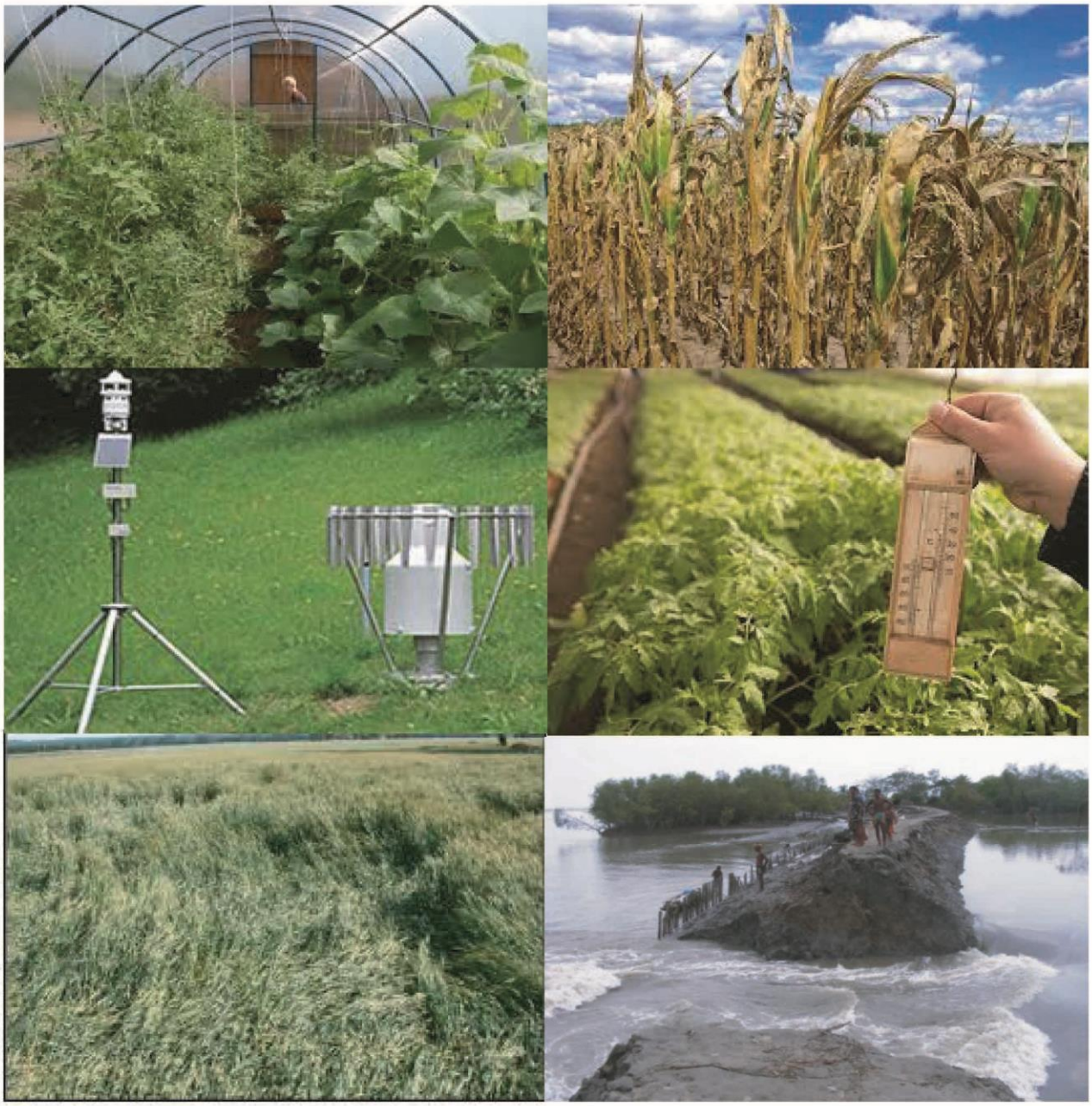
FINAL REPORT
ON

Agro-Meteorological Training Needs Assessment



Government of the People's Republic of Bangladesh
Ministry of Agriculture
Department of Agricultural Extension
Agro-Meteorological Information System Development Project
Khamarbari, Farmgate, Dhaka-1215.

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May 2019

Submitted By

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Table of Contents

List of Tables

List of Tables

List of Tables

List of Figures

List of Annexes

ACRONYMS AND ABBRIVIATIONS

AEO	:	Agricultural Extension Officer
AEZ	:	Agro Ecological Zones
AIS	:	Agricultural Information Service
AMI	:	Agro-Metereological Information
AMISDP	:	Agro-Meteorology Information System Development Project
ARIs	:	Agricultural Research Institutes
BARI	:	Bangladesh Agricultural Research Institute
BMD	:	Bangladesh Meteorological Department
DAE	:	Department of Agricultural Extension
DDAE	:	Deputy Director of Agricultural Extension
DTO	:	District Training Officer
EWE		Extreme Weather Event
GOB	:	Government of the People's Republic of Bangladesh
HL	:	Highland
HYV	:	High Yielding Variety
ICT		Information and Communication Technologies
IDI		In-depth Interview
KII	:	Key Informant Interview
LIV	:	Locally Improved Variety
LL	:	Lowland
LV	:	Local Varieties
MHL	:	Medium Highland
MLL	:	Medium Lowland
MoA	:	Ministry of Agriculture
MV	:	Modern Variety
NCA	:	Net Cropped Area
NGO	:	Non-Government Organization
SAAO		Sub-Assistant Agricultural Officer
TCA	:	Total Cropped Area
TNA	:	Training Need Assessment
TOR	:	Terms of Reference
TOT	:	Training for Trainers

EXECUTIVE SUMMARY

This report presents the findings of Agro-meteorological Training Needs Assessment under "Agro-Meteorology Information System Development Project (AMISDP)", implemented by the Government of the People's Republic of Bangladesh (GOB) through the Department of Agricultural Extension (DAE) with the financial assistance of the World Bank. The AMISDP is a five-year project to develop DAE's capacity to provide quality Agro-meteorological Advisory Services (AMAS) and forecasts to the farmers and other stakeholders as well as develop farmers' capacity to understand and utilize agro-meteorological massages to their benefit simultaneously.

The Training Needs Assessment (TNA) involved collection and analysis of qualitative and quantitative data/information through conduction of Key Informant Interviews (KIIs) and In-Depth Interviews (IDIs) of Deputy Directors and District Training Officers (DTOs), respectively of selected districts. It also included Focused Group Discussions (FGDs) of Sub Assistant Agriculture Officers (SAAOs) as well as household survey of selected farmers using a structured questionnaire at 12 different climatic hotspots covering 14 major Agro Ecological Zones (AEZs) of Bangladesh.

The selected climatic hotspots included Mithamoin (AEZ 21 & 19); Bhurungamari (AEZ 3); Murad Nagar (AEZ 19); Patnitala (AEZ 25); Dhunot (AEZ 04); Shyamnagar (AEZ 13); Galachipa (AEZ 13); Abhaynagar (AEZ 11); Fulpur(AEZ 9 and 22); Baliadangi (AEZ 3); Kaptai (AEZ 29); and Kabirhat (AEZ 18). The study locations included early flush flood, mid to late season flood prone areas; seasonal flooding and drought, predominantly drought prone areas; Nor'wester and hailstorm as well as fog, cold wave and heat wave prone areas; landslide prone high rainfall area; cyclone/storm surge/salinity and seasonal flood prone areas; as well as new land formation, low elevation and coastal areas.

Adverse/extreme weather includes unexpected, unusual, unpredictable, severe or unseasonal weather events harming agriculture, life and livelihoods. Such weather events, as identified by different categories of respondents included drought, cold wave, prolong fogy days, prolong warm period in winter, prolong rainless days during rainy season, hailstorm and nor'wester, heat wave, flood, prolong cloudy period, sudden heavy rain, prolong rainy days, soil salinity, soil/river bank erosion, cyclone and storm surge and land slide.

The household survey revealed that the major weather events exerting detrimental effects on rabi crops are drought, cold wave, prolong foggy period, sudden heavy rain (occasional and related to depression) and prolong rainy days during the rabi season. However, crops affected by these environmental events vary from location to location. Major crops affected, as reported by the respondents, include Boro, T.Aman and B. Aman rice, wheat, maize, potato, mustard, lentil, grass pea, mung bean, groundnut, tomato, brinjal, cabbage, cauliflower, bottle gourd, bitter gourd, sweet gourd, chili, garlic, ginger, watermelon, papaya, banana and mango.

During the Kharif-1 season, the important weather events causing crop damage are drought, hailstorm, nor'wester, heat wave, sudden heavy rain, cyclone and storm surges (occasional in coastal areas). The important crops affected include Boro, B. Aus, T. Aus and B. Aman rice, maize, jute, summer tomato, pointed gourd, sweet gourd, chili, mung bean, cowpea, watermelon, papaya, banana, litchi, mango, etc.

During the Kharif-II season, the major crop is T. Aman rice and in some areas B. Aman rice (continued from Kharif-I season) and a few summer vegetables in highland areas. As reported, these crops are affected by weather events like drought, prolong rainless period, flood, sudden heavy rain and prolong rainy days. Late season drought due to early cessation of monsoon rainfall causes enormous yield loss to rain-fed T. Aman rice.

There was wide variation among farmer respondents on familiarity with adverse weather events and their consequent impacts on crops, life and livelihood. Among the respondents, who were familiar with extreme weather events (EWE)s, the percent respondents receiving messages ranged from 19.77 to 60.23. However, among all respondents, about 71.2 % reported to have no knowledge on benefits of available agrometeorological information system.

A large portion of respondents (72.74%) considers that they need knowledge in technical aspects of climate smart crop production technologies in harnessing benefit from agrometeorological advisory services. A significant portion of respondents, however, did not respond on this issue. Thus, different types and diversified nature of responses suggest that the respondents are not sufficiently aware about adverse/extreme weather events and agrometeorological advisory services provided by DAE. Therefore, there is a need for the farmers to understand about the extreme or abnormal weather events occurring in different cropping seasons and their consequences on crop performance and productivity. At the same time, there is a need to understand the means to cope up with abnormal weather events to minimize crop losses wherever possible. To develop farmers' capacity, majority of the respondents (District Triaing Officers) of in-depth interview (IDI) suggested training of farmers on different aspects of EWEs and raising public awareness on EWEs.They also stressed on making the farmers aware of the benefit of forecasts and advisory services on agriculture..

Most of the IDI respondents opined that they are more or less familiar with the occurrence of meteorological events affecting crops in different seasons but about 86 percent of them considers that the present level of advisory service is not adequate and up to the mark. Although they are using quality and up-to-date agrometeorological information, the issues related to recording and processing of data, data analyses, developing forecasts and preparing advisory messages anddigital messaging in social and electronic media are areas of big concern. They suggested the need of ICT based skill and knowledge development training of district level personnel to improve the forecasts and advisory messages. They consider that forecasts and messages are not delivered on time. They emphasized on development of skills on message use andnetworking to deliver messages on time.

