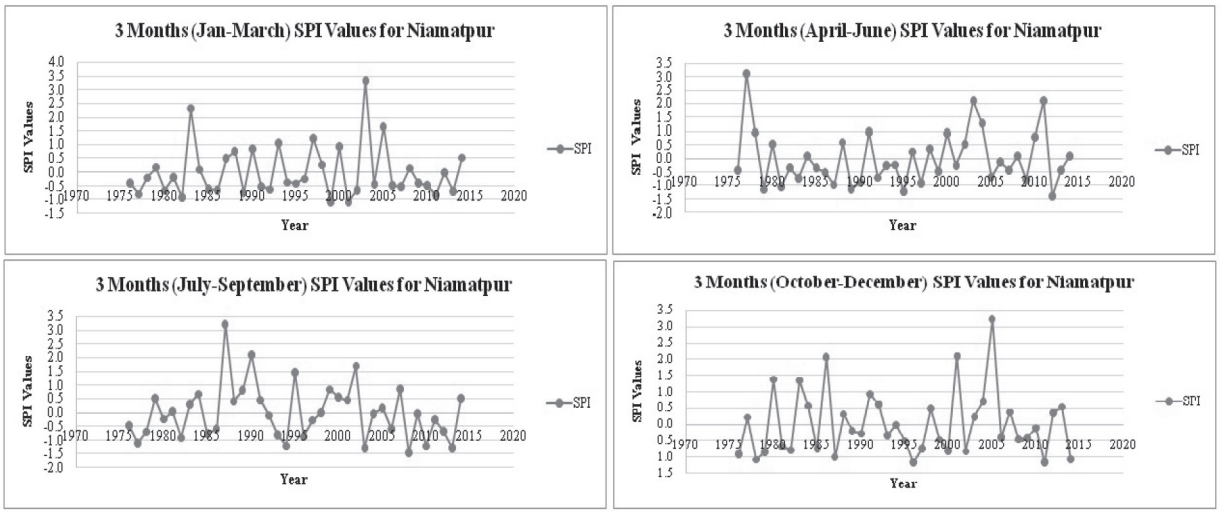


Figure: 4.6 3 Months SPI Value for Niamatpur

Similarly Porsha Upazila never experienced extreme and severe dryness during January to March for the period of 1976 -2014 (Fig 4.7). Only moderate dryness with the SPI value (-1.00), (-1.08) and (-1.08) were recorded in 1997, 1999 and 2010 respectively. The study are was also passed moderate dryness as upmost dryness during April to June, July to September and October to December in 1999 and 2012.

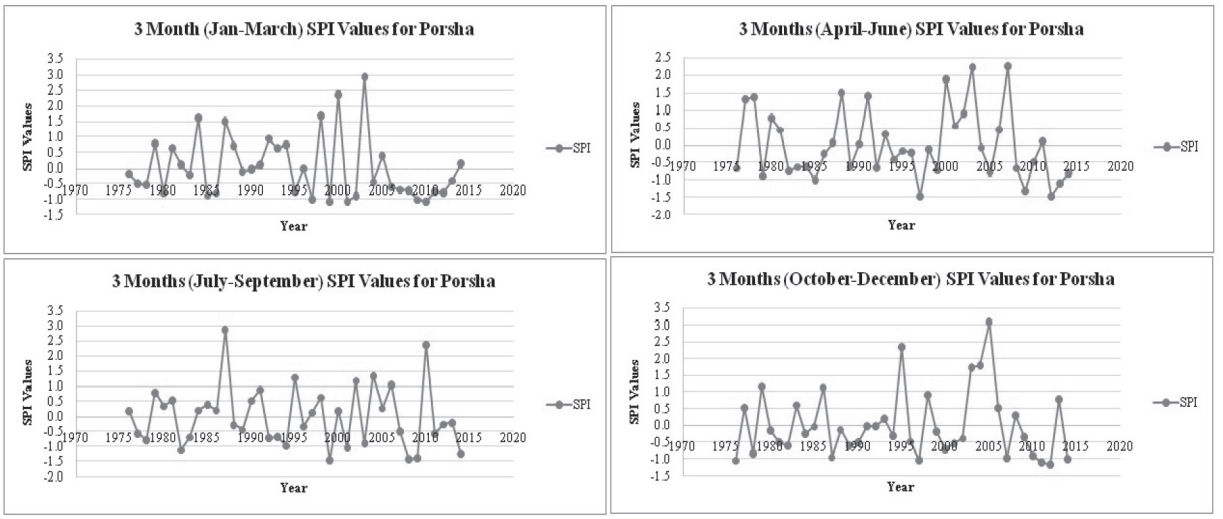


Figure: 4.7 3 Months SPI Value for Porsha

4.2.1.3. Drought frequency using 3 month SPI

The maximum numbers of mild dryness were recorded in Nachole followed by Tanore, Godagari, Niamatpur, Shibganj and Porsha during the month of January to March for the period of 1976 to 2014 (Table 4.19). The maximum occurrence (27 times) of mild dryness was recorded in Nachole. The Porsha upazila was faced a maximum of 5 times moderate dryness followed by 4 times in Shibganj. The study areas were never faced severe and extreme dryness during the month of January to March for the period of 1976 to 2014.

Table: 4.19 Frequency of drought using 3 Months (January-March) SPI

Year/Period	SPI Values	Location						Reminds
		Niamatpur	Nachole	Godagari	Tanore	Shibganj	Porsha	
1976-2014	0 to –0.99	22	27	24	25	19	19	"Mild Dryness"
1976-2014	-1.00 to -1.49	2	0	2	0	4	5	"Moderate Dryness"
1976-2014	-1.5 to -1.99	0	0	0	0	0	0	"Severe dryness"
1976-2014	< -2.0	0	0	0	0	0	0	"Extreme dryness"

Source: BWDB, 2015

The SPI values for three months (April-June) from 1976 to 2014 imparted the results that Gadagari and Nachole upazila experienced maximum 19 times mild dryness. In that time Tanore upazila observed 6 times moderate dryness and 2 times severe dryness (Fig 4.20). It was also observed that the Shibganj upazila has been experienced an extreme dryness during the April to March from 1976-2014.

Table: 4.20 Frequency of drought using 3 Months (April-June) SPI

Year/Period	SPI Values	Location						Reminds
		Niamatpur	Nachole	Godagari	Tanore	Shibganj	Porsha	
1976-2014	0 to –0.99	18	15	19	13	13	19	"Mild Dryness"
1976-2014	-1.00 to -1.49	5	4	4	6	5	4	"Moderate Dryness"
1976-2014	-1.5 to -1.99	0	1	0	2	1	0	"Severe dryness"
1976-2014	< -2.0	0	0	0	0	1	0	"Extreme dryness"

Source: BWDB, 2015

This interpretation reflected the results for the third quarter of the year (July-September). The results showed that the Tanore upazila were faced 17 times mild dryness during the time period 1976 to 2014 followed by Niamatpur, Nachole and Shibganj (15 times). Niamatpur, Nachole and Porsha upazila were experienced moderate dryness in 6 times (Table 4.21). Tanore and Godagari upazila were experienced severe drought in 4 times and 3 times respectively. Only Shibganj Upazila was noticed one extreme drought during the period of 1976-2014.

Table: Table 4.21 Frequency of drought using 3 Months (July-September) SPI

Year/Period	SPI Values	Location						Reminds
		Niamatpur	Nachole	Godagari	Tanore	Shibganj	Porsha	
1976-2014	0 to –0.99	15	15	14	17	15	14	"Mild Dryness"
1976-2014	-1.00 to -1.49	6	6	4	1	5	6	"Moderate Dryness"
1976-2014	-1.5 to -1.99	0	0	3	4	0	0	"Severe dryness"
1976-2014	< -2.0	0	0	0	0	1	0	"Extreme dryness"

Source: BWDB, 2015

There was no extreme drought was recorded in the study area during the month of October to December for the period of 1976-2014 (Table 4.22). It was indicated that only Godagari Upazila was experienced three times severe drought during the time spells. The maximum numbers of mild drought were recorded in Nachole Upazila followed by Porsha, Tanore, shibganj, Niamatpur and Godagari. Niamatpur upazila experienced moderate droughts (5 times) followed by Porsha, Shibganj, Tanore, Godagari and Nachole.

Table: 4.22 Frequency of drought using 3 Months (October-December) SPI

Year/Period	SPI Values	Location						Reminds
		Niamatpur	Nachole	Godagari	Tanore	Shibganj	Porsha	
1976-2014	0 to –0.99	18	23	16	22	21	22	"Mild Dryness"
1976-2014	-1.00 to -1.49	5	1	2	3	3	4	"Moderate Dryness"
1976-2014	-1.5 to -1.99	0	0	3	0	0	0	"Severe dryness"
1976-2014	< -2.0	0	0	0	0	0	0	"Extreme dryness"

Source: BWDB, 2015

4.2.2. Temperature

4.2.2.1. Average maximum and minimum temperature

Average temperature (25.22°C) was recorded during the period of 1976-2014 with the average maximum and minimum temperature of 30.1°Cand 16.6°C respectively (Fig 4.8). Corresponding figure, the highest maximum average temperature was 32.4°C in 1979 followed by 31.7°C in 1980, 31.4°C in 2012 and 31.3°C in 2010. In respect to the linear line and R-Square value (R^2= 0.007) for maximum average temperature, there is no significance difference between the temperature during the period of 1976 to 2014. The lowest minimum average temperature was 14.3°C degree in 2003 followed by 14.7°C in 2011, 15.1°C in 1998. The linear line of minimum average temperature showed that there is a decreasing trend-line with R-square value (R^2= 0.32). It meant that there is no significance difference in temperature during the period of 1976 to 2014.

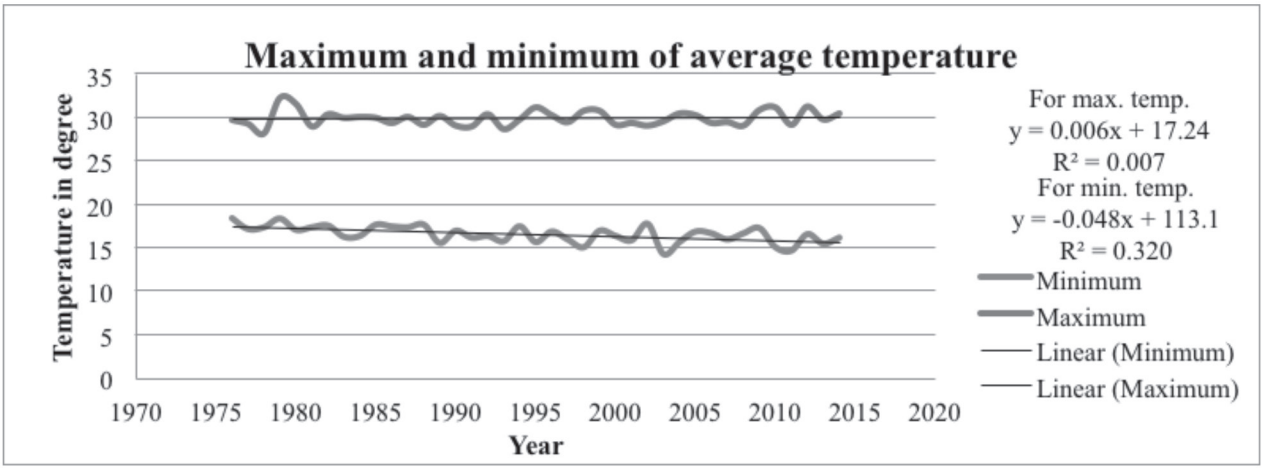


Figure: 4.8 Average maximum and minimum temperature

4.2.2.3. Number of hot days

Bangladesh has a subtropical monsoon climate characterized by wide seasonal variations in rainfall, high temperatures and humidity. According to Weather online (2016), generally maximum summer temperatures range between 30°C and 40°C and April is the warmest month in most parts of the Bangladesh. And the analysis of secondary data it was found that the average temperature of the study area was 25.22°C during the period of 1976 to 2014. Considering long term average temperature, 35°C and above daily temperature was considered as a hot day. Analyzing the daily temperature for the period of 1976 to 2014, 113 days found as the hot days in 2010 followed by 108 days in 2014, 107 days in 2012, 98 days in 2009, 97 days in 2013 and 85 days in 1979 (Fig 4.9). The minimum numbers (only 13 days) of hot days were recorded in 1981. According to linear line graph, there is an increasing trend of hot days but the R-square values (R2= 0.355) indicated that there is no significance difference in temperature during the period of 1976 to 2014.

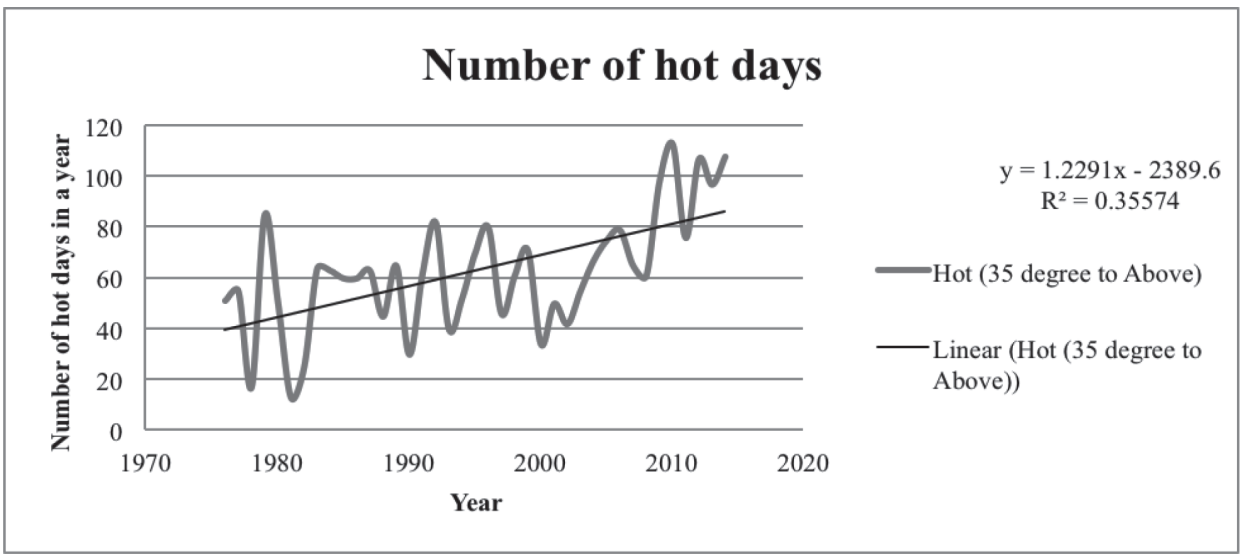


Figure: 4.9 Number of hot days

4.2.3. Humidity

4.2.3.1. Humidity of the study area

Secondary data for the measurement of humidity was collected from Bangladesh Meteorological Department. After arranging the data the figure represents that the yearly average humidity in percentage of the study area. The highest humidity was 80.7% in 1990 followed by 80.3% in 1998 and the lowest humidity was 70.4% in 1976 followed by 71.1% in 1979. The maximum humidity percentage was recorded in 1990 (Fig 4.10).

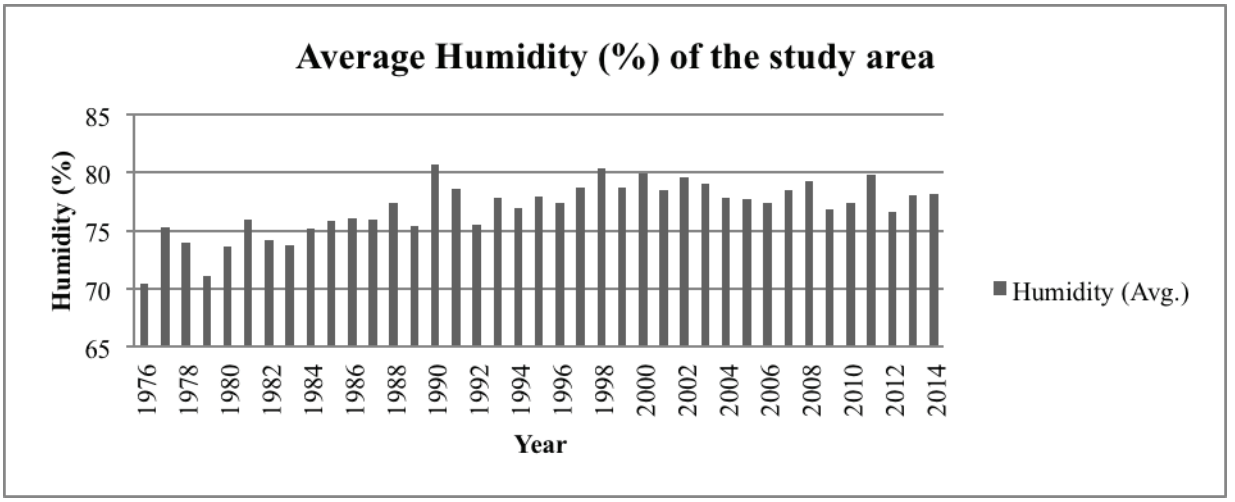


Figure: 4.10 Average Humidity (%) of the study area

4.2.3.2. Average maximum and minimum humidity in percentage

Average humidity of the study area was recorded 76.96% with the range of average maximum (87.5%) and minimum humidity (59.6%) during the period of 1976-2014 (Fig 4.11). It could be observed that the highest maximum yearly average humidity was 90% in 1987 and the lowest maximum yearly humidity was found 85% in 1976 and 2010 respectively. The linear line and R-square value (R^2= 0.057) for maximum yearly average humidity represents that there is no significance difference of humidity during the period of 1976 to 2014. The lowest minimum yearly average humidity was found 44% in 1979 while the highest minimum yearly average humidity was 70% in 1990. The linear line of minimum yearly average humidity showed that there is increasing trend of humidity but considering R-square value (R^2= 0.341), there was no significance difference of humidity during the period of 1976 to 2014.

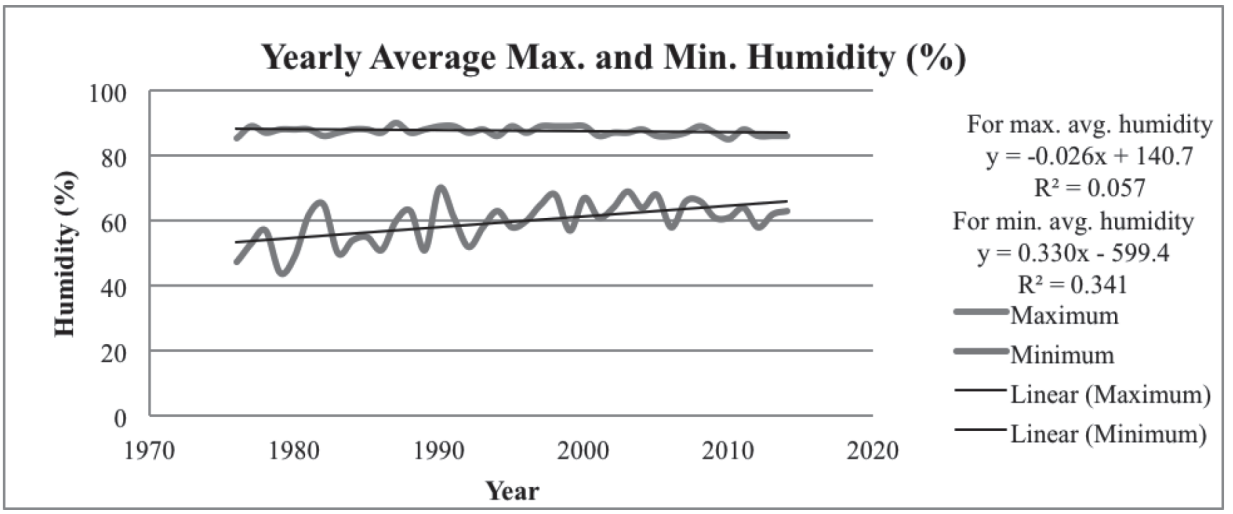
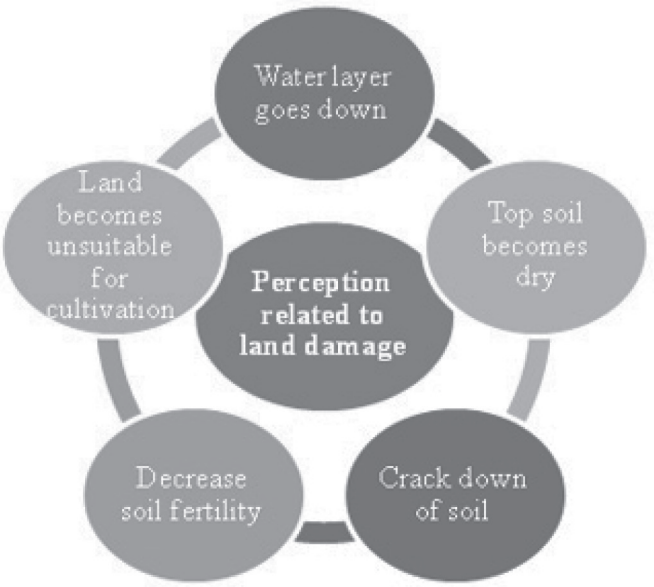


Figure: 4.11 Yearly Average Max. And Min. Humidity (%)

4.2.4. Soil Moisture

4.2.4.1. Average soil moisture

Soil moisture is one of the most important indicators to identify the dryness of soil and area. According to the figure 4.12, the average soil moisture (%) was plotted in the graph using data sets for the period of 2003 to 2014. It was observed that the highest soil moisture was found 24.87% in 2003 followed by 21.43% in 2004 and the lowest soil moisture was found 11.88% in 2010 followed by 16.11% in 2009.



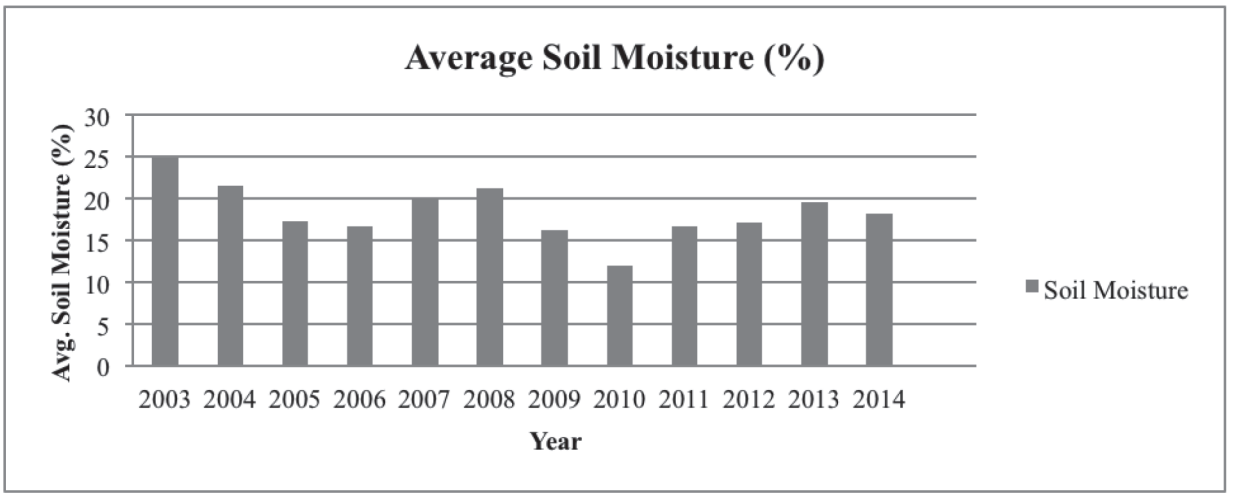
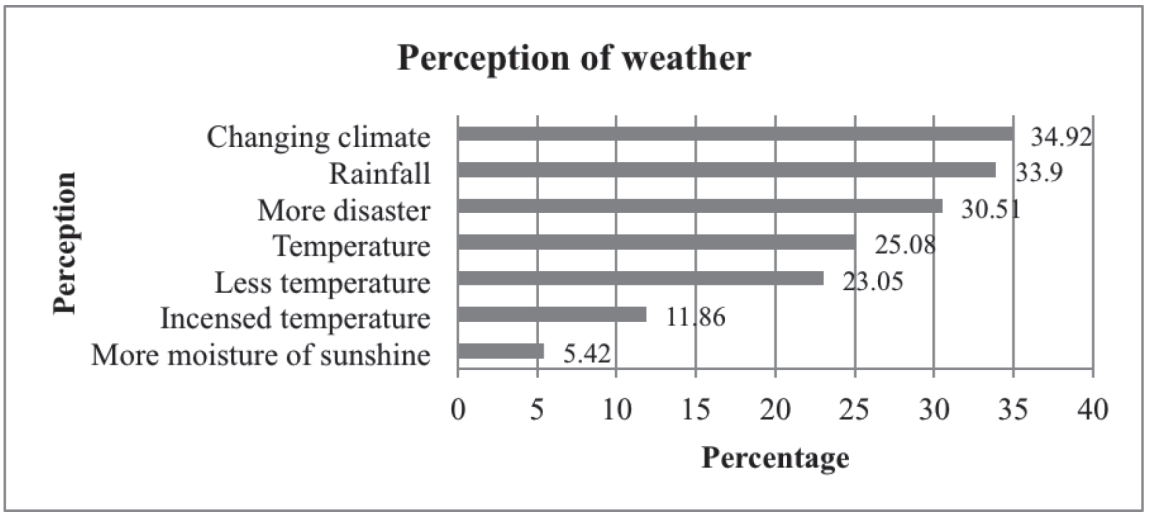


Figure: 4.12 Average soil moisture (%)

4.3. Farmers perception on Climate Change

4.3.1. Farmers perception on weather

The respondents of the study area were not well known with firm definition of climate and weather. They did not know the definition of weather clearly. They were perceived weather as a day by day status of several parameters including temperature, rainfall, natural disaster and more moisture in the sunshine.



Source: Field survey 2015

Figure 4.13 Perception on weather

According to the Oxford Dictionary, weather is the state of the atmosphere at a particular place and time as regards heat, cloudiness, dryness, sunshine, wind, rain, etc. But there is no firm definition and clear understanding of weather as perceived by the respondents. Maximum numbers of the respondents were perceived weather as the indicator of changing climate (34.92%). They thought that weather means changing climate within a short period of time followed by rainfall, frequent disasters, and temperature, less temperature, incensed temperature, and hazy sun shine. (Figure 4.13).

4.3.2. Farmers perception on Climate Change

According to the ecolife dictionary, Climate change is the long-term shift in weather patterns in a specific region or globally. Unlike global warming, which refers to just one aspect of climate change - a rise in the surface temperature of the earth's surface – climate change refers to changes in a regions overall weather patterns, including precipitation, temperatures, cloud cover, and so on. But there is no firm definition and clear understanding of climate change as perceived by the respondents. They just understand climate change means the changes of average weather of long time (79%), but they have no clear idea about the period of time. 21% respondents also were perceived that climate change means the average weather of 20-30 years (Fig 4.14).