The KII respondents (DDAEs) identified some major weaknesses/hindrances of present AMAS and suggested to bridge the gaps through inclusive messaging, delivery of user friendly messages, training of DAE field staff and farmers, introducing digital and direct messaging. At block level, 25% SAAOs feel that they are partially or fully ignorant of AMI services and another 16.67% are yet to be involved in AMIS activities. They still use costly and time consuming, localized media, personal and group meetings,use mobile phone and social media to much lesser extent. To improve field level performance, they emphasised on the necessisity of knowledge and skill devlopment trainings to handle different weather equipment including digital media (83.33%), understand phenomenon of weather extremities (75.00%) and management techniques of weather hazards (58.33).

The study has assessed the gaps in knowledge, skill and capacity at different levels of DAE officials and farmers. Based on the identified gaps in different areas, the major areas of training needs, have been identified along with the proposed training activities, as suggested by the respondents at various levels and categories.

It is expected that imparting training to different levels of users using appropriate training modules would greatly improve DAE's capacity for Agrometeorological Advisory Service delivery in one hand and farmers' capacity building on the other. It would help the farmers, inbetter understanding of the agrometeorological forecasts & messages and finally utilize those for their benefit.

CHAPTER-I
INTRODUCTION

Crop production in natural conditions like in Bangladesh, is susceptible to climatic conditions with various extreme weather events (EWE). These events involving temperature, rainfall, solar radiation, relative humidity, wind, etc., affect crop production and productivity. Cropping in Bangladesh, often, experiences prolong drought during the dry season (November-May) and heavy downpours and floods during the monsoon season (June-September), flash floods in March-April with significant crop losses under all of these extreme conditions. The effects of climatic phenomenon and extreme weather events have seasonal and regional variabilities for different agro ecological zones, and diversified crops of the country. On the other hand, increased frequency and magnitude of EWEs often results in catastrophes in crop damages leading to significant losses in productions. Thus, adaptation mechanism in such complex adversities demands a combined effort by considering regions, seasons and crops affected by integrating EWEs. A comprehensive advisory service is essential to address these agro meteorological adversities with early, location and crop specific warning systems. Luckily, data on forecasting of almost all EWEs are available in the global weather forecasting system (www.worldweatherwatch) under Global Telecommunication System (GST).

Bangladesh Meteorological Department (BMD) provides agro climatic bulletins to the Department of Agriculture Extension (DAE) and other relevant organizations. DAE use these bulletins to transform these into messages for farmers in addressing the EWEs for crops. The bulletins includes advices to the farmers against the disastrous impacts of various climatic events such as probable water stress, pest infestations and disease outbreaks, foggy and cold weather, hot waves. At present, DAE is disseminating the information relevant to crops through its country-wide field service structure.

The forecasts issued by BMD are, in many cases, difficult to understand by farmers. Moreover, most farmers do not have full access to this information because of behavioral nature, knowledge gaps, as well as technological limitations. Whatever advisory services is available, they hardly reach the farmers on times for proper planning and decision making to mitigate the adverse effects of climatic variabilities and consequently cannot take proper decisions. The concerned DAE staff are not well prepared with knowledge and skill to use agro-met data to the best use of farmers, as this is a comparatively new area knowledge dissemination.

To utilize the advanced data/information of various climatic events and transforming those in to useful forecasts and advisory messages, capacity building of agro-meteorological service providers of DAE at different levels through appropriate training is crucial. Similarly, the farmers also need to build their capacity to understand and utilize weather forecasts and advisories in their on-farm applications.
Training is a process of acquisition of new knowledge, skills and attitude for improving ones productivity in an organization or enterprise setting. Effective training requires a clear picture of how the trainees will receive the required knowledge and skill and successfully use the information received during the training to replace the traditional beliefs and practices.

Considering the urgency of the needs DAE has launched an initiative named “Agro-Meteorology Information System Development Project” (AMISDP) to fill up the gaps of capacity building of DAE and farmers. It is learnt that the project will emphasize on “agro meteorological information system”, “agro meteorological data analysis” and “agro meteorological advisories and product development” for use by different stakeholders. A huge number of officials and farmers will have to be trained on the diversities of the EWEs, location and region specific management of EWEs with sourcing, transforming information in to useful messages. This will cost both money and time to a great amount and the success of the AMISDP depends almost fully on successful human resource development in its proper implementation. Thus, the training program is to be planned, carefully based on the actual

needs assessed through a rigorous Training Needs Assessment (TNA) by an unbiased, authentic expert team/ organization. This is because the TNA process helps in understanding and determining the priority of changes in knowledge, skill, attitude and behavior having better impact on achieving individual and organizational objectives. The present study was undertaken to satisfy the needs stated with the following objectives.

1.1 Objectives

According to the terms of reference (TOR), the major objectives of the Baseline Study are:

- To determine the gap in capacities of DAE officials at different levels as well as farmers to improve their knowledge on weather and climate as well as agrometeorological services;
- To assess the gap between what is required of an official to perform competently and what he actual knows;
- To determine if a training need exists and if it does, what training is required to fill the gap and
- To determine the different levels of training which is required for various target groups.

1.2 Scope of the Work

The proposed consultancy have been accomplished through several tasks and furnished through a set of activities, mentioned below:

- identification of agrometeorological training needs of officials of DAE as well as farmers on weather and climate and agrometeorological services;
- organisational capacity assessment for conducting agrometeorological training;.
- designing agrometeorological training programmes for officials of DAE as well as farmers;
- establishindg the method of selection criteria;
- assessing the advantages and disadvantages of different training methods;
- data collection from DAE officials as well as farmers for agrometeorological training needs assessment;
- conducting interviews by using schedules and survey using semi-structured questionnaire;.
- anaslysis of both qualitative and quantitative data for agrometeorological training needs assessment and
- collection of feedback on agrometeorological training from officials of DAE as well as farmers.

1.3 Understanding the Task

The Training Need Assessment (TNA) involves two broad categories of target groups: (i) Agricultural Extension Personnel of DAE at policy and implementation levels, and (ii) target farmer beneficiaries.
It is an established fact that the occurrences of extreme weather events e.g. drought, cold wave, prolonged adverse weather condition, etc., often have devastating impacts on crop production and productivity as well as lives and livelihoods of farming community.

Impact of meteorological factors on crop growth and development are consecutive, although sometimes they do not emerge over a short time. The weather and climatological information should be specific, according to the kind of crop, its sensitivity to environmental factors, water requirements and so on. Smart agrometeorological advisory service may provide various meteorological i and biological information covering phenology, incidence, spread and outbreaks of crop insect pests and plant diseases and so on. The methodology of the study was developed by keeping these issues in mind.

CHAPTER-II
REVIEW OF LITERATURE

2.1 Climate and Agriculture

Weather plays the dominant role in farm production. Weather is always variable, and farmers have no control over this natural phenomenon. Thus, agriculture is highly dependent on weather and subject to its variability. Hence, despite tremendous improvements in technology and crop yield potential, agricultural production remains highly dependent on climate, because solar radiation, temperature, and precipitation are the main drivers of crop growth. Pest and diseases t infestations, as well as the supply of and demand for irrigation water are influenced by climate. Recurrent weather variability and sudden weather hazards such as flash floods, untimely rains, hailstorms, sudden heat and cold waves, prolonged cloud cover, fogs, etc. often causes crop damage physically and indirectly from insects pests and disease outbreaks due to abnormalities in weather conditions. Weather abnormalities also incur recurring losses in storage and transport of agricultural produce due to parasites, insects &diseases, etc.

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Bangladesh agriculture is blessed by sub-tropical weather providing the opportunity of year-round production of a diverse range of crops in different seasons. However, weather abnormalities affects crop growth and development and abnormal and extreme weather events damages crops physically as well as influencing incidence and outbreaks pests and diseases and thereby affecting crop production and productivity as discussed in sections 3.3.1, 3.3.2 and 3.3.3. The major components of variability in weather and climate in in Bangladesh are (i) more variable and erratic rainfall, (ii) erratic onset, advance and retrieval of monsoon, (iii) changes in intensity and frequency of monsoon lows and depressions, and increased extreme weather events, floods, heat and cold waves, etc.

2.1.1 Solar Radiation and Crop Plants

Solar radiation is the energy source that sustains organic life on earth. Crop production is in fact an exploitation of solar radiation. Photosynthetically active radiation (PAR) plays the vital role in plant growth and development through chlorophyll synthesis and photosynthesis as well as photosensitive regulatory mechanisms such as phototropism and photoperiodic activity (Harpal et al., 2004). Light of the correct intensity, quality, and duration is essential for normal plant development. It affects the production of tillers; the stability, strength, and length of the culms; the yield and total weight of plant structures; and the size of leaves and root development (Rodriguez et al., 1999). Light of the correct intensity, quality and duration is essential for normal plant development.

2.1.2 Temperature and Crop Production

Atmospheric and soil temperature is of paramount importance for organic life as it governs the physiological and biochemical processes. As such, temperature has a primary role in plant growth and its geographical distribution over the earth (Harpal et al., 2004). Air temperature is the most important climatic variable that affects plant life. Crop growth is restricted between critical range between 10 to 40^0C. However, each species and variety of plants and each age group of plants has its own upper and lower temperature limits beyond which a plant is considerably damaged and may even be killed. It is therefore the amplitude of variations in temperature is more important to plant growth. Soil temperature influence the germination of seeds, the functional activity of the root system, the incidence of plant diseases and the rate of plant growth (Singh, Singh, and Rao, 1998).

2.1.3 Availability of Water for Plant Growth

Rainfall is the ultimate source of water for plant growth and in most parts of the world crop production depends on rainfall. Rainfall contributes to about 65 percent of global food production, while the remaining 35 percent is produced with irrigation. In most parts of the world, rainfall is, for at least part of the year, is insufficient to grow crops and rainfed crop production is adversely affected by annual variations in precipitation. Knowledge of the probable dates of commencement and end of the rainy season and the duration of intermittent dry and wet spells can be very useful for planning various agronomic operations such as preparing a seedbed, manuring, sowing, weeding, harvesting, threshing, and drying. This results in minimizing risk to crops and in optimum utilization of limited resources including water, labor, fertilizer, herbicides, and insecticides.

2.1.4 Drought

Drought is a climatic hazard that occurs in almost every region of the world. It causes physical suffering, economic losses, and degradation of the environment. A drought is a creeping phenomenon, and a dry spell becomes a drought or severe drought and its effects are long lasting and widespread. There are three main types of drought: meteorological, agricultural, and hydrological (National Drought Mitigation Center, 1996). A drought may be viewed as *Meteorological drought* - an expression of rainfall departure from normal over some period of time; *Agricultural drought* - a period when there is not enough soil moisture to meet the needs of crops at a particular time; and *Hydrological drought* - referring to deficiencies in surface and subsurface water supplies.

2.1.5 Crop Pests and Weather

Weather is the most important factor that determines the geographical distribution and periodic abundance of crop insect pests and diseases. Weather controls the development rate, survival, fitness, and level of activity of individual insects; the phenology, distribution, size, and continuity of insect populations; migration and their establishment; and the initiation of insect outbreaks (Pedgley, 1990; Drake and Farrow, 1988).