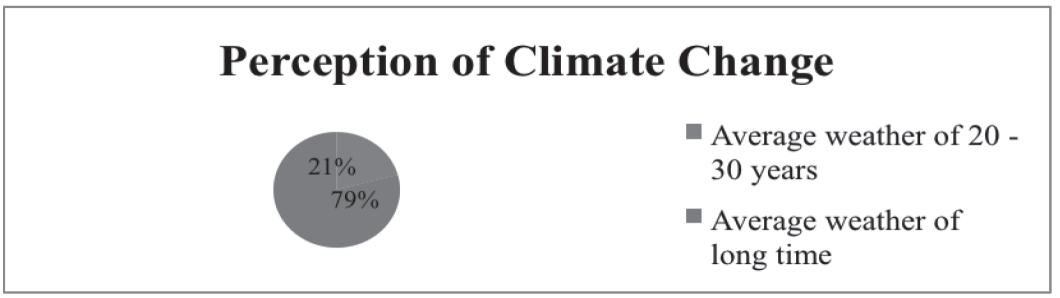


Figure 4.14 Perceptions on Climate Change

4.3.3. Weather and climate change indicators perceived by the farmers

Respondents are the permanent resident of the study area; thereby they have long experience in the area about the weather and climate. For this reason the respondents were asked to know about the changes of weather and climate. All of the respondents of the study area said that from their long experience, the weather and climate is changing day by day. They were also identified numerous numbers of weather and climate change indicators including temperature, rainfall, soil fertility, ground water level, soil rupture, drought, flood etc. 86.44% respondents were mentioned that the temperature is increasing day by day and during the summer those feels warmer weather compared to the past few years and 55.59% respondents of the study area noticed that the average rainfall is decreasing during the rainy season. This is the reason the intensity of drought (28.14%) and flood (23.05%) is increasing year by year. People also said that decrease of soil fertility (21.36%), crack down of top soil (21.02%) and ground water layer goes down (17.63%) caused by weather and climate change (Fig 4.15).

Case: Climate Change

Md. Shahin Ali, the permanent resident of Panihar village of Godagari upazila in Rajshahi district; thereby he has long experience in the area about the weather and climate. He cannot give the firm definition of weather and climate change. He just understands weather means the daily environment and climate change means the average weather of long period of time, but he has no clear idea about the period of time. He perceived that climate change means the average weather of 30-40 years. The identifying indicator by the respondents is temperature, rainfall, soil fertility, ground water level, soil rupture, drought and biodiversity.

He realized temperature is increasing day by day and the variations of temperature have been increased. Presently, the weather is not uniform; it is comparatively too hot during the summer and cold at winter. Among the summer season the day is relatively warm but cold at night. Rainfall is decreased compared to previous, but suddenly excessive rainfall appears in some years. Soil fertility decreasing day by day because in recent year, to get expected production from agriculture a lot of chemical fertilizer is required which would not before. Ground water level goes down day by day. 15-20 years ago, 25-30 feet deep pump was enough to uptake ground water but now it requires 70-80 deep pumps. Over the past few decades have increased the incidence of drought. In the summer a lot of moisture decreases, causing a rupture occurs on crop land. Biodiversity is being destroyed day by day. Once there was a lot of wildlife such as jackal, rabbit, wildcat, tiger fishy, weasel and various types of snake etc. but these animals are now extinct.

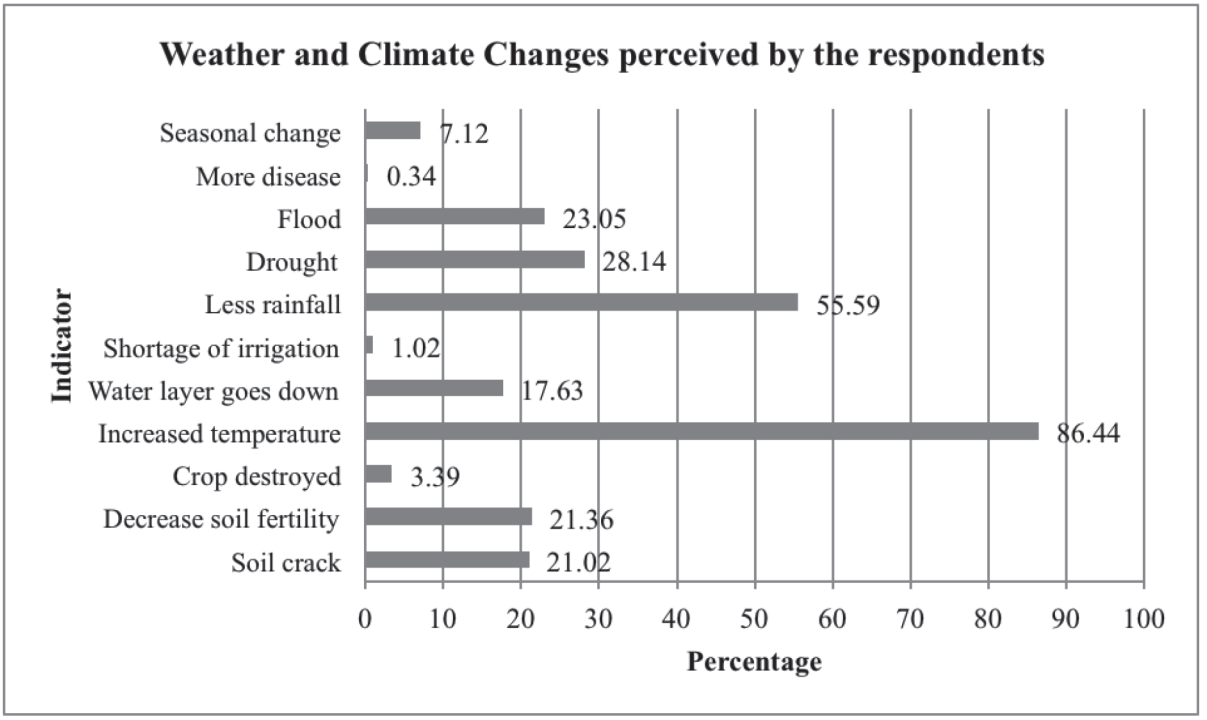
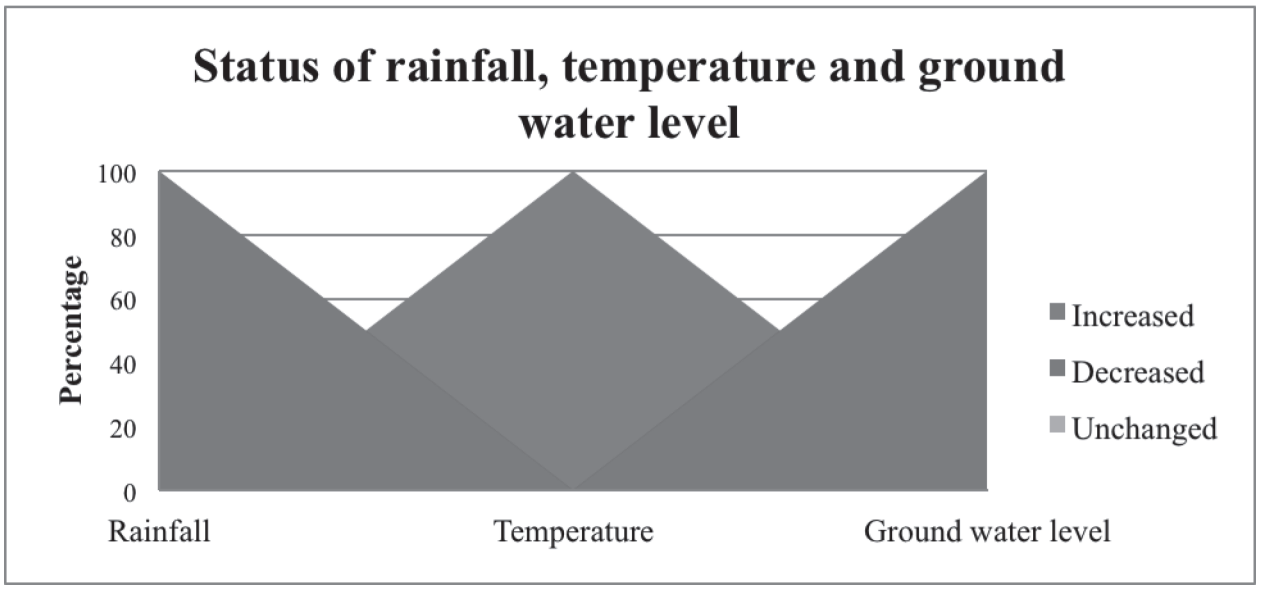


Figure 4.15 weather and climate change indicators

Visibility of season is also now is the matter of question. As the earlier six distinct seasons were observed but now a -days only three seasons were noticed by the respondent. Only summer, rainy season and winter were reported by the respondent. They also mentioned that summer exist longer time in the study area. Extreme (high) temperature was recorded in the summer and cold (low temperature) were noticed during winter. They also believed that this is happening due to climate change.

4.3.4 Farmers perception about the present status of rainfall, temperature and ground water level

The respondents were asked to know about the present status of rainfall, temperature and ground water level than ever before. The results showed that all the respondents of the study area were perceived temperature is increasing day by day but the rate of rainfall is decreasing and the ground water level goes down as a result the shortage of irrigation and drinking water occur during the summer (Fig 4.16).



Source: Field survey 2015

Figure 4.16 Status of rainfall, temperature and groundwater table

4.3.5 Farmer's perception on land and crop damage due to climate change

Respondent's perception on land and crop damage due to climate change was explored through semi-structured questionnaire survey, focus group discussion and key informants interview. Analyzing the collected qualitative data on respondent's opinion about the damage related to land and crop damage, it was observed that the respondents of the study area were identified mainly five causes which are inter-related to each other. They perceived ground water level goes down during dry season, for this reason the top layer of soil become dry and cracks are created on the ground. As a result, soil fertility decreased and the lands become unsuitable for cultivation (Fig 4.17).

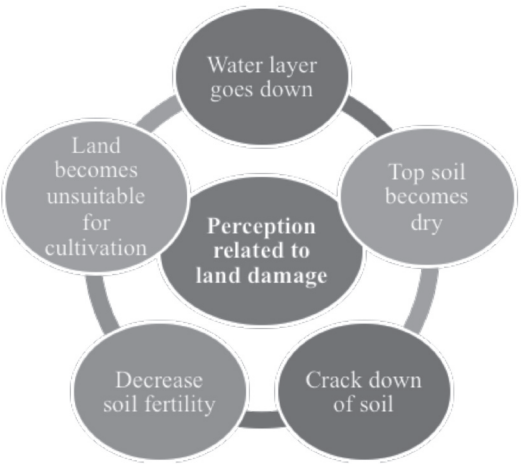


Figure: 4.17 Perception about land damage due to climate change

All the respondents mentioned that they are seriously affected by climate change during all of three cultivation seasons. Changes in climate also impacted on the availability of water and irrigated water for agriculture. People of the study area identified that crops died due to shortage of ground water and increased insects attack during the cultivation. As a result the production cost is increased and the overall crop production is decreased (Fig 4.18).

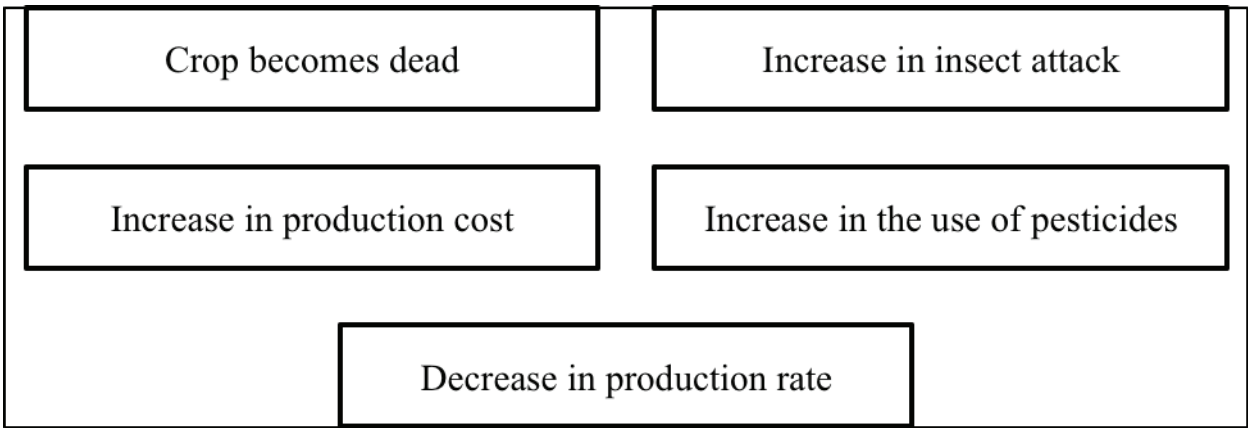


Figure: 4.18 Perception about the damage related to crops due to climate change

4.4 Farmers perception about drought and its impact

4.4.1 Perception of drought

The respondents of the study area do not know the definition of drought clearly. They just understand drought is a natural disaster with extreme temperature and lack of rainfall. Several statements were identified related to drought definition likely drought as a period of unusually dry weather that persists long enough to cause problems such as crop damage and reduced water supply. There is no firm definition and clear understanding of drought as perceived by the respondents. Drought meant lack of soil moisture for the spell of periods, dryness of weather and no rainfall for over the periods. As perceived by the local people, increased of temperature during summer (50.17%) followed by more sunshine during the day (42.71%), soil become rupture (37.29%), less rainfall (30.51%), less soil moisture (29.15%), Water table goes down (23.73%), shortage of irrigation water (4.75%), decreased soil fertility (4.41%) and destruction of crops (2.37%) was considered as drought (Fig 4.19).

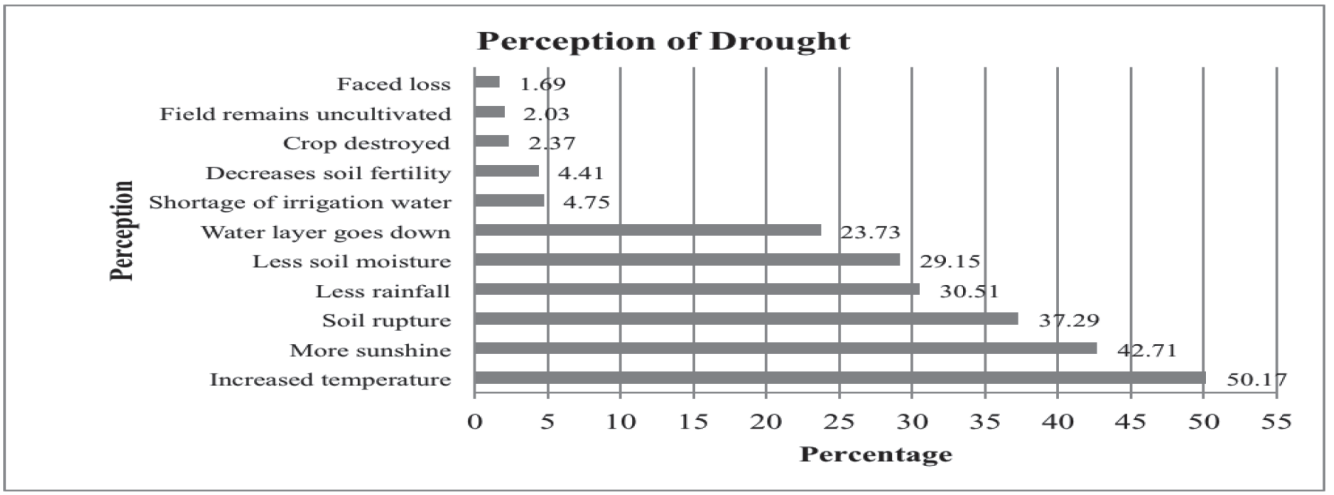


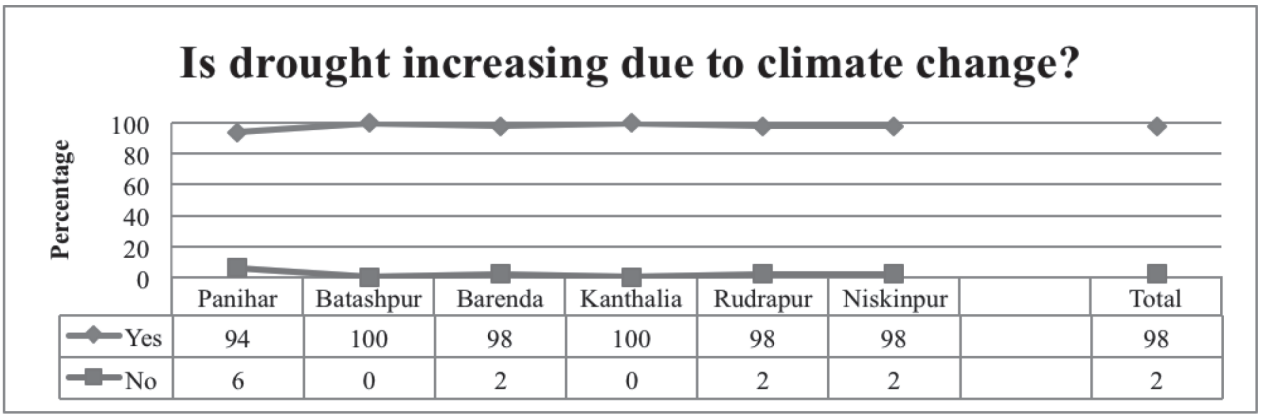
Figure: 4.19 Perception on drought

Perceptions of drought and the associated risks are crucial to formulate appropriate relief and mitigation policies. Perceptions also can shape the responses to drought and the confusion on what difficulties may

drought cause in dealing with the hazard. Some of the difficulties are as follows: (i) Drought was perceived as a creeping experience because its' beginning and breaks are often intricate to recognize. Clear distinction between non-drought and drought is absent; (ii) Drought is generally viewed as a temporary occurrence. As a result, it is usually not taken seriously once the rains have started again; it is considered as a calamity and managed as an event; (iii) The direct impacts of drought direct impacts like withering crops, dry watering points, reduced forage for livestock etc., are obvious. Second and third order effects, such as price rise, increased food imports, surges in rural-urban migration rates, are not recognized. As a result, much of the impacts attributable to drought are difficult to identify.

4.4.2 Perception of drought frequency due to climate change

The respondents were also asked to know the status of drought frequency due to climate change. 98% respondents agreed that drought is increased than previous years due to climate change while only 2% respondents disagreed with the statement (Fig 4.20). Among the villages, it was observed that all the respondents of Batashpur and Kanthalia villagementioned that drought is frequently increased due to climate change followed by Barenda (98%), Rudrapur (98%), Nikinpur (98%) and Panihar (94%). On the other hand, 6% respondents of Panihar village said that there is no impact of climate change on drought followed by Barenda (2%), Rudrapur (2%) and Nikinpur (2%).



	Panihar	Batashpur	Barenda	Kanthalia	Rudrapur	Niskinpur		Total
Yes	94	100	98	100	98	98		98
No	6	0	2	0	2	2		2

Figure 4.20 Is drought increasing due to climate change

4.4.3 Impacts of drought in the study area

From this study it was reported that drought affects all parts of the communities and environment. Several types of drought impacts are often categorized as economic, environmental and social impacts. Economic impacts are related to the destruction of crops, asset loss, price hike, low income generation activities etc. Environmental impacts are related to the plants and animal habitat, water supply, soil erosion, soil fertility etc and social impacts include health, public safety, social conflicts and changes in lifestyle. But the people of the study area have no clear idea about the impacts of drought. Analyzing the qualitative data, it was found all the respondents noticed that local droughts occur regularly and affect the crop production, livelihoods, health and society.

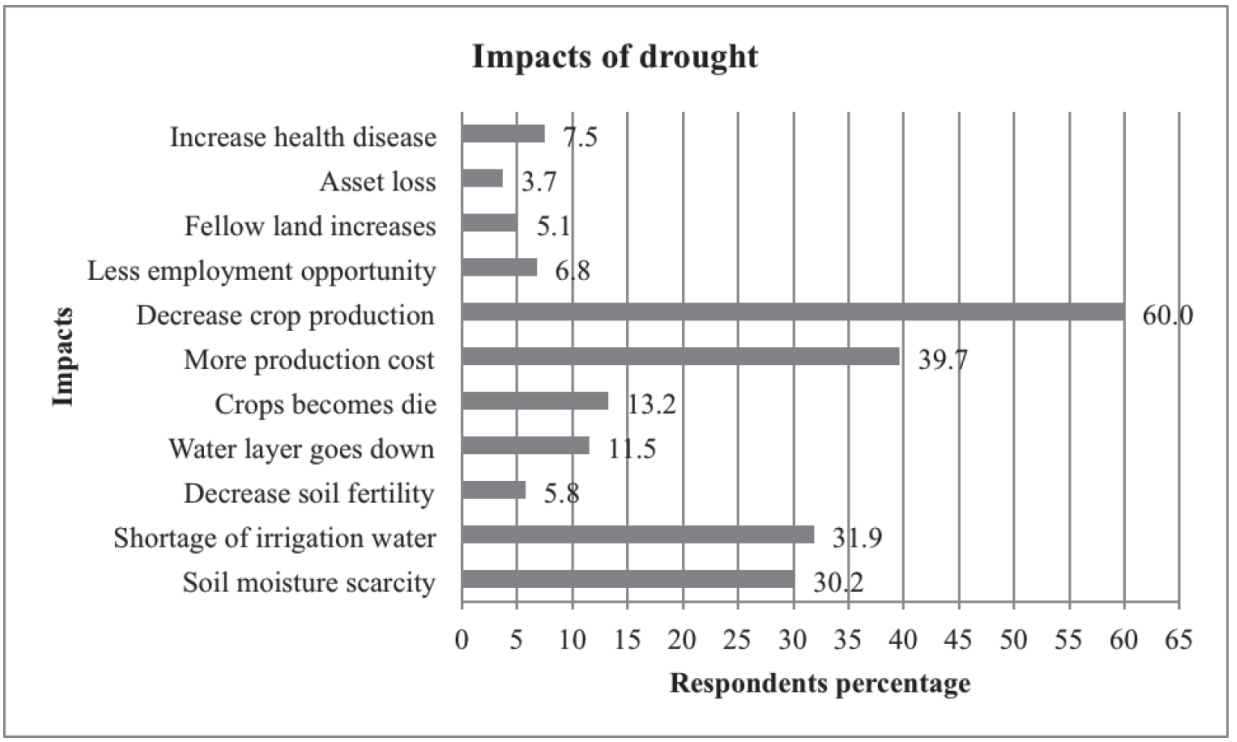


Figure 4.21 Impacts of drought

Respondents of the study areas mentioned that the agricultural drought is linked to soil moisture scarcity (30.2%). These could be occurred at different stages of crop growth, development and reproduction. They were also said that drought has impacted negatively on irrigation water (31.9%), ground water level (11.9%), and soil fertility (5.8%). For these reason crops becomes die (13.2%) and if they want to better yield in production, the cost is increased (39.7%). Maximum percentage of respondents was mentioned that decreased crop production (60%). Drought could be reduced the employment opportunities (6.8%), declined crop production with increased fallow land (5.1%), and assets loss (3.7%). These could be accelerated household food insecurity and impacted on health. Subsequent impact of decreased food consumption lead to significant increase of illnesses (7.5%), this may cause an increased chronic energy deficiency among the agricultural workers (Fig 4.21).

4.4.4 Drought symptoms due to climate change

It was mentioned that lack of rainfall or erratic rainfall can cause damage to crops. In turn, less rainfall lead to shortage of irrigation water. Several symptoms or indicators were identified by the respondents including soil crack, decrease the soil fertility, burning of crops, changes in cultivation period and creates many other problems (Fig 4.22). The ultimate results, drought during the monsoon period decreases production, which in turn, increases the prices of agricultural commodities and affects their demand.

Case: Cropping pattern (batashpur, Tanore)

Md. Alamgir Mandol, a traditional farmer, lives in Batashpur village of Tanore upazila of Rajshahi district. He stated that mainly three farming season exist there and he practice agriculture in all the season since many years ago.

Month based season and cropping patterns are following ---

January-June (IRRI): Its dry season but in this season farmers get sufficient irrigation water supply from deep tube well. The main crop of this season is paddy (IRRI). The popular name of this species is 'Jirasal'. Farmers said that 'Jirasal' is drought resistant species and this species grown very well in hot dry days. Besides IRRI mustard, wheat and potato are grown on a small scale there and onion, garlic and coriander are cultivated around the homestead.

July-October: In this season agricultural activities are depends on rain water because at this point supply of irrigation water from deep tube well is kept off. In this season the main crops is paddy, locally known as 'Vadra irri or Borsha irri'. Some associate crops are grown but in this season most of the agricultural lands are kept in fallow.

November-January: In this season, all the agricultural fields are usually planted by paddy (Aman), and some other associate crops are grown in the selective agricultural field because other types of crops cannot grow in this season. These associate crops are gourd, garlic, brinjal, onion, ginger and various types of vegetables.

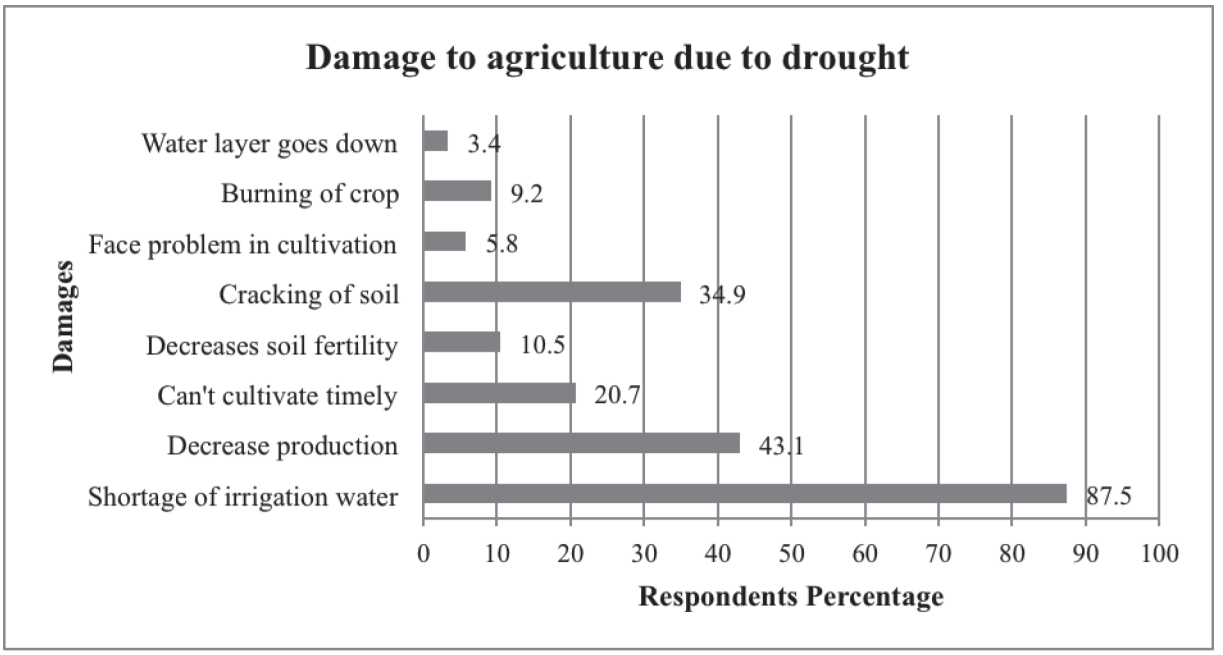


Figure 4.22 Damage to agriculture due to drought

87.5% respondents were reported the key indicator of drought mentioning shortage of irrigation water during the drought period followed by decreased production, soil cracks were appeared in the field of agriculture and they can't cultivate timely (20.7%). Respondents also said that during the drought period soil fertility had been decreased (10.5%), crops were burned (9.2%), and many other problems such as agricultural machinery were faced (5.8%).

4.4.5 Changes in cultivation time due to drought

Respondents were asked to know about the changes of cultivation time due to drought. It was mentioned that they were changed time for crop cultivation due to drought impact. They were adjusted time prior to the beginning of the cultivation time and second option was to later period of the cultivation season (Fig 4.23).