Weather influence on pest incidence and outbreak may be immediate, cumulative, direct, indirect, time lagged, exported, or imported. Imported/exported influences arise because insects are highly mobile, and outbreaks may be initiated by windborne migrations (Drake, 1994; Baker et al., 1990). Among the weather elements, temperature, humidity, and wind play the major roles in life of major insect pests of crops such as Aphids, Armyworms, Borers, Grasshoppers, Locusts, Cotton Bollworms, Fruit Fly, Flies, Midges, Mites, Nematodes, etc. in their incidence, build up, outbreaks as well as negative impacts on their life (Harpal et al., 2004).

2.1.6 Climate Change and Variability

Altered weather patterns can increase crop vulnerability to infection, pest infestations, and choking of crop weeds, insects, and diseases. Changes in food supply could lead to permanent or semi-permanent displacement of populations in developing countries, consequent overcrowding and associated diseases. Therefore, considerations of the potential impacts of climate change on agriculture should be based not only on the mean values of expected climatic parameters but also on the probability, frequency, and severity of possible extreme events. Temporal and spatial variance of meteorological conditions and storms can affect soil conditions, water availability, agricultural yields and susceptibility to pest and pathogen infestations.

Extreme weather events include spells of very high temperature, torrential rains, droughts, etc. Under an enhanced greenhouse effect, change can occur in both mean climate parameters and the frequency of extreme meteorological events. Relatively small changes in mean temperature can result in disproportionately large changes in the frequency of extreme events. Sequential extremes can affect yields and diseases. Droughts, followed by intense rains, for example, can reduce soil water absorption and increase the potential for flooding, thereby creating conditions favoring fungal infestations of leaf, root and tuber crops in runoff areas.

2.1.7 Climate and Extreme Weather Events Bangladesh

Bangladesh has a tropical monsoon climate characterized by wide seasonal variations in rainfall, maximum and minimum temperatures, humidity, etc. Regional climatic differences in this flat country are minor. Four seasons are generally recognized: a hot, muggy summer from March to May (Pre-monsoon); a hot, humid and rainy South-West monsoon season from June to September; a warm-hot wet to dry transitional season from October to November (Post-monsoon) and dry winter from December to February (winter or North-East monsoon). In general, maximum summer temperatures range between 38^0C and 41^0C. April is the hottest month in most parts of the country. January is the coolest month, when the average temperature in most places ranges between 16–20^0C during the day and around 10^0C at night. Winds are mostly from the north and North-East in the winter, blowing gently at 1 to 3 Km/hour in northern and central areas and 3 to 6 Km/hour in southern coastal region. From March to May, violent thunderstorms, called nor ‘westers is a common EWE and sometimes it produces winds of up to 60 Km/hour. During the intense cyclonic storm, usually occurring during post-monsoon to pre-monsoon periods, southerly winds of more than 160 Km/hour brings disastrous storm surge to coastal areas (GOB, 2018).

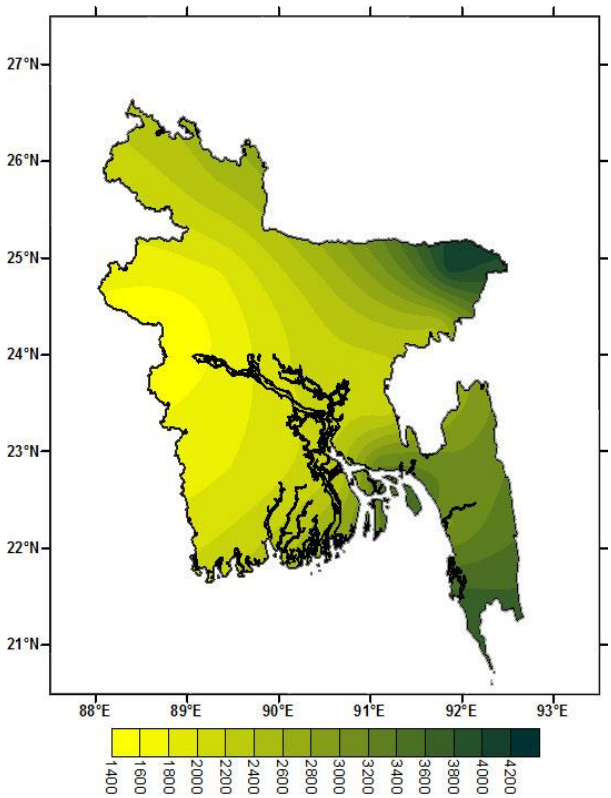


Fig. 1. Spatial distribution of mean annual rainfall

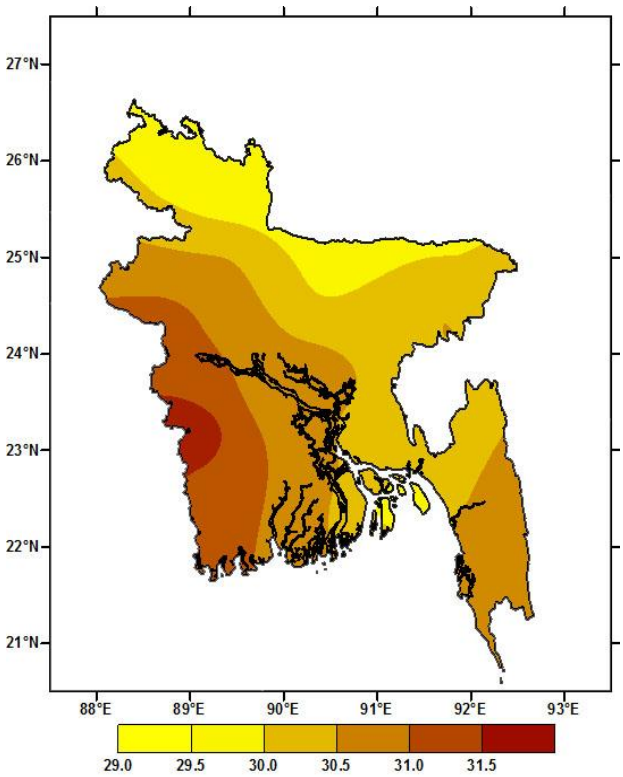


Fig. 2. Spatial distribution of mean annual max. temp. (^{0}C)

The distribution of mean annual rainfall, maximum temperature (Fig. 1 and Fig. 2) and other weather parameters indicate that Bangladesh, despite being a small country, has wide range of climatic variability requiring location specific agrometeorological forecasts and advisories with respect to benevolent and malevolent weather conditions to help farmers adopt strategies and practices to maximize environmental benefits and minimize risks in crop production.

2.1.8 Climate Change and Impact in Bangladesh

Average rainfall of Bangladesh is 2300 mm ranging from 1300 mm in south-west to 5000 mm in north-east. Due to climate chance, 10-15% increase in annual rainfall is expected by 2030 and 27% by 2075. Above average monsoon rainfall has been reported (Islam and Neelim, 2010; Choudhury et al., 2003), which causes frequent occurrence of high intensity floods over the vast floodplains. From recent past, increased rainfall in the Himalayan and Meghalaya range, larger area is flooded for longer duration. Outputs of PRECIS model have indicated a significant change in rainfall pattern throughout the country.

On the other hand, reduction of already insignificant rainfall during the drier months (November to March), combined with higher surface dryness, would increase moisture stress and phonological drought, especially in the western parts of the country (Huq et al., 1996). Drought affects crops and cropping from mid October to mid June. A major concern of long term dry season drought is over extraction of ground water for irrigation all over the country resulting in reduced aquifer and associated draw down of STWs. Modeling exercises to understand scientific projection of climate change in Bangladesh indicated a general increase in surface temperature, with higher rate of change during the drier periods (Agrawala et al., 2003; Mondal et al., 2013). Substantial increase in surface temperature is also reported in India (Chattopadhyay, undated). Increased in surface temperature is affecting adaptability of and performance of a large number of winter crops.

The general impacts of climate change are numerous. These include erratic rainfall – short rainy season and sudden very high rainfall; flood and water logging during rainy season; land and river

bank erosion; occurrence of extreme temperature frequently; low rainfall and excessive drought in the dry season; prolong summer and short winter; sudden cold and heat waves, siltation of rivers and reduced water flow; Ingress of saline water in the inland areas and increased salinity; increased prevalence and intensity of climatic disasters – floods, hailstorms, tornados, cyclone and storm surges. Cyclones and storm surges are catastrophic natural disasters affecting agriculture, infrastructure, natural resources, lives and livelihoods almost every year in Bangladesh.

Advent of progressively increasing global warming, the erratic nature of climate and occurrences of EWEs requires more attention in making efforts to keep climate related risks in agricultural production and productivity at low as possible to maintain sustainable food security.

2.1.9 Crop Responses to Weather Extremes

Precipitation, the primary source of soil moisture, is probably the most important factor determining the productivity of crops. Inter-annual precipitation variability is a major cause of variation in crop yields and quality. Drought stress and heat stress frequently occur simultaneously, exacerbating one another. They are often accompanied by high solar irradiance and high winds. Under drought stress, plant's stomata close, reducing transpiration and, consequently, raising plant temperatures. Flowering, pollination, and grain-filling of most grain crops are especially sensitive to water stress. By reducing vegetative cover, droughts exacerbate wind and water erosion, thus affecting future crop productivity. Excessively wet years may cause yield declines due to flood and waterlogging and increased pest infestations. High soil moisture in humid areas can also hinder field operations. Intense bursts of rainfall may damage younger plants, promote ripening grain lodging in standing crops, and cause soil erosion. Episodes of high relative humidity and hailstorms can affect yield and quality of fruits and vegetables. And, the costs of drying crops are higher under wetter climate regimes (Cynthia Rosenzweig, et. al., 2001).

In Bangladesh, during rabi growing period (16 October to 15 March), the major crops grown include Boro rice, wheat, maize, pulses, oilseeds, potato, a large number of vegetables, spices and condiments as well as many other crops. The major weather extremes affecting rabi crops includes drought, cold wave, prolong fogy periods, prolong warm period in winter, sudden heavy rainfall, prolong cloudy days (depression), and soil salinity in coastal areas. During Kharif-I growing season (16 March to 15 July) inadequate pre-monsoon rainfall often adversely affects establishment and subsequent performance of *Kharif-I* crops at different locations, especially in low rainfall areas. The major crops affected are broadcast and transplanted Aus rice (HYV), Jute, Mungbean (HYV), Blackgram (MV), Sesame (LIV) and Groundnut and a good number of summer vegetable along with Boro rice continued from rabi season. Other weather extremes affecting Kharif-I crops are drought, nor'wester, hailstorms, heat waves, sudden heavy rainfall, cyclone and intrusion of saline water in coastal areas. In Kharif-II growing season (16 July to 15 October), the cropping diversity is greatly reduced and the only major crop grown during this period is T. Aman rice. In some areas, the B. Aman rice and jute sown during Kharif-I season is continued. The major EWEs affecting Kharif-II crops include flood, intermittent drought, prolong rainless days, sudden heavy rainfall and prolong rainy days and cyclone (in coastal areas).

2.2 Agrometeorology

Agrometeorology is the science investigating the meteorological, climatological, and hydrological conditions that are significant to agriculture owing to their interaction with the objects and processes of agricultural production (Molga, 1962). It puts the science of meteorology to the service of agriculture, in its various forms and facets, to help with the sensible use of land, to accelerate agricultural production and to avoid the irreversible abuse of resources (Smith, 1970).

Agrometeorology is an interdisciplinary and a well-defined science as it has a set approach in theory and methodology. Its subject matter links together the physical environment and biological responses under natural conditions. Agrometeorology applies every relevant meteorological knowledge and skills to help farmers make the most efficient use of their physical environment in order to sustainably improve agricultural production both in quality and quantity of their land and resources. The goal of agrometeorology is to develop agrometeorological services, strategies, and support systems for on-farm strategic and tactical decisions and to implement them in collaboration with specialists in agriculture, livestock and forestry.

Agrometeorology offers practical solutions for harnessing climate potential and for protection/ avoidance of climate-related risks for long-term utilization of natural resources. In short-term it contributes field-scale decision making that directly and help farmers practice sustainable, high-quality, more profitable agriculture, with fewer risks, lower costs, and less environmental degradation (Rijks and Baradas, 2000).

2.3 Coping with Climate Risk in Agriculture

The sources of weather and climate related risks in agriculture are numerous and diverse as discussed earlier. These include limited water resources, drought, desertification, land degradation, erosion, hail, flooding, cyclone and storm surges (devastating natural calamities) and many more. Effective weather and climate information and advisory services can help develop sustainable and economically viable agricultural systems, improve production and quality, reduce losses and risks, minimize costs, increase productive and natural resource use efficiency and improve the environment ((Rathore and Chattopadhyay, 2016).

To boost awareness on increasing climate variability and the elevating climate risk in agricultural production it is necessary to develop understanding on the phenomena, impacts, actions, problems, solutions and policies related to priority extreme meteorological events. Awareness of elevating risks is a matter of extension (Hansen & Sivakumar, 2006; Stigter, 2006). Solutions to problems due to extreme events are therefore to be found in a combination of agrometeorology with an understanding of the livelihood of farmers in which the agrometeorology has to be applied (Stigter, K. 2008).

Preparedness for weather related risks and uncertainties, needs support in four defined directions of prioritization. These are (i) extreme events and their consequences caused by meteorological and climatological disasters on all time scales, including related aversion attempts; (ii) pests and diseases, including countervailing measures; (iii) trying to use beneficial climate and weather and (iv) applications of agrometeorological services. The agrometeorology services needs to be farmer participatory with well-trained intermediaries. The agrometeorological services should be developed in such a way as to increase the resilience of farmers to stimulate further and wider developments in rural areas (Stigter, K. 2008).

2.4 Agrometeorological Advisory Services (AAS)

The agrometeorological and agroclimatological information that can be directly applied to try to improve and/or protect the livelihood of farmers in agricultural production may be considered to belong to agrometeorological services. AAS provides specialized inputs to the farmers as advisories that can make a tremendous difference in agricultural production by taking the advantage of benevolent weather and minimize the adverse impact of malevolent weather (Chattopadhyay and Channdras, 2018). AAS, in case of extreme weather events may provide specialized inputs that can help agricultural production by taking timely actions against extreme weather events (Chattopadhyay, undated). Therefore, the management of weather and climate risks in agriculture is an important issue and more so due to unstable and erratic behavior of weather due to climate change. The intergovernmental Panel on Climate Change (IPCC) has highlighted multiple climate risks for agriculture and food security as well as the potential of improved weather and climate early warning

system to assist farmers to reduce related risks and enhance opportunities, improve the efficient use of costly and limited resources and increase agricultural production (Rathore and Chattopadhyay, 2016).

Farmer centric AAS consists of four inter related components. These are (i) Weather awareness, local weather data acquisition, and short range weather forecasts; (ii) Crafting of agro-advisories, dissemination and feedback gathering; (iii) an automated content management system for agrometeorological advisory generation and dissemination; and (iv) On-site capacity building, knowledge and technology transfer and engagement with local institutions (Nidumolu, et. al., 2018).

However, complete avoidance of all farm losses due to weather factors is not possible but losses can be minimized to a considerable extent by making adjustments through timely and accurate weather forecast information. When specifically tailored weather support is available to the needs of farmers, it contributes greatly toward making short-term adjustments in daily farm operations, which minimize input losses and improve the quality and quantity of farm produce (Mjelde et al., 1997). Thus, Agrometeorological Advisory Services facilitate flexible, weather-based agricultural planning and help build evidence and capacities of communities, technical and developmental agencies to plan and implement climate-adaptive responses (Lobo et al., 2017).

In Bangladesh, the AAS can help farmers in planning and implementing the broad farming activities such as Sowing/ transplanting of Kharif crops based on onset of monsoon; Sowing of Rabi crops using residual soil moisture; Delay in fertilizer application based on intensity of rain; Pesticide application based on wind condition; Prediction of occurrence of pests and diseases based on weather; prophylactic measures at appropriate time to control pests and diseases; Weeding/ thinning at regular interval; Irrigation at critical growth stages of crops; Quantity and timing of irrigation based on meteorological threshold; timely harvest of crops; etc.

To be effective, the advisories need to be delivered to the end users without any delay in simple language that can be easily understood.

2.5 Weather Forecast and Generation of Agrometeorological Advisory

The primary need of farmers is a location specific and quantified weather forecast for rainfall, maximum and minimum temperatures, wind speed and direction, relative humidity and cloudiness, etc. The weather forecasts is applied to generate crop specific advisories to offer farmers guidance on cultural practices to be adopted according to phenological stages of plant development, help farmers anticipate disease and pest outbreaks and plan other weather related operations from cultivar selection to dates of sowing, planting, transplanting, intercultural operations, harvesting and postharvest operations, protect crops from various climatic stresses and the like (Rathore and Chattopadhyay, 2016).

2.5.1 Weather and Climate Forecasting

Three types of weather forecasts are used in developing agricultural advisories. These are the short-range forecast valid for 48 hours, the medium-range or extended forecast valid for five days, and the long-range or seasonal forecast valid from a month to a season.

Short range forecast covers next 24 hours and extends up to 72 hrs. A short-range weather forecast is based on a detailed analysis of the physical processes occurring in the atmosphere. It incorporates information about current weather conditions and forecast information on high and low temperatures, wind velocity and direction, time and amount of precipitation, relative humidity, sunshine duration, and sudden weather hazards. The information is sufficiently accurate and can be effectively used by agricultural scientist for agricultural operations and farmers may take tactical decisions such as cultural practices and crop protection to minimize input losses resulting from adverse weather condition.

Medium range weather forecast covers a period of 3 to 7 days. The basis for preparing medium range forecast information (up to 5 days) is similar to that of the short-range forecast, but the forecast is not very detailed. An extended forecast contains generalized information including change of weather type, sequence of rainy days, extended wet and dry spells, and general weather hazards such as cold and heat waves. The forecast information is sufficiently accurate and available from meteorological centers. The extended weather forecast is most effective and useful in agriculture as it gives sufficient lead time for both planning and executing farm operations such as crop intercultural operations and other weather dependent activities. It is useful to farmers to make the most efficient and economic use of labor and equipment, management of water for irrigation and scheduling of plant protection measures.

Long range forecast or Seasonal Climate Outlook is used in making long range forecast accurately on the basis of parametric and power regression model relating to relating past climatic data. It gives the information of trends and changes in general circulations, which are related to forthcoming weather like cyclonic storms, thunder storm, monsoon etc. Long range forecast can be highly useful in prediction of likely trends in agricultural production and productivity.

Each of these forecasts is useful in agriculture. Whereas short-range forecasts are most valuable in daily farm operations, medium range and seasonal forecasts are important in longer-term farm operations and planning. Based on these forecasts, agrometeorological advisories are prepared to enable farmers make the best use of favorable weather conditions and make adjustments during adverse weather (Mavi and Tupper, 2004).

In using the forecast information for preparing agricultural advisory, it is important to bear in mind that weather forecast accuracy is inversely related to the lead time of the forecast. The shorter the lead time, the greater the accuracy of the forecast. Weather forecasts for longer time spans become more and more generalized, and their accuracy decreases as the lead time increases. A 24-hour forecast is more accurate and comprehensive than a 48-hour forecast. A five-day forecast is less accurate and less specific than a 48-hour forecast. Similarly, a long-range or a seasonal forecast is much more generalized and less accurate than a five-day forecast.

2.5.2 Development of Agrometeorological Advisory and Products

Generalized forecasts have, however, limited use in farming. Weather information for agriculture needs to be tailored to meet the needs of farmers. It should not be a repackaging of the general weather forecast of the national forecasting centers. Generalized forecasts should be a tailored product that can be effectively used in growing crops, managing animals, and controlling pests and diseases. A comprehensive agroclimatological forecast or a farm advisory is an interpretation of how expected weather is likely tp affect crops and farm operations. Therefore, it is necessary for the Agrometeorologist to develop a *weather synopsis* and *interpretation of weather for crops, farm operations, crop pests and diseases, and the like* (Mavi and Tupper, 2004)..

Weather synopsis: This is the description of locations and movements of low pressure systems, high pressure systems, upper air troughs, fronts, and associated weather with these systems. This information is derived from synoptic observations, prognostic charts, and visible and infrared imageries from meteorological satellites. For seasonal forecasts the inferences are drawn from historical data, sea-surface temperature, SOI values and phases, and other relevant tele-connections.

Interpretation of weather: Interpretation of weather conditions on crops takes into account the impact of weather on germination, growth rate, drought protection, and irrigation demand, etc. The cumulative effect of weather encountered and anticipated is used to determine dates of harvest, duration of harvest, and quality and storage capabilities of grains, fruits, and vegetables. It also takes into account the drying rate of soil, evaporation losses, effect of heat, cold, and wind on applications of chemicals and fertilizers, and the drying rate of curing, wetting, and rewetting grains and hay. Since

a close relationship exists between many plant diseases, insect pests, and weather, the incidence of these diseases and pests is forecast in the light of accumulated and anticipated weather. Simulation, synoptic, and statistical techniques are used for forecasts which pertain to the probable development, intensity, spatial and temporal spread, or suppression of diseases.

2.5.3 Content and Effectiveness of Agro Advisories

To be effective, the advisory should ideally consist of (i) weather summary of the last week, weather forecasts and crop moisture index, drought severity index, soil moisture status etc. It should also provide information on phenological stages of crop, pest and diseases and crop stress conditions. The advisory content may include crop management practices such as time of sowing, likely date of next irrigation, control operations of pests and diseases, fertilizer application etc. based on the likely situation of weather in the next few days. Information on crop planning, varietal selection, harvesting time may also be provided. It may also have information on spraying conditions for insects, weeds etc. The advisories should also serve as an early warning function for extreme weather events such as heavy rains, flash floods strong winds and temperatures, etc. (Rai, Suchit. 2014).

Generation of such actionable advisories requires comprehensive knowledge of not only crop production but also adequate knowledge on weather phenomenon and proper understanding of crop-weather interactions. Therefore, capacity building of concerned personnel is of paramount importance in acquisition weather data and forecasts, analyze the data and information to generate location and time specific advisories.

The efficiency of agro-advisories depends on (i) accuracy and reliability of forecasts issued; (ii) knowledge on crop-weather relationships of concerned Agrometeorologist; (iii) adaptation of technologies for the anticipated changes in weather based on forecasts and advisories issued; and (iv) capabilities of farmers to carryout timely operations as mentioned in the advisory messages/ bulletins.