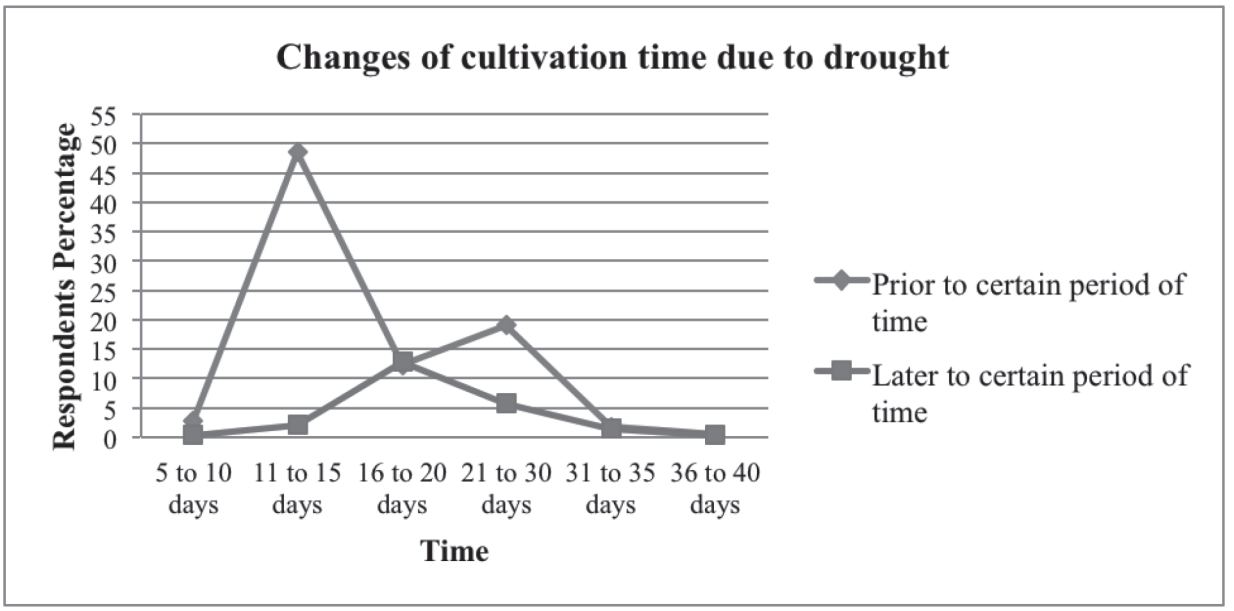


Figure 4.23 Change in cultivation time due to drought

Maximum percentage of the respondents was changed 11 to 15 days prior to actual cultivation time followed by 21 to 30 days (18.98%), 16 to 20 days prior (12.2%) and 5 to 10 days (2.71%).

In second option, 12.88% respondents said that, to mitigate the drought damage they began their farming 16 to 20 days later from specified cultivation time followed by 21 to 30 days (5.76%), 11 to 15 days (2.03%) and 31 to 35 days (1.36%).

4.4.6 Health problems due to drought

It is expected that increased air temperatures will cause more stress on human body. Humans are warm-blooded animals, so they are affected by increased heat and humidity. Drought often creates a lack of clean water for drinking, sanitation and personal hygiene, which can lead to a wide range of life-threatening diseases.

Figure 4.24 Health problems due to drought

Several diseases were reported by the respondents (Fig 4.24). Maximum respondents mentioned diarrhea (79%) followed by fever (66.8%), dysentery (56.9%), dizziness/headache (33.6%), skin disease (21.7%), blood pressure (17.6%), jaundice (10.8%), fluxes (8.1%), cough (6.1%), cholera (5.4%) and dehydration (2%) .

4.5 Drought adaptation

4.5.1 Adaptation measures to reduce drought impacts

Several measures were adapted by the respondents to mitigate drought impacts. These may be at the farm level, household level or at individual level. The measures depend on several factors including drought

frequency, intensity and scale of drought loss (Fig 4.25).The primary concern of drought is shortage of water, most of the planned activities aim at reducing the effect of such shortage, through measures that are taken before, during and after drought.

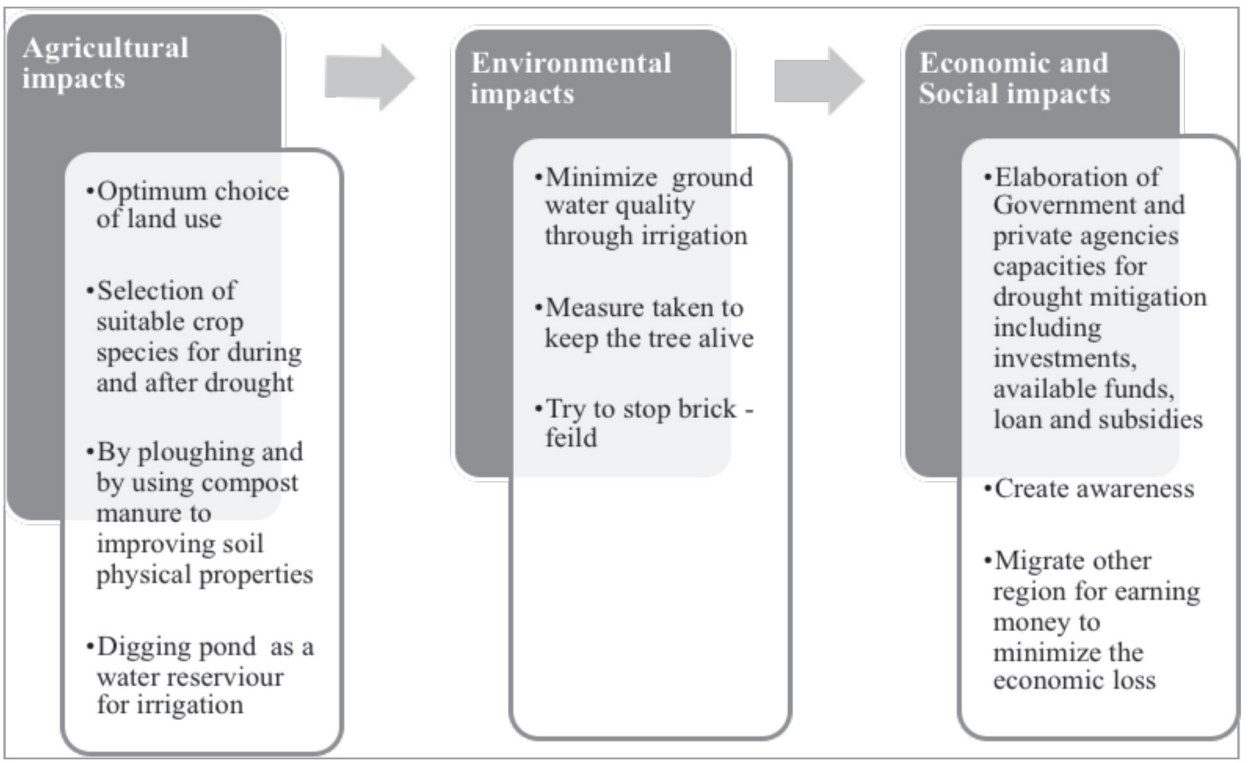


Figure 4.25 Drought adaptation measures

It was mentioned that the people of the study area took some of the measures to reduce the harmful effects of drought on agriculture and their livelihoods. The measures included optimum choice of land use, selection of suitable crops for cultivation during and after the drought, plow the land before the drought and using compost manure to improve the physical properties of soil and digging pond as a water reservoir for irrigation during the drought. The people of study area just try to keep ground water quality intact through irrigation, measure taken to keep the trees alive and try to stop brick field to minimize the harmful environmental impacts. To mitigate the economical and social impacts due to drought the people of the study area elaborate themselves to Government and private agencies for investments, available funds, loan and subsidies. They also create awareness about ways to mitigate drought and migrate other region for earning money to minimize the economic loss.

Case: Shifting profession (Barenda, Nachole)

Md. Rafiq Arotdar, lives in Barenda village of Nachole upazila at Chapai Nawabganj district. Once he was a rich farmer but now he is a fruit dealer. He converted his agricultural land to orchard because he was suffering heavy losses in agriculture in each year. He identified drought is the main cause for that losses because it increase the cost of production. On the other hand, to established an orchard initial cost is higher than agriculture but the maintenance cost is comparatively low because it requires minimum labour, fertilizer and water. Thereby, good profits can be found all over.

Until last year, he was 32 biga's (1biga=33decimals) of agricultural land, but this year he converted his land 8 biga for plum orchard, 7 biga for mango orchard and pomegranate orchard. 2/3 years mature seedlings are purchased from nearby nursery (Kollanpur nursery) for established orchard. A benefit of planting mature seedling is that it gives fruits from next year.

To establish a plum orchard it requires 200 plum seedlings per biga. Locally the species name is Apple kul and initial cost is around 10000tk. Mango orchard requires 20 khishapati and gopalvug variety seedlings and 50 amrupali variety seedlings per biga, and the initial cost is around 8000tk. And pomegranate orchard requires 50 pomegranate seedlings per biga, and the initial cost is around 7500tk. He guesses from his experience, he can earn at least 50000tk in a year from one biga orchard where from agriculture he cannot earn nearly 25000tk in a year.

Agricultural crops can be grown easily within mango and pomegranate orchard at the first 6/7 years of establishment, which helps to earn extra money from the same land.

4.5.2 Recover from drought loss due to climate change

The respondents mentioned that they recovered themselves from drought loss by adopting wide range of options. They were recovered drought loss by taking loan from NGOs (53.90%) followed by cattle rearing, loan from others, fish cultivation, changing professions, small business, small trading and selling of own property (Table 4.23). Only 3.73% respondents were mentioned that they have no options to recover drought loss.

Table 4.23 Available options to recover drought loss

Drought recovery measures	Rajshahi		Chapai Nawabganj		Naogaon		Total N=295
	Panihar	Batashpur	Barenda	Kanthalia	Rudrapur	Niskinpur	
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Cattle rearing	0	22 (40.7)	40 (69)	11 (34.4)	23 (41.1)	45 (76.3)	141 (47.80)
Fish cultivation	3 (9.4)	2 (3.7)	0	0	0	10 (16.9)	15 (5.08)
Small trading	0	2 (3.7)	1 (1.7)	0	1 (1.8)	0	4 (1.36)
NGO loan	16 (50)	19 (35.2)	32 (55.2)	32 (100)	34 (60.7)	26 (44.1)	159 (53.90)
By working	22 (68.8)	9 (16.7)	1 (1.7)	0	2 (3.6)	0	34 (11.53)
Business	0	2 (3.7)	0	0	1 (1.8)	0	3 (1.02)
Can't recover	0	9 (16.7)	1 (1.7)	0	0	1 (1.7)	11 (3.73)
Tuition	0	1 (1.9)	0	0	0	0	1 (0.34)
Selling property	0	1 (1.9)	0	0	2 (3.6)	0	4 (1.02)
Loan from others	21 (65.6)	3 (5.6)	0	0	38 (67.9)	0	21 (21.02)

Source: Field survey 2015

Among the villages, it was found that all respondents of Kanthalia took loan from NGOs to recover drought loss followed by Rudrapur (60.7%), Barenda (55.2%), Panihar (50%), Niskinpur (4.1%) and Batashpur (35.2%) respectively.

4.5.3 Suitable crop species in drought-prone areas

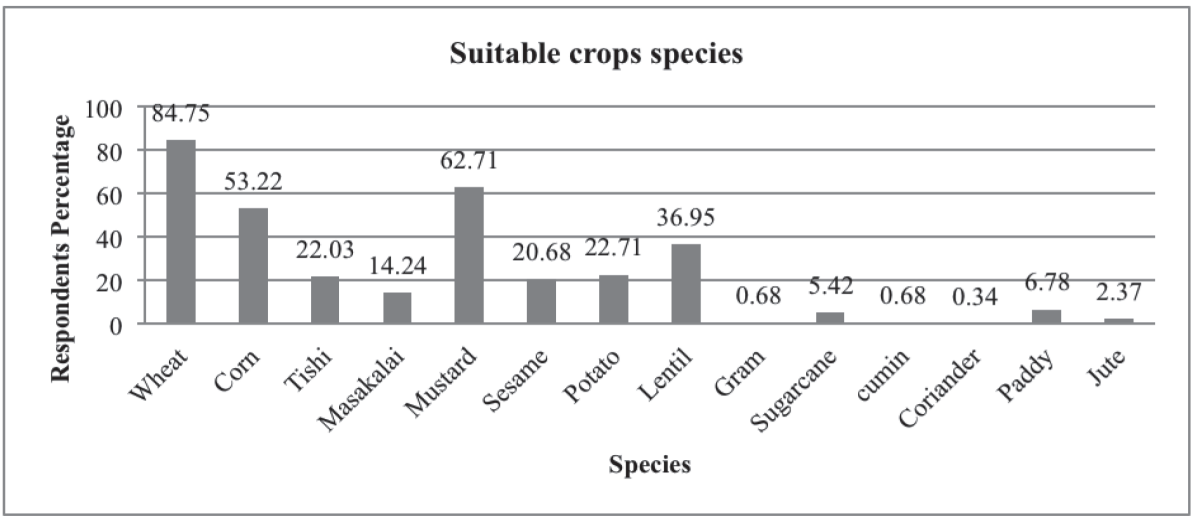


Figure 4.26 suitable crops in drought prone areas

Most of the crops were died during the drought period. Few crops were grown well during drought in the drought pore areas (Fig 4.26). The highest percentage of respondents was mentioned that wheat (84.75%) grows well in the drought prone areas followed by Mustard, corn (53.22%), lentil (36.95%), potato (22.71%), linseed (22.03%), masakalai (14.24%), paddy (6.78%), and sugarcane (5.42%). Wheat grows very well during the drought because it requires very little irrigation, mostly one or two times irrigation is enough for wheat cultivation. In a different variety of wheat namely the 'IRRI Wheat' is the most drought tolerant species; 'Sonali' and 'Kanchan' are another drought tolerates species of wheat. Mustard, lentil, pulse (maskalai), potato, melon (bangi), watermelon, brinjal, papaya, coriander were also grown very well during the drought period. These crops require very little irrigation water, once or two times in a season. If once the rain comes then these crops do not require irrigation water. IRRI (species name- Jirasal) grows well in dry season; hot sunny days are very effective for getting an expected yield from this type of paddy, although it requires irrigation once in three days.