2.6 Dissemination of Weather Forecast and Advisory

The agromet advisories generated at District levels are being disseminated to the farmers through mass media (Radio, Print and TV), Internet etc. A multi- media system for dissemination of agro-meteorological advisories to the farming community has been put in place in which beside the conventional modes e.g. radio, television & print media, concerted efforts are made to reach farmers through emerging modes of communication such as mobile phones and the internet, as well as short message service (SMS) and voice messages are being send to subscribing farmers in India. The agromet advisory bulletins based on medium range weather forecasting (3-10 days) are issued biweekly in India (Rai, Suchit. 2014). A mechanism has also been developed to obtain feedback from the farmers on quality of weather forecast, relevance and content of agromet advisory and effectiveness of information dissemination system. India has also made significant achievement for development of IT based dissemination framework.

In Bangladesh, Agrometeorological Advisory Services has been introduced recently through the Department of Agricultural Extension (DAE) which provide Agromet Bulletin including weather forecast and agromet advisories in Bengali and English (Chattopadhyay, undated).

2.7 Status of Weather Forecast and Agrometeorological Services in Bangladesh

Bangladesh Meteorological Department (BMD), an organ of the Ministry of Defense is the main source of historical climatic data in Bangladesh. It is archiving good quality climate data through its 35 observatories since 1980. BMD collects information by the observatory teams at different locations and the teams analyze the data three hourly and exchange with neighboring countries three hourly interval through GTS (Global Telecommunication System) link. World community collects this data six

hourly through WMO link. Various data collected by BMD include rainfall, air temperature (Max, Min and hourly), solar radiation, bright sunshine hour, relative humidity, dew point temperature, soil moisture and temperature at different depths (5,10,20,30,50 cm), evaporation, estimation of evapotranspiration with daily ET equation, etc. (GOB , 2018). Based on the weather observation, BMD provides short and medium range weather forecasts but it is not mandated to provide daily and Agrometeorological Advisory Services.

Considering the necessity of integrated Agrometeorological and Agricultural Extension services to the benefit of farmers and protect crop agriculture from vagaries of weather, the Government of the People's Republic of Bangladesh is implementing Agro-Meteorological Information Systems Development Project (Component –C of Bangladesh Weather and Climate Services Regional Project) in the Department of Agricultural Extension (DAE). Meanwhile the AMISDP activities has been initiated in all the 64 districts of Bangladesh as an effort to develop District-based and location specific integrated agro-advisory and crop extension services for the farmers.

2.8 Agrometeorological Training for Capacity Development

Training is regarded as a systematic and planned process to change the knowledge, skills and behavior of personnel to achieve the objectives of the organization they work for. In contrast to education, training is task-oriented because it focuses on the work an individual performs. The acquisition of knowledge and skills is a continuous process throughout one's career and not just a one-time effort. The need for continued training in agrometeorology was demonstrated by a survey on education and training requirements (Olufayo et.al., 1998).

Recent operational developments includes developing extension around the establishment of agrometeorological services that recognizes the importance of paying attention to the enormous need for training of extension personnel at the intermediate level between makers of agrometeorological products and end users. For effectiveness and sustainability of any integrated agro meteorological service, the availability of quality trained technical and professional personnel in agricultural meteorology are critical factors.

Since 'Agricultural Meteorology' is concerned with discovering, defining and applying knowledge of the interactions between meteorological and hydrological factors, and biological systems to practical use in agriculture, it includes two basic subject areas: (i) Physical sciences - specifically the physics of the atmosphere (i.e. meteorology and climatology) and soil physics and hydrology; (ii) Biological sciences - specifically physiology, ecology and pathology of plants and animals, and associated disciplines of agriculture such as agronomy and horticulture. In agrometeorological training programs, special attention is paid to the application of meteorology in the farming community and the demonstration of such practices under field conditions.

In some agrometeorological training centres, the specialized training courses includes: 1. Basic Agricultural Meteorology - for beginners; 2. Data Base Management - for agro-climatologists; 3. Modeling in agricultural meteorology - for advanced professionals; and 4. Hydrometeorology - for water resource managers. Other major areas of training may include Quantification of Crop-Weather Relationship; Modeling Biological Response to Climate; Remote Sensing of the Environment and Vegetation; Agroclimatological Database management; Agrometeorological Modeling; Environmental Management; Climate Change Impact assessment, Adaptation and Mitigation; Pest and Disease Management;

In the context of the requirements of AAS, capacity development of involved personnel is essential to develop and sustainably maintain AAS. This could be done through proper education and training of concerned personnel in agrometeorology, especially those involved in Agricultural Extension Services in Bangladesh.

CHAPTER-III
METHODOLOGY

Methodology is one of the most important part for any study as it explains the procedures and methods and identify tools and techniques through which the desired information is generated. This section discusses the study area, study population and its selection procedures, instruments to be used, implementation strategy, quality control procedure and data management etc. Considering the objectives of the study, time and types of respondents under the study, both qualitative and quantitative research methods were applied in collecting the data to attain the objectives as stated in the TOR.

However, the following methodology was finalized in consultation with the client during study planning and inception stage and necessary changes were made according to the client's requirement.

3.1 Review of literature

To be familiar with the study, the relevant literatures were reviewed and secondary data were collected. The review of literature included the relevant project documents i.e., Development Project Proposal (DPP), relevant project reports/publications, reports of other similar studies, information/records available at DAE and other concerned agencies. Statistical information was collected from BBS and BADC publications, local DAE offices in the project area and Internet searching. The activities were continued till compilation and delivery of the report. A detailed "Review of Literature" on the subject matter is preented in Chpter II.

3.2 Geographic location

The AMISDP of Department of Agricultural Extension (DAE) is being implemented in 64 districts representing 14 regions (Table 1). The review of the locations identifies 19 AEZs out 30 AEZs of Bangladesh. The selection of Districts and Upazila for the study, thus represents wider coverage of agro-ecological situations and likely to provide variations in the need of agrometeorological advisory services.

Table 1: Sample Regions, Districts and Upazilas

Region	District	Upazila	AEZ
1. Dhaka	1. Kishoreganj	1. Mithamain	AEZ 21 & 19
	2. Tangail	2. Dhanbari	AEZ 08 & 09
2. Comilla	3. Comilla	3. Muradnagar	AEZ 19
	4. Brahmanbaria	4. Bijoypur	AEZ 19 & 22
3. Syhet	5. Sunamganj	5. Tahirpur	AEZ 21 & 22
	6. Sylhet	6. Jaintapur	AEZ 29 & 20
4. Mymensingh	7. Sherpur	7. Nokhla	AEZ 22 & 09
	8. Mymensingh	8. Fulpur	AEZ 22 & 09
5. Jessore	9. Jessore	9. Abhaynagar	AEZ 11 & 14
	10. Magura	10. Salikha	AEZ 11
6. Bagura	11. Bagura	11. Dhunot	AEZ 04
	12. Joypurhat	12. Akkelpur	AEZ 03 & 25
7. Rajshahi	13. Rajshahi	13. Durgapur	AEZ 11
	14. Naogaon	14. Nazipur	AEZ 25
8. Khulna	15. Satkhira	15. Shyamnagar	AEZ 13
	16. Bagerhat	16. Mongla	AEZ 13
9. Barishal	17. Borguna	17. Bamna	AEZ 13

Region	District	Upazila	AEZ
	18. Patuakhali	18. Galachipa	AEZ 13
10. Rangpur	19. Rangpur	19. Mithapukur	AEZ 27 & 3
	20. Kurigram	20. Bhurungamari	AEZ 3
11. Faridpur	21. Shariatpur	21. Naria	AEZ 10, & 12
	22. Faridpur	22. Char Bhadrason	AEZ 10
12. Rangamati	23. Rangamati	23. Kaptai	AEZ 29
	24. Bandarban	24. Lama	AEZ 29
13. Chattagram	25. Cox's Bazar	25. Kutubdia	AEZ 23
	26. Noakhali	26. Kabirhat	AEZ 18
14. Dinajpur	27. Dinajpur	27. Birol	AEZ 01 & 25
	28. Thakurgaon	28. Baliadangi	AEZ 01

3.3 Study Design

The study involved both qualitative and quantitative methods of gathering data to meet the objectives of the assignment. The qualitative data were collected at the officers' levels of DAE as well as through review of secondary data obtained from Bangladesh Metrological Department, various publications and searching internet. Besides, farmers' opinion and information on their needs of different agrometeorological advisory services, skills and their expected means of receiving and using the advisories to their benefits were collected. The study involved qualitative data collection through Key Informant Interview of Policy level and District level personnel of DAE, In-Depth Interview of DAE's District Level Training Officers, Focus group Discussions (FGDs) and quantitative data collection through household survey using semi-structured questionnaire.

3.3.1 Selection of Indicators for Development of Study Tools

Proper study tools and methods play vital role for assessing the present status of any study like agrometeorological advisory services, identification of gaps as well as assessment of training needs on various aspects of agrometeorological issues at different levels. To ascertain the qualities of study tools some indicators were selected for all study tools used. The relevant indicators of different studies are presented below.

3.3.1.1 Indicators for Key Informant Interview of Policy and District Level Personnel of DAE

Key informant interviews (KIIs) are qualitative in-depth interviews of 15 to 35 individuals who are likely to provide needed information, ideas, and insights on a particular subject or topic of interest. The KIIs involve interviewing people who have particularly informed perspectives on an aspect of the program being evaluated. The interview is loosely structured, relying on a list of issues/indicators to be discussed.

In the context of DAE personnel and farmers' Training Need Assessment on agrometeorological advisory services, the major topics/indicators included are the followings:

- Knowledge on the basic contents of GOB and DAE's policy on AMAS;
- Knowledge on the primary sources and quality of agrometeorological data and forecasts used by DAE;
- Present level of capacity of DAE to collect, analyse, interpret agrometeorological data and develop/prepare advisories/recommendations for farmers; are there specified peoples for the purpose?
- Need and scope for diversification of agrometeorological data source and improving the quality agrometeorological forecasts and advisories,

- Present contents of agrometeorological advisories and bulletins in terms of climatic events including climatic extremities;
- Effectiveness of current agrometeorological bulletins and forecasts released by DAE for the farmers;
- What additional weather/climatic parameters needed to be monitored at local levels to further improve advisory services to help minimize crop damage at local levels?
- Perceived gaps in the development and delivery of agrometeorological advisory services with respect to farmers' needs in different agro-ecological situations;
- If such gaps/deficiencies exists, what actions would be appropriate to minimize or bridge the gaps (data capture, collation, collaboration with other entities may be considered);
- Is present level of capacity of DAE officials at different levels satisfactory in understanding and dissemination of agrometeorological information contained in bulletins and other media to the benefit of farmers?
- How effectiveness of overall agro-met services and products and user satisfaction may be improved and made available down to root level?
- What are the perceived training needs for different levels of DAE officials (e.g., Policy, District, Upazila and Block)?
- What are major channels used to disseminate DAE's agrometeorological information and advisories?
- How the climatic forecasts system should be made available at different levels starting from implementers to the farmers?
- Suggestions of the respondents for further improvements in dissemination of agrometeorological information and advisories (e.g., mass media, print media, SMS service, etc.)
- The final recommendations of respondent for improvement of agrometeorological information and advisory services.

3.3.1.2 Indicators for In-Depth Interview of DAE's District Training Officers (DTOs)

In-depth interviewing is a qualitative research technique that involves conducting intensive individual interviews with a small number of respondents to explore their perspectives on a particular idea, program, or situation. In the context of the present assignment, the in-depth interviews of DTOs of selected districts were aimed at understanding the existing status of agrometeorological information and advisory service delivery from the district down to the farmers. It also included identification of critical training needs of DAE officers from the district down through the ranks to the SAAOs and farmers to streamline and improve the agrometeorological information and advisory services delivery. The major indicators included the followings:

- Awareness and perception on DAE's present agrometeorological services;
- Perception on agro-climatic factors (e.g., rainfall, temperature, humidity, wind speed, solar radiation, etc.) and occurrences of their extremities (e.g., flood, drought, storms, hailstorms, heat wave, cold wave, etc.) causing crop damage, crop production and productivity in the district;
- Capability /of district and Upazila level DAE personnel to understand and interpret agrometeorological information and forecast to develop messages for the farmers;
- How the climatic condition and plants' periodic biological (Phenological) responses could be determined and utilized in agrometeorological services?

- What would be the suitable means and mode of dissemination of agrometeorological advisory services and location specific information to maximize its outreach to the farmers?
- What are the present level of gaps between the farmers' advisory requirement and the delivery capabilities of DAE officials at different levels?
- What specific types of training would be required for capacity building of DAE personnel at different levels and *how these training be made effective*?
- What types of farmers' training is needed to develop/improve farmers' knowledge and skills to understand and utilize the current and potential agrometeorological information and how the training may be designed for the farmer beneficiaries;
- How SAAOs may be more involved to take part in dissemination of messages directly to the farmer beneficiaries.
- Should DAE develop its own service delivery mechanism? What could be the various component message generation and delivery mechanism?
- Specific suggestions and recommendations to streamline DAE's agrometeorological services and make it more effective?

3.3.1.3 Indicators for Focus group Discussion (FGD)

A focus group discussion (FGD) is an effective means to gather together people from similar backgrounds or experiences to discuss a specific topic of interest. It is one of the most common methods of qualitative data/information collection. It explores the views, experiences, beliefs and motivations of individual participants. The FGD uses group dynamics where questions are asked and discussed about participants' perceptions, attitudes, beliefs, opinion or ideas on particular issues.

In the context of the present assignment, the FGDs were carried out with the SAAOs of DAE. The major indicators considered for FGDs included the following points:

- Weather or climate induced hazards affecting crops in different seasons;
- Major land types most affected by climatic hazards/extreme events;
- Extent of crop damage by various climatic hazards in different seasons;
- Elaborate on present availability of agro-meteorological advisory services provided to the farmers;
- What are the essential advisory services needed for different crops with respect to crop vulnerability to climatic hazards in different seasons;
- How advance forecasts based on long-term historic data should be provided to the farmers in the form of advisories?
- How agrometeorological advisories be channeled/delivered that ease understanding and used by the farming community (e.g., Display boards at UC offices/important market places, mobile phone/SMS, etc.)?
- Ideas on farmers capability of using advisory services provided. What should be done to ease the farming community to use the information fruitfully
- State of effectiveness and user satisfaction on present agro-met services and products both at SAAO and farmers' level;
- Is there a necessity of training of SAAOs and farmers on different aspects of agro-met services in order to effectively deliver advisory services and minimize crop loss and sustain crop productivity?
- Suggestions on the type of training and subject matter contents for SAAOs;

- Suggestions on the type and subject matter contents of farmers' training on utilization of services and forecasts;
- Suggestions on organization and implementation of farmers training.

3.3.1.4 Indicators for Sample Survey at Farmers' Level

Quantitative survey typically uses structured questionnaires to obtain information to understand the needs of individuals/target community about certain topics. Generally, the respondents are asked for their opinions in a structured way to obtain facts and statistics on the issues under investigation. To get reliable results, it is important to survey people in fairly large numbers and to make sure they are a representative sample of the target population.This method generate a large amount of data which are then analyzed statistically.

The survey instrument was designed keeping in consideration the requirement and gaps according to indicators and how these may be helpful in attaining the objectives within the scope of work. The indicators for farmers' survey included:

- Demographic information to assess the capability of the farming community to understand and utilize the required AMASs delivered to them;
- Seasonal variation of climatic and weather parameters (e.g. rainfall, temperature etc.) and its Binfluence/impacts on different crop production activities in different seasons;
- Prevalence of different climate related hazards in different cropping seasons;
- Crops cultivated in different seasons (Rabi, Kharif-I and Kharif-II) and crop specific advisory services deemed needed.
- Impacts of climate induced hazards on yield loss in different crops and overall agricultural productivity;
- Farmers' existing mitigation/adaptation measures against different climatic hazards;
- Farmer's knowledge and perception on agrometeorological forecasts and perceived requirements of agrometeorological advisory services;
- Effectiveness and user satisfaction levels of present agrometeorological forecasts and services;
- Farmers' preferences of the means of receiving advisory services.

3.3.2 Development of Study Instruments/Tools

3.3.2.1 Instrument for Qualitative Survey

The study instrument of qualitative survey i.e., KIIs of Policy and District level officers (Annex 1 and Annex 2, respectively) were designed by incorporating the identified indicators (Section 4.1.1) to meet the requirements of the objectives of the assignment as indicated in the ToR.

3.3.2.2 Instrument for In-Depth Interview of DAE's District Level Training Officers

The in-depth interview of District Training Officers of selected districts was designed based on selected indicators mentioned in section 4.1.2. It was designed to provide clear understanding of the existing status of agrometeorological information and advisory services delivery from the district down to the farmers. It also identified critical training needs of DAE officers from the district down through the ranks to the SAAOs and farmers (Annex 3).

3.3.2.3 Instrument for Focused Group Discussion

In the context of the present assignment, the FGDs was carried out with the SAAOs of DAE The study instrument has incorporated the relevant FGD indicators (Section 4.1.5) as stated in Annex 5.

3.3.2.4 Instrument for Quantitative Survey of Farmer Respondents

The quantitative survey of farmers was aimed at identifying the baseline situation as has been stated in the ToR. The survey instruments have been designed in consideration of the indicators (4.1.5) and the requirements to help attaining the objectives within the scope of work. The survey schedule includes both demographic information of the respondents as well as information related to the relevant indicators (Annex 5). The questionnaire has been made modular with coding to help computer aided data management and analysis.

3.4 Recruitment and Training of Field Resechers/Enumerators

For field implementation of the study, adequate number of Field Resarchers/Enumerators were recruted conforming with the qualification and experience as specified in Bidding document. The enumerators were trained for two days at CRDS headquarters on concepts and purpose of the study as well as the on the study tools to be used in capturing the data from the field on household survry, Key Informant Interviews, In-depth interviews and Focused Group Discussion.

View of Training of Field Resechers/Enumerators at CRDS

3.5 Pre-sharing and Finalization of Survey Instruments

The draft study instruments were shared with the client and upon client's positive note, it was shared with the enumerators (i) to find out the strength and weakness of the instruments; (ii) to determine whether the users understand questions; (iii) to observe the ability of the field staff to administer the questionnaires. After pre-sharing, the instruments were modified, updated, and finalized incorporating of feedbacks from field users and comments on the draft instruments from experts from the project. Upon finalization, adequate number of instruments were printed for commissioning the study in the field.

3.6 Study locations

From the enlisted districts and Upazilas 12 climatic hotspots were selected in consultation with the client. The selected climatic hotspots represents Flash Flood prone Haor Area (Mithamoin), Early Flush Flood, River Bank erosion prone area (Bhurungamari), Mid-Late flood prone area (Murad Nagar), Drought prone/HBT area (Mohadevpur), Drought prone covered BARIND (Dhunot Cyclone, Storm Surge/Salinity (Shyamnagar), Storm Surge/Salinity/Seasonal flood (Galachipa), Seasonal flood, Drought prone (Abhaynagar), Nor'wester/Hail storm prone (Fulpur), Cold & Heat wave prone

(Baliadangi), High rain fall, vulnerable to land slide (Kaptai) and New land formation, low elevation, coastal area (Kabirhat) (Table 2).

Table 2: Site Selection based on Climatic Hotspots

Sl. No.	District	Upazila	Rationale for Selection
1	Kishoreganj	Mithamoin	Flash Flood prone area (Haor Area)
2	Kurigram	Bhurungamari	Early Flush Flood, River Bank erosion
3	Comilla	Murad Nagar	Mid-Late flood
4.	Naogaon	Mohadevpur	Drought prone/HBT
5	Bogra	Dhunot	Drought prone covered barind
6	Satkhira	Shyamnagar	Cyclone, Storm Surge/Salinity
7	Patuakhali	Galachipa	Storm Surge/Salinity/Seasonal flood
8	Jessore	Abhaynagar	Seasonal flood, Drought
9	Mymensingh	Fulpur	Nor 'wester/Hail storm
10	Thakurgaon	Baliadangi	Cold & Heat wave
11	Rangamati	Kaptai	High rain fall, vulnerable to land slide.
12	Noakhali	Kabirhat	New land formation, low elevation, coastal area

3.7 Sampling and Data collection

In collecting the qualitative data, the DAE officers at policy and implementation (district) level were interviewed. The major mode of the interview were (i) Key Informant Interviews (KIIs) of policy level and district level personnel; (ii) In-depth interview of district level training officers using a semi structures format, and (iii) Focused Group Discussion (FGD) of Sub Assistant Agriculture Officers (SAAOs) as well as farmer level stakeholders.

The Key Informant's Interview (KII) was carried at DAE's central (policy) level using a pre designed checklist (Annex 1). The KIIs collected opinions of policy level personnel regarding relevant policy issues as well as agro meteorology service delivery mechanisms. Their opinions on sourcing of agrometeorological data, data analysis and development of forecasts/advisories and training needs of policy/central level personnel were sought. The KIIs checklist of district level DAE officers was focused on sourcing/development of agrometeorological advisory messages and forecasts, service delivery mechanisms and existing training needs of different levels of personnel were emphasized (Annex 2).

A semi-structured interview schedule was used in case of in-depth interview of district level Training Officers to assess the present status of knowledge base with particular emphasis on extreme weather events prevalent in the district and the affects it causes on crop damage and productivity. This interview also aimed at identifying the various kinds of training needs at district to the Upazila, Block and farmer levels (Annex-3).

The FGDs were carried out in each sample Upazila at the grassroots level extension personnel (SAAOs) working directly with the farmers in field. The FGD checklist emphasized as to what advisories is disseminated to the end users and how these are disseminated to identify the gaps in delivery mechanisms and channels used as well as to capture the perceived means of improved delivery mechanisms. It also elucidated the appropriate training requirements of the SAAOs (Annex-4).

The quantitative data were collected at farmers' level by administering a survey schedule designed to meet the requirements and objectives of the study and in accordance to the identified indicators. The locations of survey were determined using random sampling of unions/villages of the identified 12 hotspot districts and Upazilas indicated in the modified ToR.