4.5.4 Use of organic fertilizer

Organic fertilizer has many benefits compare to the chemical fertilizer. Maximum percentage of respondents mentioned that organic fertilizer increase soil fertility (81.36%) followed by production increase (74.24%), improved moisture holding capacity (24.07%) and decrease environmental pollution (Table 4.24). Respondents were also reported that organic fertilizer prevents soil aridity and hence it increase the moisture content of the soil and the use of organic fertilizer has no negative impact on the health and environment.

Table 4.24 Benefits of organic fertilizers

Benefits of organic agriculture	Rajshahi		Chapai Nawabganj		Naogaon		Total N=295
	Panihar	Batashpur	Barenda	Kanthalia	Rudrapur	Niskinpur	
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Fertility increase	27 (81.8)	40 (74.1)	57 (96.6)	32 (100)	27 (48.2)	57 (96.6)	240 (81.36)
Production increase	22 (66.7)	34 (63)	31 (52.5)	32 (100)	41 (73.2)	59 (100)	219 (74.24)
Soil moisture increase	23 (69.7)	9 (16.7)	6 (10.2)	10 (31.2)	19 (33.9)	4 (6.8)	71 (24.07)
Decrease environment pollution	4 (12.1)	0	1 (1.7)	0	11 (19.6)	0	16 (5.42)

Source: Field survey 2015

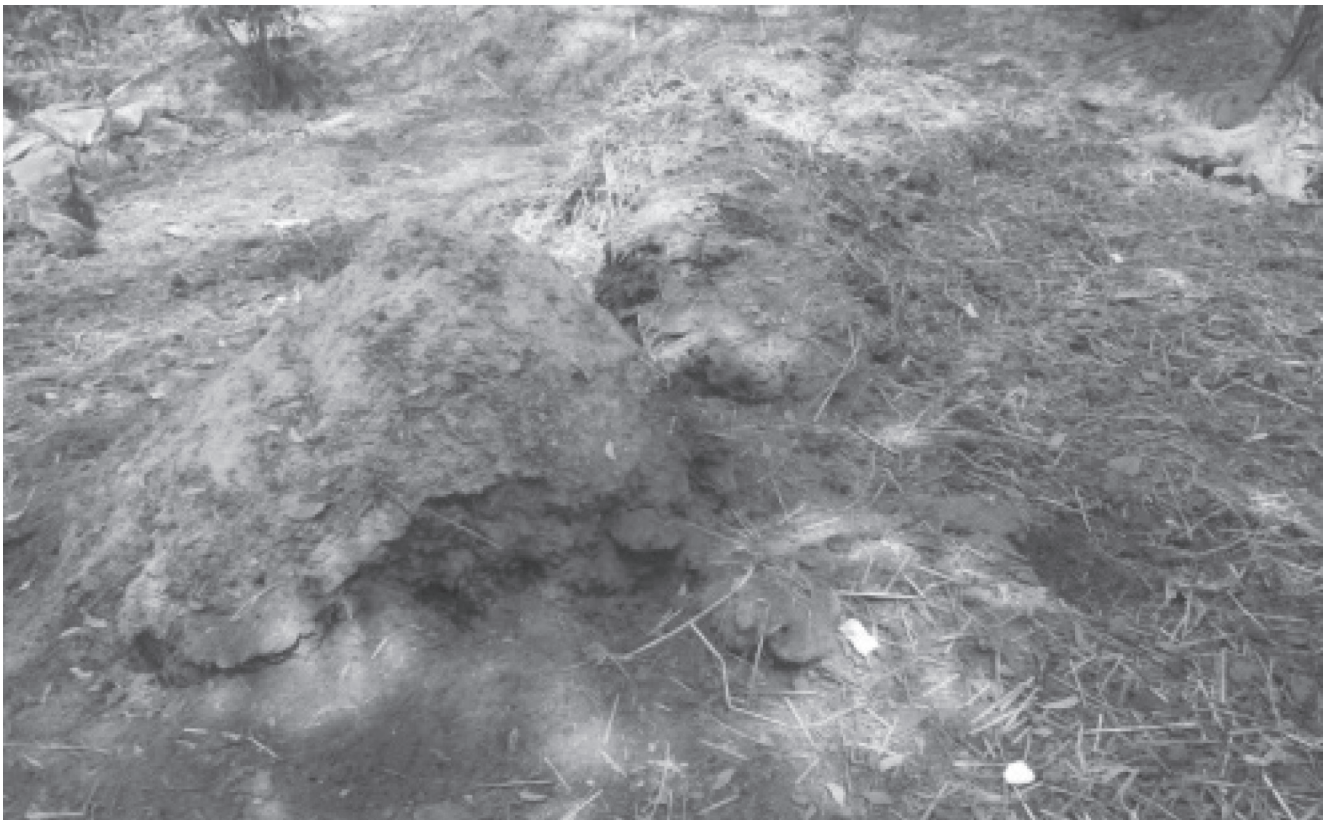
Among the villages, all the respondents of Kanthalia was reported that organic fertilizer increase the soil fertility followed by Barenda and Niskinpur (96.6%) and all the respondents of Kanthalia and Niskinpur were identified that it helps to increase the crop production followed by Rudrapur (73.2%). 69.7% respondents of Panihar village argued that organic fertilizer increase the soil moisture followed by Kanthalia (31.2%) and 19.6% respondents of Rudrapur reported that it decrease the environmental pollution followed by Panihar (12.1%).

Case: Organic farming

A village named Panihar at Godagari union of Godagari upazila of Rajshahi district. Md. Dinar Ahmed resides in that village. He is a traditional farmer. In every year, at least 12 acres of agricultural land he cultivated with paddy.

He does not use chemical fertilizer to produce paddy, he adjusted his agricultural land by using organic fertilizers but in order to protect crops from several disease like as pestilence, rice burns disease etc. the use of pesticides is required.

Compost is made in the usual manner. The necessary materials for making composts are cow dung, cooking ash, small quantities of dry straw and banana plants. For making compost, at first dig a 7-8 feet deep hole on the ground with 9-10 feet dia and then 8/9 months continued to accumulate cow dung, cooking ash and other materials.



The significant difference between the use of organic manure and chemical fertilizer is that organic manure increase the yield of crop and decrease the disease and insect attack. Organic fertilizer increases water retention capacity compared to the chemical fertilizer. And also chemical fertilizer is more costly than organic fertilizer.

Mr. Ahmed stated that, by using organic manure in the Aman season the production rate of paddy is 2160-2400 kg per acre but in case of using chemical fertilizer this production rate is 1200-1440 kg per acre. In Boro (chaitali) season, in the use of organic fertilizer the paddy production rate is 2640-3000 kg per acre while the production rate is 1440-1800 kg per acre by using chemical fertilizer. And another remaining agricultural season he did not use organic fertilizer because the adjacent time between two seasons is very short and that time there hasn't any access road to transport fertilizer.

4.5.5 Income generating activities for livelihood options

Drought reduced crop production, accelerate various types of health disease and many other negative influence. Ultimately, the local people have been affected financially and lacking from standard of living. Hence, the availability of diverse livelihood opportunity is the crucial for drought affected people. Many of them were engaged in alternative income generation activities for their survival as well as a better life during the drought period.

Diversified income generating activities were mentioned by the respondents from the study areas. The maximum numbers of respondents (n=110) mentioned cattle rearing followed by wage labour, small business, vegetable cultivation in the homesteads, driving (auto/nosimon) and fishing (Table 4.25). Those farmers have more livelihood opportunities can manage better their livelihood during drought impacts.

Table 4.25 Available livelihood opportunities

Income generating options	Rajshahi		Chapai Nawabganj		Naogaon		Total N=295
	Panihar	Batashpur	Barenda	Kanthalia	Rudrapur	Niskinpur	
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Cattle rearing	15 (48.4)	24 (45.3)	19 (36.5)	0	8 (15.1)	44 (74.6)	110 (37.29)
Vegetable cultivation	1 (3.2)	5 (9.4)	3 (5.8)	2 (6.5)	3 (5.7)	42 (71.2)	56 (18.98)
Small business	0	16 (30.2)	11 (21.2)	8 (25.8)	14 (26.4)	7 (11.9)	56 (18.98)
Day labor	23 (74.2)	9 (17)	18 (34.6)	18 (58.1)	16 (30.2)	9 (15.3)	93 (31.53)
Fishing	10 (32.3)	1 (1.9)	2 (3.8)	0	1 (1.9)	0	14 (4.75)
Auto/ rickshaw driver	9 (29)	3 (5.7)	0	0	13 (24.5)	0	25 (8.47)

Source: Field survey 2015

Among study villages, 74.2% respondents from Panihar mentioned wage labour as the main livelihood option followed by cattle rearing (48.4%), fishing, driving and vegetable cultivation. In case of Batashpur, 45.3% respondents were reported that cattle rearing as the main income generating activities during drought crisis followed by small business, wage labour, vegetable cultivation, driving and fishing. 36.5% respondents from Barenda mentioned that cattle rearing as the main income generation activities followed by wage labour, small business, vegetable cultivation and fishing. Wage labour was the main income generation activities in Kanthalia village followed by small business. In Rudrapur 30.2% respondents reported that wage labour was the main livelihood options followed by small business. 74.6% respondents from Niskinpur reported that cattle rearing as the main income generation activities followed by vegetable cultivation, wage labour and small business.

4.5.6 Support from public or private level to mitigate the drought

Drought has serious impact on agriculture, livelihoods, health, environment and society. During and after the drought the people of the area faces several types of problems, that's why they need to additional support from public or private agencies. External and internal support can help drought victim for their better livelihoods. 55.25% respondents were mentioned that they were received support during drought (Table 4.26). On the other hand, 44.75% respondents were disagreed with this statement. They were mentioned that they received support including seed, fertilizers (From Government) and loan and relief from NGOs. Among the villages, a total 89.8% respondent of Niskinpur village received loan from local NGO's followed by Kanthalia (78.1%) and Barendra (62.7%). All the respondents of Kanthalia mentioned that they got seed and fertilizer for government followed by Barenda and Niskinpur (11.9%), and 23.7% respondents of Niskinpur reported they received relief from government and private agency.

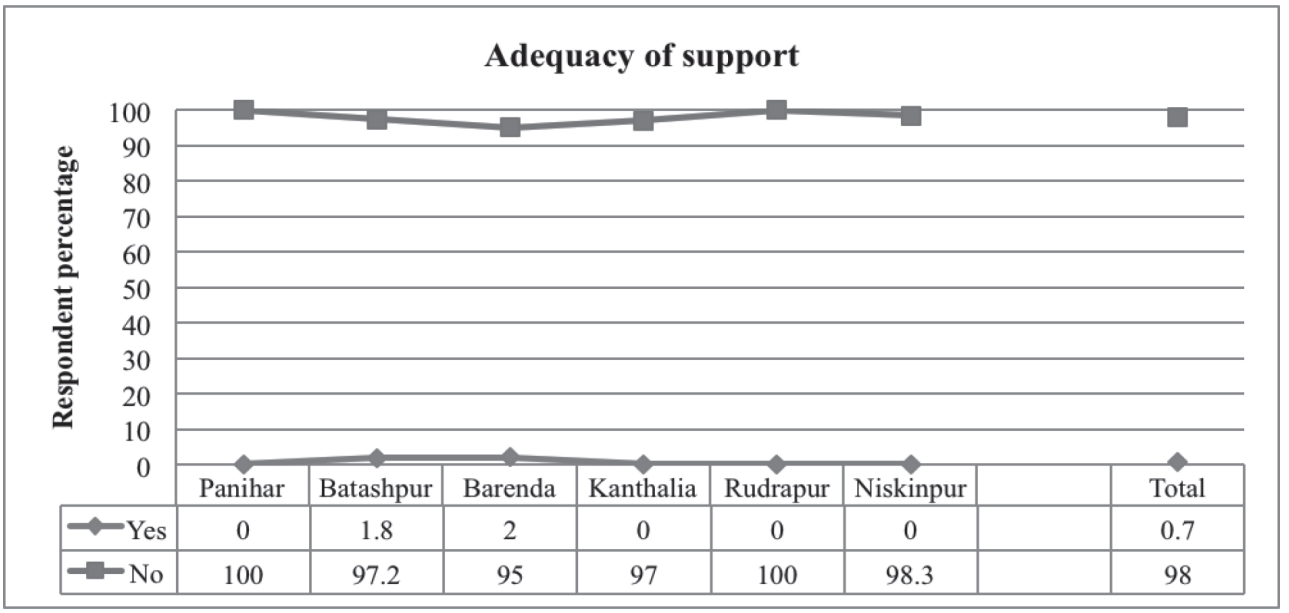
Table 4.26 Support for drought victims

Helps		Rajshahi		Chapai Nawabganj		Naogaon		Total N=295
		Panihar	Batashpur	Barenda	Kanthalia	Rudrapur	Niskinpur	
		N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Yes	Seed and fertilizer from govt.	0	6 (11.1)	7 (11.9)	32 (100)	2 (3.6)	7 (11.9)	163 (55.25)
	Loan from NGO	0	23 (42.6)	37 (62.7)	25 (78.1)	2 (3.6)	53 (89.8)	
	Relief	0	0	1 (1.7)	0	3 (5.4)	14 (23.7)	
No help		33 (100)	28 (51.9)	18 (30.5)	0	49 (87.5)	4 (6.8)	132 (44.75)

Source: Field survey 2015

4.5.7 Adequacy of support

A total 163 (55.25%) respondents reported that they got help from public and private agencies to mitigate the negative impacts of drought. They were asked to know about the adequacy of support whether they got from public or private agency. 98% of the respondents were reported that the support was not adequate for the mitigation of drought impact (Fig 4.27). Only 0.7% respondents were mentioned that they received adequate support from various agencies. Among the villages, all the respondents of Panihar and Rudrapur were mentioned that they do not get adequate support from various agencies followed by Niskinpur (98.3%), Batashpur (97.2%), Kanthalia (97%) and Barenda (95%). On the other hand, only 2% respondents from Batashpur reported that they get adequate support from various agencies followed by Batashpur (1.8%) to mitigate the drought impact.