3.7.1 Sampling for Qualitative Survey

Key Informant Interview (KII): The sample size of KII was 30. Of them, 28 samples were drawn from the 28 selected districts (District level officers) and two from the DAE central level. The Consultants Team has conducted the KIIs.

Focus Group Discussion (FGD): In all 12 FGDs were carried out at one randomly selected Union of each selected hotspot Upazilas. The teams of enumerators/supervisors have conducted the FGDs.

In-depth Interview (IDI): Altogether, 28 IDIs, one in each selected district, have been conducted with the District Training Officers of DAE by the team of consultants and enumerators/supervisors.

3.7.2 Sampling for Quantitative Survey:

Thirty six sample respondents were selected from each of the selected climatic hotspots and was surveyed using the questionnaire developed earlier. Thus in all there were 432 respondents interviewed.

Quantitative Data Collection: Field investigators/enumerators collected data according to pre-designed survey schedule with a compulsory abiding instruction. This facilitated the Field Co-coordinator to check and verify the consistencies and the quality of data. The consultant team member also joined the enumerators in the field during field data collection period and helped investigators/ enumerators collecting data correctly while checking the consistency of the filled-in questionnaires.

3.7.3 Field Survey Monitoring and Quality Control

The Team of Consultants imparted training to the Field investigators for data collection using different study instruments. A field activity schedule was prepared and circulated among the field investigators and other concerned personnel to follow to be on track in terms of time-bound activities without sacrificing quality. The field staffs collected field data and subsequently were checked by the field coordinators. The Field Co-coordinators coordinated the day-to-day work of the field investigators mainly through cell phones.

3.7.4 Data Transmission

The survey was undertaken simultaneously by four groups of enumerators at different locations. As data collection progressed, the data sheets were sent to CRDS Data Centre regularly on weekly basis. Upon receipt and initial checking by concerned personnel, the data were analyzed by professional data analyst.

3.7.5 Data Management

3.7.5.1 Quantitative Data Management Plan

Quantitative data management included registration, editing and coding, data entry operators' training, development of data entry program, data entry, data verification and cleaning, development of tabulation plan, generation of output tables and data analysis. These entire activities were accomplished by the assigned Data Analyst.

Registration of filled in questionnaire: The questionnaire/checklist (Input formats) were collected from the field and recorded in the registration book according to some predetermined format. The data entry operator was responsible for registration of filled-in questionnaire. He entered the filled in questionnaires for preparation of the database.

Editing and Coding: Each filled-in questionnaire was edited for consistency and completeness. Some questions were pre-coded while the open ended responses were post-coded according to the instructions of Data Analyst.

Data Cleaning: The Consultant mainly relied on logical verification of entered data with the questionnaires. Devising suitable in-built computer programs had further strengthened this. Any illogical deviation observed was cleaned and corrected properly.

Data Entry: Data entry was done as per the data entry program developed by the Data Analyst. The data entry was done using MS Access, a computer aided program. The following were the stages in computerization and processing of the collected data:

- Visual check for identification of apparent error
- Developing data input program

3.7.5.2 Qualitative Data Management

Qualitative data (KIIs and FGDs) are generally open ended. Hence, the responses were tabulated initially based on indicator/topics. Wherever appropriate, the responses were coded for ease of computer aided analysis and ranking them usually in descending order. The responses of qualitative survey (FGD and KII), reflected mainly the perception of the respondents, hence these were used to derive conclusions and comments on target information.

3.8 Data Analysis and Quality Control

3.8.1 Creation of a Data Base

The secondary data collected from different sources including climatic data, climatic extreme events and related consequences, various agrometeorological forecasts and advisories of different kinds as well as primary data collected from household survey and other components of the present study were stored in an MS Access database to be used for analyses according to analytical framework stated above.

3.8.2 Quality Control in Data Management

For quality control of primarily data, these were analyzed through computerized program integrating some of the indicators to be adopted for ensuring quality outputs of the baseline information. The following stages in computerization and processing of the collected data were followed:

i. Five (5%) percent of the filled–in questionnaires were checked against entered data to measure the error level in entry when these reach the data control centre of CRDS.
ii. Checking of data by sorting those in ascending or descending order

3.9 Designing of Output /Dummy Tables and Data Analysis

The Consultant Team prepared the dummy output tables for each item of collected data. The output tables contained both mono-variate and bi-variate as required. The Data Analyst developed programs using SPSS to produce the desired outputs.

The Data Analyst also developed the data analysis plan and ran the analysis according to the approved output tables in consultation with the consultants' team.

3.10 Reporting Obligations

Besides the Inception Report, submitted earlier, a Draft Final Report (Present) and an edited Final Report will be submitted to the client according to the ToR and Contract Agreement.

3.10.1 Inception Report

The inception report has been prepared soon after signing the contract agreement. as stated earlier in the very early part of the assignment. The report was submitted to the client in 10 copies.

3.10.2 Draft Final Report

The draft report has been prepared based on the data generated and analyses carried out by the Data Analyst according to output tables designed. The report contained required information as indicated by the study objectives and scope of work as mentioned in the ToR. The information and opinions obtained from the root level as well from the experts were incorporated in the Draft Report. Ten copies of Draft Report were submitted to the client for giving comments.

3.10.3 Final Report

After taking care of the comments and incorporating logical suggestions and having the written approval from the client the report will be finalized and 10 (Ten) copies of the Final Report will be submitted by the end of the fourth month of signing of the contract.

CHAPTER-IV
FINDINGS OF THE STUDY

4.1 Agro-Ecology of Study Locations

The geographic locations of sample districts covers Kishoreganj and Tangail districts of Dhaka region; Comilla and Brahmanbaria districts of Comilla region; Sunamganj and Sylhet districts of Sylhet region; Shrpur and Mymensingh districts of Mymensingh region; Jessore and Magura districts of Jessore region; Bogra and Joypurhat districts of Bogra region; Rajshahi and Naogaon districts of Rajshahi region; Satkhira and Bagherhat districts of Khulna region; Borguna and Patuakhali districts of Barisal region; Rangpur and Kurigram districts of Rangpur region; Shariatpur and Faridpur districts of Faridpur region; Rangamati and Bandarban districts of Rangamati region; Cox's Bazar and Noakhali districts of Chottogram region; and Dinajpur and Thakurgaon of Dinajpur region. Thus, the sample districts covers almost all of the major Agro Ecological Regions (AEZs) of the country.

The climatic hotspots selected for the present study includes Mithamoin Upazila (Kishoreganj) representing Flash Flood prone haor area (AEZ 21 & 19); Bhurungamari (Kurigram) representing Early Flush Flood and River Bank erosion prone area (AEZ 3); Murad Nagar (Comilla) representing Mid-Late monsoon flood prone area (AEZ 19); Mohadevpur (Naogaon) representing Drought prone Barind Tract ((AEZ 25); Dhunot (Bogra) representing drought prone covered Barind tract (AEZ 04); Shyamnagar (Satkhira) representing Cyclone and Storm Surge prone saline area ((AEZ 13); Galachipa (Patuakhali) representing Seasonal flooding, Storm Surge prone saline area (AEZ 13); Abhaynagar (Jessore) representing Seasonal flood and Drought prone area; Fulpur (Mymensingh) representing Nor'wester and Hail storm prone area; Baliadangi (Thakurgaon) representing Cold & Heat wave prone area; Kaptai (Rangamati) representing High rainfall area vulnerable to land slide ((AEZ 29); and Kabirhat (Noakhali) representing New land formation, low elevation, coastal area ((AEZ 18).

The salient features of major agro ecological regions in terms of land and soil types, agro-climate and ecological risks and hazards is discussed in following sections.

4.1.1 Mithamoin Upazila of Kishoreganj District

The area falls under *Sylhet Basin (AEZ 21)* and a part of it under *Old Meghna Estuarine Floodplain (AEZ 19)*. Sylhet Basin occupies a large area of lower, western side of the Surma-Kushiara floodplain. It is characterized by having pronounced ridge and basin landscape. The ridges of Old Brahmaputra soils penetrate into the western part of the lower-lying Sylhet Basin. The region extends over large part of Sunamganj, Habiganj, Netrokona and Brahmanbaria districts.

The physiography of haor basin area is characterized mainly by smooth, broad basins with narrow rims of higher land along rivers. Relief is locally irregular near rivers. The difference in elevation between river banks and adjoining basin centers is 3-6 m or more. The ridges are mainly moderately deeply flooded, and basins are deeply or very deeply flooded. The whole region is subject to early floods and rapid rise in flood-levels, particularly in the north. Flood-water drains rapidly from the ridges after the rainy season, but basins (haors) stay wet for most or all of the dry season.

Agro Climate of Haor Basin Region represents the wettest area of Bangladesh. The major climatic parameters shaping agro-climate and agriculture includes the amount and distribution of rainfall, temperature and its diurnal fluctuation, relative humidity, occurrences of extreme climatic events, etc. As said this is a very wet region, especially in the north. The mean annual rainfall increases from about 2500 mm in the south to more than 5000 mm in the extreme north (FAO, 1988). The area experiences an annual average rainfall of 3901 (± 776.1) mm with a bi-modal distribution pattern. It

may be noted that substantial amount of monthly rainfall (>100 mm) occurs in March after which it increases rapidly and highest amount of monthly rainfall (836 ± 259.1 mm) occurs in June. Rainfall declines in July (583 ± 179.6 mm) and again peak in August (753±32.3 mm). The amount of rainfall progressively declines thereafter and drop down to < 100 mm in October.

Crops and Cropping Patterns: Environmental or agro-ecological conditions and related risks and opportunities are the main determinants of cropping pattern along with several socioeconomic factors. The only crop grown in haor basin is boro rice in Boro-Fallow-Fallow cropping pattern. In fact, the fallow period of Kharif-I and Kharif-II seasons remains inundated in haor basin, hence other crops cannot be grown during this period. In relatively higher elevations on the river bank and ridges, where flood water recedes earlier, some early rabi crops such as mustard, lentil and few early winter vegetables are grown as very minor crops. The area is highly vulnerable to Flash Flood and poses threat to total failure of only crop Boro rice.

4.1.2 Bhurungamari of Kurigram District and Baliadangi of Thakurgaon District

The area represents Tista Meander Floodplain (AEZ 3) covering 9,468 sq km occupying major part of the Tista floodplain as well as the floodplain, Dharla and Dudhkumar rivers. Most areas have broad floodplain ridges and almost level basins. There is an overall pattern of olive brown, rapidly permeable, loamy soils on the floodplain ridges, and grey or dark grey, slowly permeable, heavy silt loam or silty clay loam soils on the lower land and medium in weatherable K minerals. Eight general soil types occur in the region, moderately acidic throughout, low in organic matter content on the higher land, but moderate in the lower parts. Fertility level is low to medium. Soils, in general, have good moisture holding capacity. This area is prone to early flush flood and river bank erosion and Baliadangi (Thakurgaon) is more prone to both cold wave and intermittent warm period in winter season.

4.1.3 Murad Nagar Upazila of Comilla District

The area falls under Old Meghna Estuarine Floodplain (AEZ 19). This region occupies a large area of mainly low-lying land overlying deep non-calcareous, estuarine silts between the south of Surma-Kushiara Floodplain (AEZ 20 and 21) and the northern edge of the young Meghna Estuarine Floodplain (AEZ 18).