	Panihar	Batashpur	Barenda	Kanthalia	Rudrapur	Niskinpur		Total
Yes	0	1.8	2	0	0	0		0.7
No	100	97.2	95	97	100	98.3		98

Figure 4.27 Adequacy of support

4.5.8 The way to minimize the drought problem

Drought impacted on agriculture, livelihoods, health, environment and society. Drought caused huge damage to the crops depend on season, scale and crops and hence it reduced crop production and impacted on food security issues. For this reason, respondents were asked to know about the way to minimize the problems which are arising during the drought period. 74.24% respondents noticed that they can solve the problems and manage drought by their own initiatives with the use of their local knowledge (Fig 4.28). 37.29% respondents reported that they can manage drought with the consultation neighboring people followed by discussion with experienced farmers (elderly people) and do necessary actions according agriculture officials (Advice, training etc).

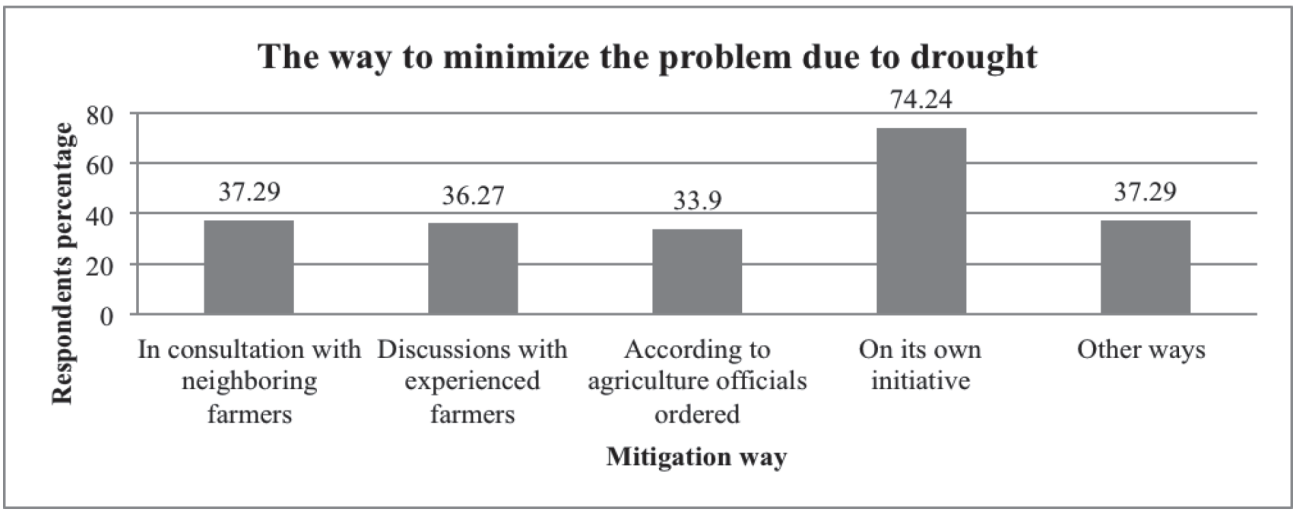


Figure 4.28 The way to minimize drought problems

Case: Mango Orchard

Shibganj upazila in Chapai Nawabganj district of Bangladesh is famous for mango production. Shibganj is highly drought prone area. The amount of annual rainfall is not sufficient for agriculture of this area because the soil is so much dry. For this reason, maximum agriculture lands are not suitable for the cultivation agricultural crops. Nevertheless it is still growing, but the production costs are much higher than profit. To eradicate this problem farmers do not practice only agriculture in his land, he practice agriculture with mango orchard. Md. Babu Miah, a farmer lives in Kanthalia para under Shibganj upazila. He has been practice small portion of land through agriculture for basic family need, and the remaining large portion of land he practice mango orchard. He has three types of mango orchard such as established mango orchard (more than 10 years old orchard), moderate mango orchard (less than 10 years old orchard) and newly planted mango orchard.

To establish a mango orchard first of all seedling was purchased from nursery. Usually 2/3 years old grafting seedlings were planted. A total 24-30 fajli/ashina varieties seedling are planted per acre and in the midst of them a total 15 amrupali varieties seedlings are planted. The initial cost for establishment of one acre mango orchard is around 25 thousand taka. In an established orchard, the yearly maintenance cost takes 10-12 thousand taka.

4.5.9 Farmers opinion for drought management

The respondents were asked to know about the way to cope with drought. Most of the respondents suggested for tree plantation (93.6%) followed by digging pond (both khas and private), Installation of tube well, loan provision from NGOs, use of organic manure for farming, relief from government, subsidy provision from government (seeds and fertilizers) and creating mass awareness related climate change and drought issues (Fig 4.29). Droughts are damaging because of the long-term lack of water availability to the plants and as well as drinking water. Hence 53.2% respondents of the study area thought that digging of pond in the drought prone area may be the way to cope with drought. 22.7% respondents were also identified that NGO can help them to cope with drought by giving loan. Government can provide relief (18%) and seed and fertilizer support (17%). Mass awareness is the crucial to combat drought and climate change issues in the study area.

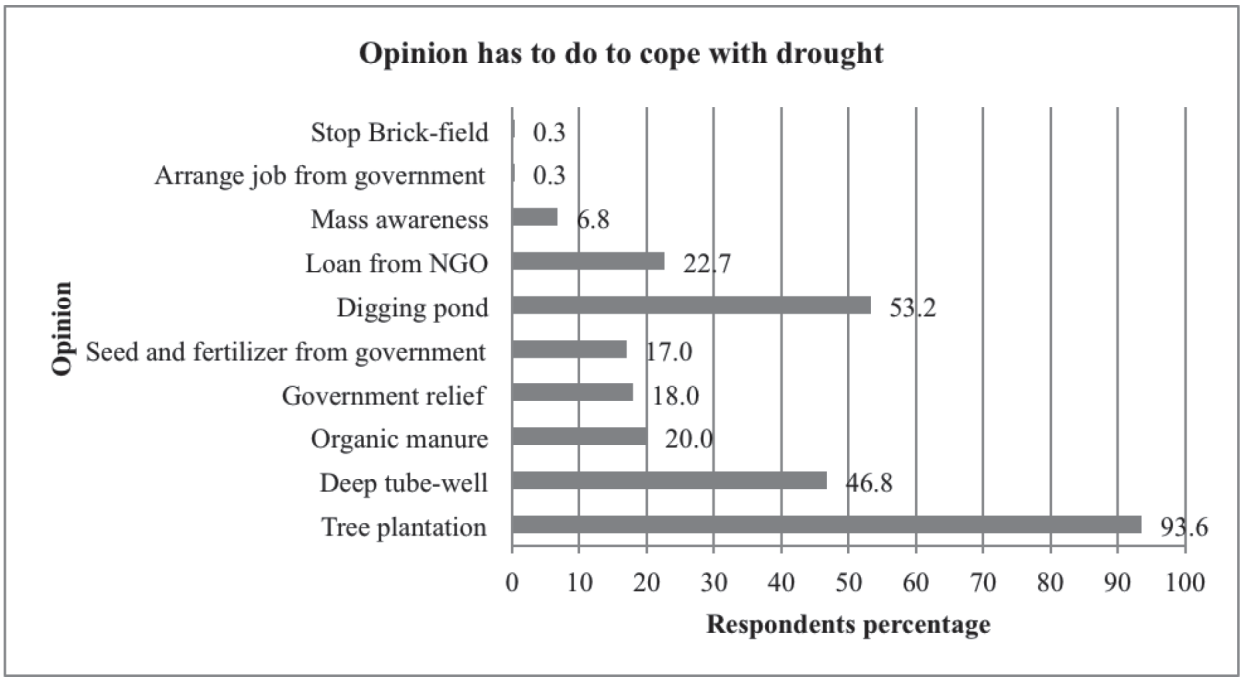


Figure 4.29 Farmer's opinion in coping with drought

Chapter Five: Discussion

It is clear that the respondents of the study area were not familiar with the firm definition of weather, climate and climate change. They were able to recognize weather as a day by day environmental condition which is related to the temperature, rainfall, humidity and disasters. Most of the respondents perceived climate change as the average weather of 20-30 years. They explained climate change as the natural internal and spontaneous process and thus the changes of climatic condition over a long period of time. They used few indicators in describing climate change according to their own experience and perception. Temperature, rainfall, soil fertility, ground water level, soil rupture, drought, flood etc. were used as the common indicators of weather and climate change. According to Intergovernmental Panel on Climate Change (2012), weather means the state of the atmosphere at a place and time as regards heat, dryness, sunshine, wind, rain, etc. Climate in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The usual period for averaging these variables is 30 years, as defined by the World Meteorological Organization. Climate in a wider sense is the state, including a statistical description, of the climate system. In various chapters in this report different averaging periods, such as a period of 20 years, are also used. And climate change means a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. The results shows in this study that all the respondents of the study area perceived climate change as temperature is increasing day by day, the rate of rainfall is decreasing and the ground water table goes down. Resultant impact demonstrating shortage of irrigation and drinking water during the summer and agricultural land are seriously affected due to climate change. They perceived ground water table goes down during dry season, for this reason the top layer of soil becomes dry and cracks are formed on the ground. As a result, soil fertility decreases and the land become unsuitable for cultivation. Crops die due to shortage of ground water and increased insects attack during all three season of cultivation resulting low yield with high production cost.

Several studies revealed that many countries, especially the developing countries, like Bangladesh, will continue to be affected by extreme weather variability such as increasing temperature, severe water shortage, and flood-inducing rainfall events during the coming decades (IPCC, 2007; Huq & Ayers, 2008; MoEF-GoB, 2009; Mbugua, 2011; Nizam, 2013). Weather variability and sea-level rise are the most pressing predicted consequences of climate change with a 0.6°C global temperature change, 2% to 3% precipitation increase of the tropical latitudes and 3% precipitation decrease in subtropical areas within the 20th century. Scenarios predict global temperature could increase between 1.4°C and 5.8°C by the end of the 21st century (IPCC, 2001). Rakib, *et al.,* (2014) stated that temperature is gradually increasing at the north-western part of Bangladesh regarding farmers' perception with respect to pragmatic experience. They notified about the rainfall discontinuation and timing of the rainy session in conjunction with precipitation intensity. Agricultural activities were encountered with water scarcity problem due to climatic and non-climatic issues. The low lands and agricultural field suffered from dryness owing to lack of rainfall at the rainy season.

Farmers perception greatly emphasized on the depletion of groundwater level, water shortage, drought impacts respect to agricultural production. Agriculture is one of the most sensitive sectors to climate change (Cline, 2007), particularly changes in temperature, rainfall patterns, and increased likelihood of extreme events such as droughts and floods. In Bangladesh, the overall impact of climate change on agricultural production will be negative (Huq & Ayers, 2008). Other impacts of climate change such as temperature extremes, drought, and salinity intrusion, are also causing declining crop yields in Bangladesh. Several studies have been conducted in Bangladesh to assess the vulnerability of food grain production to various climate scenarios. One such study noted that a 4°C increase in temperature would have a severe impact on food production in Bangladesh, resulting in a 28 per cent reduction for rice and a 68 per cent reduction for wheat (BCAS, 1996; Rahman & Alam, 2003). Temperature and rainfall changes have already affected crop production in many parts of Bangladesh, and the area of arable land has already decreased. The shortening of the winter season is resulting in a decline in production of winter crops, particularly potatoes ((Huq & Ayers, 2008). Similar threats were reported by the respondents in this study. Increases in water stress have also affected the production of major crops, again particularly rice, which needs significant amounts of water. The IPCC FAR note that the production of rice and wheat could fall by 8%t and 32% respectively by 2050 (Easterling *et al.,* 2007).

Respondents perceived that the frequency of drought is increasing over the last several decades. Different drought impacts are often categorized as economic, environmental and social impacts. Economic impacts are related to crops damage, asset loss, price hike and low income generation activities. Environmental impacts are related to the plants and animal habitat, water supply, soil erosion, soil fertility etc and social impacts include health, public safety, social conflicts and changes in lifestyle. To mitigate the harmful effects of drought the people of the study area have been taken few measures including land use preference, use of suitable crops and with varieties during and after the drought, plow the land before the drought and using compost manure to improving the physical properties of soil and digging pond as a water reservoir for irrigation during the drought. To mitigate the economical and social impacts due to drought the people of the study area extend themselves to Government and private agencies for investments, available funds, loan and subsidies. Several studies reveal that the frequency, the severity and the impacts of drought have been affected by climate change (Lloyd-Hughes, 2012). Drought is the most complex of all natural hazards (Wilhite, *et al.,* 2007) and a particular climatic disaster which may add significant costs for farmers and their agricultural systems extensively. Although drought has not been well described and defined (Wilhite & Pulwarty, 2005), the natural resource-dependent sectors such as agriculture are the most vulnerable to the impact of this phenomenon (Patwary & Rahman, 2014). Drought is an episodic feature that could lead to the loss of crop production, food crisis and famine (Paul, 1998.). Drought impacts can manage at macro (national), meso (local) and micro (village and household) levels. However, the micro-level management which is '*what the farmers do in response to drought*' is of great importance (Keshavarz, *et.al.,* 2010). Eskandari (2001) reviewed the literature of the long-term annual precipitation trends which indicated that drought had a worldwide return frequency of every 20-30 years. Record shows that Bangladesh has experienced approximately 19 (Habiba, *et.al.,* 2011) drought events between 1960 and 1991 which mean

a drought every 1.6 years. The Northern part of Bangladesh is among the most vulnerable regions to climate change impacts (Mbugua, 2011). The majority of the population lives in this area in abject poverty. People are extremely dependent on rain fed agriculture for their daily livelihood. As a consequence, the abnormalities in rainfall patterns and temperature adversely impact their socio-economic and environmental survival (Ruane, *et.al.,* 2013). The long-term climate variability impacts include significant changes in rainfall patterns and temperature (Patwary & Rahman, 2014). The northern part of Bangladesh experiences droughts regularly (Mbugua, 2011; Patwary & Rahman, 2014). In the last three to four decades when climate change reported to be observed in the northern Bangladesh, the situation has gradually decreased (Habiba, *et.al.,* 2012). In Bangladesh, the agricultural activities are mainly rain-fed and heavily depend on rainfall (Mbugua, 2011). This dependence makes this northern region particularly vulnerable to the adverse impacts of climate change. It has been reviewed in the literature that the scope (geographic coverage), frequency and magnitude of climatic changes and environmental degradation such as deforestation, water level decreasing and soil erosion have been gradually increasing in this region (Brammer, 2012) The potential adverse effects of climate change on this region's agricultural sector are of a major concern because of this dependence (Patwary & Rahman, 2014). Farmers apply various strategies to reduce the impacts of drought. Some applications have a limited impact on drought mitigation and some strategies increase farmers' responsibility during drought (Burton, et.al., 1998). Patwary & Rahman (2014) stated that the people are practicing their personal choice to mitigate the drought and adapt to climate change. They are practicing their personal food habit, food consumption and daily dietary change. This is the initial stage of micro level adaptation strategy. This strategy is fully related to crop diversification. Farmers in drought places are more likely to produce peanut, cereals, potatoes, oil crops, spice crops, strawberries and maize and less likely to grow rice, wheat, jute, and sugar. These results indicate that they have already started to make crop planting shifts according to local climatic conditions. Farmers faced with drought are inclined to choose a crop that is more adaptive, multifunctional and high yielding, with better economic returns under such conditions (Ju H. *et.al.,* 2008). Some crops in the northern region of Bangladesh are able to adapt. It is an emerging time to think about switching out of growing some crops entirely. For example, by later of this decade the drought prone area will no longer be suitable for growing some crops such as millet (local name '*coun*'), some edible oil corps (local name *teel, tishi, kalijira*) and a number of rice varieties. Potatoes, maize, and peanuts are becoming better options. When we start thinking through all that, it means changes in people's diets and these are fairly fundamental cultural changes due to drought. A number of studies have been outlined the predicted impacts of climate change on food production, and also on food security (Patwary & Rahman, 2014).

Chapter Six: Conclusion

Climate is changing and this is generous statement in the study area. The change is impacting on people's livelihood by damaging crops and agricultural production. As they perceived, seasons are changing and only three seasons are visible in the study area. Winter is becoming shorter and dry spell is extending the prevalence. The rainy season is demonstrating peculiar phenomenon including erratic rainfall, low or less rainfall or excessive rainfall at the end of rainy season. Local fish species are scarce due to lack of water and water bodies in the study area. Rain-fed agriculture and agricultural activities are decreasing over time due to climate change impact. As they mentioned, lot of species (both plant and animals) becoming rare or invisible in the study locations. This indicates the sign of biodiversity loss. Most of the respondents (from household survey, FGDs, In-depth interview and Key Informants Interview) were reported that if the situation continues, the problem may have severe impacts due to climate extreme. The aged person able to say about the changes but they have no clear idea on climate change. The adults who are below thirties can say little bit about the climate change effect and its consequences. A clear knowledge gap related to climate change impacts are prevailing in this area. Following recommendations were made based on study findings:

- Creation of mass awareness on climate change issues is very much crucial through NGOs, clubs, Nation Building Departments (NBDs), Local elected Bodies(LBDs) and volunteers
- Training on climate change and drought related adaptation measures should be provided through FFS, yard meeting, group meeting or farmer lead approach
- Make them capable to combat climate and drought hazards their own initiatives
- Climate change risk insurance especially drought insurance in the study area is very much crucial to sustain victim's livelihood
- There is misconception and hazy conception related climate change issues and drought adaptation issues. These should be made clear understanding for them.
- More research should be conducted on compatibility among drought adaptation measures

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Appendix-1: Determination of sample size for the study

To find out the sample size determinants were used. The calculations are follows-

Z score for 95% confidence level is 1.96

Sample Size = $\{(Z\ score)^2 \times StdDev \times (1- StdDev)\} \div (margin\ of\ error)^2$

$= \{(1.96)^2 \times 0.5 \times (1- 0.5)\} \div (0.05)^2$

$= (3.8416 \times 0.25) \div 0.0025$

$= 0.9604 \div 0.0025$

$= 384.16$

≈ 385 Respondents are needed.

Sample Size with population = $\frac{SS}{1+(\frac{SS-1}{Population})}$

$= \frac{385}{1+(\frac{385-1}{1263})}$

$= \frac{385}{1+\frac{384}{1263}}$

$= \frac{385}{\frac{1647}{1263}}$

$= \frac{385 \times 1263}{1647}$

$= 295.236794$

≈ 295 Respondents are needed.

Now,

For Panihar village, $\frac{142\times295}{1263}$ = 33.1670625 ≈ 33 respondents are needed.

For Batashpur village, $\frac{236\times295}{1263}$ = 55.1227237 ≈ 55 respondents are needed.

For Barenda village, $\frac{251\times295}{1263}$ = 58.6262866 ≈ 59 respondents are needed.

For Kanthalia para village, $\frac{136\times295}{1263}$ = 31.7656374 ≈ 32 respondents are needed.

For Rudrapur village, $\frac{240\times295}{1263}$ = 56.0570071 ≈ 56 respondents are needed.

For Nishkinpur village, $\frac{258\times295}{1263}$ = 60.2612827 ≈ 60 respondents are needed.

So, from these six villages, a total 295 respondents are needed to survey.

Farmers' perception (Sample size calculation):

District	Upazila	Union	Village	Total household	Number of respondents for survey	Male	Female
Rajshahi	Godagari	Godagari	Panihar	142	33	23	10
	Tanore	Kamargawn	Batashpur	236	55	38	17
Chapai Nawabganj	Nachol	Nizampur	Barenda	251	59	41	18
	Shibgonj	Chatrajitpur	Kanthalia para	136	32	22	10
Naogawn	Niyamotpur	Bhabicha	Rudrapur	240	56	39	17
	Porsha	Ghatnogor	Nishkinpur	258	60	42	18
Total=	1263	295	205	90			

Appendix 2: Annual Rainfall in the study area

Year	Godagari	Tanore	Nachole	Shibganj	Niamatpur	Porsha
1976	997	1310.2	1336.1	1123.8	1116	1245.5
1977	1627.9	1470.2	2116.2	1895.3	1774	1664.8
1978	1259.5	1415.8	1254.5	1331.5	1318.4	1406.2
1979	1267.3	1415.4	1322.6	1437	1263	1733.6
1980	1435.4	1576.7	1438.5	1483.5	1633.6	1688
1981	1543.9	1836.3	2432.8	2110.9	1172.8	1655.6
1982	956.8	1049.5	**796.2**	921.2	**1017.4**	955.3
1983	1265.2	1263.5	1329.9	988	1627.2	1271.8
1984	1343.7	1344.3	1329.9	1656	1706.7	1430
1985	1379	1335.5	1343.6	1333	1073.5	1371.4
1986	1662.3	1592.7	1729.7	1424.1	1416.8	1653.1
1987	1700.4	1717.4	1559.1	1459.2	**1977.7**	**2162.3**
1988	**2180**	1917.3	1796.2	2015.7	1734.6	1708
1989	1496	1789.4	1279.3	1588.8	1382.5	1154.6
1990	1277	1472.5	1553.2	1463	1809.3	1551
1991	1528.5	1692.6	1576.2	**2276**	1847.9	1998.8
1992	973.3	1182.5	1342.3	1009	1331.7	1200.6
1993	1536.4	1269.6	1495.1	718	1191.5	1420.1
1994	1530.7	749.5	986.7	1070	1074.1	1120.8
1995	1449.2	1792.7	1514.4	2116	1504.1	2144.7
1996	986	1203	979.9	1481	1125.6	1285.9
1997	1284.7	1670	1115	1583	1151.7	1055.2
1998	1395.2	1943.5	1844.3	2107	1590	1826.7
1999	1632.7	**2624.5**	**2615.4**	**148.1**	1475.1	902.5
2000	1692.9	2387.5	1827.8	2078.9	1711.9	1862.6
2001	1469	1714.3	1569.3	1570	1728	1204
2002	1152.6	2102	1536.6	1416	1863.5	1890.9
2003	988	2052.7	1443.7	1098.7	1681.5	2038
2004	1377	1626.6	1875.8	1304	1759.2	2103.4
2005	1413.33	1530.1	1379.7	1649	1804	1905.5
2006	1214.8	1431	945.2	1006	1208.8	1917.1
2007	1291.8	**582.7**	1732.5	1897	1605	1623.7
2008	1132	815.1	992.6	1322	1046	1005.6
2009	1047.2	1111.2	1212.3	1755	1222.8	**782.9**
2010	906.5	1011.1	905.7	979	1261	1860.4
2011	1620.9	1249	1480	1388	1632.2	1167.8
2012	**834.5**	1233	886.4	1287	1047	935.4
2013	1164	1183	1158.2	1419	1074	1336.5
2014	1144.8	1507	1023.4	1328	1490	852.6

Appendix: 3 Survey questionnaire

Household survey
Form No: Date : ……
Farmers Perception on Climate Change and Adaptation Related to Drought on Selected Northwest region in Bangladesh
Salam/ Adab. I'm Md. Shafiqul Islam, I am conducting a study titled **'Farmers Perception on Climate Change and Adaptation Related to Drought on Selected Northwest region in Bangladesh'**. Information provided by you will be kept strictly confidential and will only be used for research purpose. It is absolutely your discretion whether you will agree or not to be interviewed. You can refuse to answer any or all the questions. Thank you in advance for your cooperation. Do you want to know anything else about this study? Can we start the discussion now?

1. Personal Information:	
(A)Name:	(B)Father's/Husband'sName:
(C)Mother'sName:	(D)Village:
(E)Union:	(F)Sub-district:
(G)District:	(H) Male=1 , Female=2

2. **General Information of Residence :**								
	Name of the Member	Age	Male/ Female	Occupation	Relation with respondent	Marital status	Education Qualification	Disability
1	2	3	4	5	6	7	8	9
1.								
2.								
3.								
4.								
5.								
6.								
7.								
8.								
9.								
10.								

Notes:

(4) Male=1, Female=2

(5) Agriculture=1, Small trade=2, Labour=3, Van/Rickshaw puller=4, Auto/nosimon driver=5, Mechanics=6, House wife=7, Servant=8, Handicrafts=9, Fishing=10, others (specify) =11

(7) Single=1, Maried=2, Widow=3, Divorcee=4,

(8)Children under 5 years=0, Class1-9=1-9, SSC=10, HSC=12, Graduate=15, Masters=16, Trade course=66, Diploma=77, illiterate=88

(9) Disability=1, non disability=2

3. Residence Status:		
(1) Full Concrete	(2) Half Concrete	(3) Mud wall & roof of Tin
(4) Thatched wall and roof with tin	(5) Cottage	

4. Status of Land:

Description	Homestead land decimal	Cultivated Land decimal	Uncultivated Land decimal	Pond decimal	Total decimal
Own Property					
Leased Property					

5. Description of other property:

Description	Shallow Machine	Power Tiller	Motorcycle	Television	Sewing Machine
Own Property					

6. Description of Domestic animals:

Animal	Count in number
Cow	
Buffalo	
Goat	
Sheep	
Duck	

Hen	

7. Source of safe water:

(1) Deep Tubewell	(2)Tap Water / Pipeline Water	(3) Well	(4) River/Pond water	(5) others (specify)

8. Type of work that women are assign at home for their growth of income:	
(1)	Cultivation of vegetables
(2)	Nursery
(3)	Raising Poultry
(4)	Keeping cows
(5)	Raising Goats
(6)	Fish farming
(7)	Sewing
(8)	Handcraft

9. Household income and expenditure:				
Monthly income	Source of income –1 ……	Source of income – 2 ……	Source of income – 3 ……	Total =
Monthly expenditure	Domestic spending	The cost of children's education	Others	Total =

10. Drinking water collection time from sources

(1)	Less than 3o minutes
(2)	30-60 minutes
(3)	More than 60 minutes

Part 2

1. What do you understand about weather?

2. What do you understand about climate?

3. Is there any changes occuring in weather and climate?

Yes	No

4. If yes, What are the changes in weather and climate visible to you?

5. How does climate change affect us?

6. What do you understand about Drought?

7. Is drought increasing or decreasing as a result of climate change?	
Yes	No

8. How does farmers get affected by drought

9. How does Agriculture get affected by drought?

10. What are the suitable crops in your drought prone areas?

11. Do you know about the impact of chemical fertilizer and pesticide?

12. Do you know about the advantages of organic farming?

13. What are the alternative livelihoods when crop failure occurred by drought?

14. What are the health hazards caused by drought?

15. How do you understand drought and what steps do you take to prevent drought?

(a) Before the drought:

(b) During drought :

(c) At the end of the drought:

16. How do you compensate if drought damage takes place?

17. What kind of service you're getting and from where (government sector or from the private sector) in managing drought?

18. Are those services are sustainable?

19. How do you solve the after effects of drought most of the times?

20. What is your comment on climate change and drought?

Name and signature of interviewee:	……
Name and signature of interviewer:	……

Author

Md. Shafiqul Islam is a natural scientist. He has been deployed himself as the development actor since 1996. At present he is working as an Assistant Professor at the Center for Sustainable Development (CSD), University of Liberal Arts Bangladesh. His specialization is in the field of climate change adaptation, disaster risks reduction, organic agriculture, forestry, agro forestry, biodiversity, drought management, poverty alleviation, sustainable livelihoods and sustainable development. He is working as a Doctoral researcher at the Institute of Disaster Management and Vulnerability Studies, University of Dhaka, Bangladesh. He earned his Master's degree in Forestry from the Institute of Forestry & Environmental Sciences from the University of Chittagong in 1997. He has twenty years of experience in cross range of fields, including NGOs, private companies & university. He has conducted a good number of researches in the diverse field including natural resources management, climate change adaptation, organic farming, sustainable development, economics, humanities and social sciences. His books, articles and researches on immense issues have been published in both national and international journals. He has participated and presented his papers in the international and national conferences and workshop. He is one of the contributors of the World Guide to Sustainable Enterprise (Volume 2: Asia Pacific) published by Greenleaf Publishing, UK. He is interested in research in the field of organics, biodiversity, natural resources management and climate change adaptation.

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