The physiography of the area is smooth, almost level, floodplain ridges and shallow basins. Relief is made irregular locally by many man made cultivation platforms. Seasonal flooding ranges from shallow to moderately deep. Areas close to eastern hills are subject to flush floods. Basin centres, throughout the region, are subject to early and rapid flooding. Soils are relatively uniform within this region. Silty soil predominates, but there are significant proportions of silty clay or clay basin soils.

Agro Climate of AEZ 19 is relatively uniform despite its great extent. The mean annual rainfall is about 2000 mm over most of the region, but it exceeds 2500 mm in the north-east and exceeds 3000 mm in extreme south-east.

Crops and Cropping Patterns: Diversified crops are grown in this area. In highland and medium highland situations, HYV T. Aus and HYV T. Aman rice, partly followed by dryland rabi crops as well as various high value vegetable is the main practice. With irrigation, HYV Boro followed by HYV T. Aman is the general practice; increasingly, mustard is grown on residual soil moisture between T. Aman and Boro rice. In Medium Lowland, T. Aman/Jute is flowed by a wide range of rabi crops including wheat, mustard, potato, chili, khesari, etc. On both medium lowland and Lowland, with irrigation, predominantly HYV Boro rice is grown, the area is often subject to mid to late season flooding mainly due to heavy down pour as well as overflow of rivers.

4.1.4 Dhunot of Bogra District

The area is represented by *Karatoya-Bangali Floodplain (AEZ 4)*. The AEZ covers (2,577 sq km) this region is very similar to the Tista Meander Floodplain in physiography and soil, and comprises a mixture of Tista and BRAHMAPUTRA sediments. Most areas have smooth, broad, floodplain ridges and almost level basins. The soils are grey silt loams and silty clay loams on ridges and grey or dark grey clays in basins. Five general soil types occur in the region, of which non-calcareous grey floodplain and non-calcareous dark grey floodplain soils predominate. The soil is moderately acidic throughout. Organic matter contents are generally low in the cultivated layer of ridge soils and moderate in basins. General fertility is medium. The eastern half of Bogra and most of Sirajganj districts are included in this zone. The entire area is made up of drought prone covered Barind tract (AEZ 04). However, diversified cropping is practiced both with and without irrigation.

4.1.5 Patnitala of Naogaon District

The area is represented by *Level Barind Tract (AEZ 25)* covering about 8 sq km area. This region is developed over Madhupur Clay. The landscape is almost level. The predominant soils have a grey, silty, puddled topsoil with ploughpan. Shallow grey terrace soil and deep grey terrace soils are the major components of general soil types of the area. The soils are low in available moisture holding capacity and slightly acidic to acidic in reaction. Organic matter status is very low and most of the available nutrients are limiting. This area represent drought prone Barind Tract.

4.1.6 Fulpur of Mymensingh District

The region is represented by *Northern and Eastern Piedmont Plains (AEZ 22)* covering about 18,171 sq km and *Old Brahmaputra Floodplain (AEZ 9)* covering 7,230 sq km area. AEZ 22 includes the country's hill areas. Relief is complex. Hills have been dissected to different degrees over different rocks. In general, slopes are very steep and few low hills have flat summits. BROWN HILL SOILS is the predominant general soil type of the area. Organic matter content and general fertility level are low. The AEZ 9 occupies a large area of Brahmaputra sediments before the river shifted to its present Jamuna channel about 200 years ago. The region has broad ridges and basins. Relief is irregular, especially near the old and present river channels. Soils of the area are predominantly silt loams to silty clay loams on the ridges and clay in the basins. Organic matter content is low on the ridges and moderate in the basins, top soils moderately acidic but subsoils neutral in reaction. General fertility level is low. The region is prone to Nor'wester and Hail storm that causes crop damage, especially to standing boro rice causing lodging and grain shattering.

4.1.7 Abhaynagar of Jessore District

The region is represented by *High Ganges River Floodplain (AEZ 11)* and *Gopalganj-Khulna Beels (AEZ 14)*. AEZ 11 covers 13,205 sq km area that includes the western part of the Ganges river floodplain which is predominantly highland and medium highland. Most areas have a complex relief of broad and narrow ridges and inter-ridge depressions. The upper parts of high ridges stand above normal flood level. Lower parts of ridges and basin margins are seasonally shallowly flooded. General soil types predominantly include calcareous dark grey floodplain soils and calcareous brown floodplain soils. Organic matter content in the brown ridge soils is low but higher in the dark grey soils. Soils are slightly alkaline in reaction. General fertility level is low. On the other hand AEZ 14 occupies 2,247 sq km extensive low-lying areas between the Ganges river floodplain and the Ganges tidal floodplain. Soils of the area are grey, and dark grey, acidic, heavy clays overlay peat or muck at 25-100 cm. General soil types include mainly peat and non-calcareous dark grey floodplain soils. Organic matter content is medium to high. Fertility level is medium. The area is prone to moderate to severe drought in the dry season and moderate to deep flooding during monsoon.

4.1.8 Shyamnagar of Satkhira District and Galachipa of Patuakhali District

The region is represented by the *Ganges Tidal Floodplain (AEZ 13)* covering about 17,066 sq km. This region occupies an extensive area of tidal floodplain land in the southwest of the country. The greater part of this region has smooth relief having large areas of salinity. Riverbanks generally stand about a metre or less above the level of adjoining basins. Non-calcareous grey floodplain soil is the major component of general soil types. Acid Sulphate soil also occupies a significant part of the area, where it is extremely acidic during the dry season. Most of the top soils are acidic and subsoils are neutral to mildly alkaline. General fertility level is high, with medium to high organic matter content. The area is highly prone to Cyclone and Storm Surges of catastrophic nature and seasonal floods. This region, prone is a predominantly single cropped (T. Aman) area due to unsuitability of dry season cropping due to soil salinity.

4.1.9 Kaptai (Rangamati District)

The area represents *Northern and Eastern Hills (AEZ 29)* occupying 18,171 sq km area. This region includes the country's hill areas. Relief is complex. Hills have been dissected to different degrees over different rocks. In general, slopes are very steep and few low hills have flat summits. Brown Hill Soil is the predominant general soil type of the area. Organic matter content and general fertility level are low. This region, prone to high rainfall and hill slopes are vulnerable to occasional landslides.

4.1.10 Kabirhat (Noakhali District)

The area represents *Young Meghna Estuarine Floodplain (AEZ 18)* covering an area of 9,269 sq km. This region occupies young alluvial land in and adjoining the Meghna estuary. The major soils are grey to olive, deep calcareous silt loam and silty clay loams, and are stratified either throughout or at shallow depth. Calcareous alluvium and non-calcareous grey floodplain soils are the dominant general soil types. Top soils and subsoils of the area are mildly alkaline. General fertility is medium but low in N and organic matter. The area experiences new land formation due to deposit of silt carried by BGM river system along the coastline. Accordingly, the region has low elevation and mild soil salinity.

4.2 Household Survey

The study involved both qualitative and quantitative methods of gathering data to meet the objectives of the assignment. Quantitative data were collected using a semi-structured questionnaire to obtain information to understand the needs of individuals/target community about Extreme Weather Events (EWEs) and their needs of Agrometeorological Advisory Services as well as their present status of receipt and usages of available Agrometeorological Advisory Services. The study was carried out at 12 climatic hotspots (Table 2). The finding of the study is discussed below:

Group Interview of farmers at Baliadangi, Dinajpur

Group Interview of farmers at Dhunot, Bogra

4.2.1 Demographic Characteristics of the respondent families

4.2.1.1 Family Size Distribution of Respondent Families

The overall family size of the respondents in the districts across study locations was 4.6 persons/family. The mean family size at different locations ranged from 3.6 to 5.7 with a mean DS of ± 1.5. Since there were 36 respondents at each location, the total number of family members varied from 130 (Abhaynagar) to 204 (Mithamoin) as shown in Table 3.

Table 3: Family size distribution of respondents by study location

Name of Location	Family Size (No. of Members/Family)		
	Mean	SD (±)	Total No. of Family Members
Mithamoin	5.7	1.7	204
Bhurungamari	5.5	1.7	198
Murad Nagar	4.2	1.5	150
Patnitala (Nazipur)	4.1	1.2	147
Dhunot	5.2	1.6	188
Shyamnagar	3.6	1.0	131
Galachipa	4.3	1.4	155
Abhaynagar	3.6	0.9	130
Fulpur	4.5	1.1	161
Baliadangi	4.7	1.5	169
Kaptai	4.6	1.4	164
Kabirhat	4.8	1.9	171
Mean	**4.6**	**1.5**	164

4.2.1.2 Age group distribution of respondent family members

It was observed that over the locations, about 15.1 percent respondents were minor (< 10 year of age), 21.7 percent were youths (15-20 years of age), a bulk majority of 48.1 percent were adult and about 15.1 percent were old (> 50 years of age). However, the percentage figures within each age group varied widely among the locations (Table 4).

Table 4: Age group distribution of respondent family members by location

Name of Location	Age group distribution (Per cent)			
	< 10 Years	10-20 Years	21-50 Years	> 50 Years
Mithamoin	20.1	33.3	36.8	9.8
Bhurungamari	19.2	15.2	42.9	22.7
Murad Nagar	11.3	18	49.3	21.3
Patnitala	13.6	17.7	52.3	16.3
Dhunot	16.5	22.3	45.7	15.4
Shyamnagar	11.4	19.8	57.2	11.5
Galachipa	15.5	24.5	51.6	8.4
Abhaynagar	7.7	17.7	58.5	16.2
Fulpur	21.1	21.1	47.2	10.6
Baliadangi	15.4	21.3	50.3	13
Kaptai	12.2	24.4	47.5	15.9
Kabirhat	11.7	21.6	47.4	19.3
Mean	**15.1**	**21.7**	**48.1**	**15.1**

4.2.1.3 Gender Distribution of Respondent Family Members

Gender distribution of family members of the respondents at different study locations is presented in Table 5. It may be observed that proportion of male population of respondent families ranged from 50.9 to 57.7 percent among the locations with a mean value of 53.6 to percent. While the female population ranged from 42.3 to 49.1 percent with a mean value of 46.4 percent. However, the proportion of both male and female members varied among the study locations considerably (Table 5). More or less similar observation was reported earlier (ASSSRBP, 2016)

Table 5: Gender distribution of respondent families at different locations

Name of Location	Distribution of gender (%)		
	Male	Female	Total
Mithamoin	52.5	47.5	100
Bhurungamari	51.0	49.0	100
Murad Nagar	56.0	44.0	100
Patnitala (Nazipur)	53.7	46.3	100
Dhunot	52.1	47.9	100
Shyamnagar	53.4	46.6	100
Galachipa	55.5	44.5	100
Abhaynagar	57.7	42.3	100
Fulpur	54.7	45.3	100
Baliadangi	56.8	43.2	100
Kaptai	51.2	48.8	100
Kabirhat	50.9	49.1	100
Mean	**53.6**	**46.4**	**100**

4.2.1.4 Relationship of Respondent with Family Members

It was observed that 22.0 percent of the family members were the respondent as well as household head. 0.5 percent were husband but not the household head or the respondents. 20.6 percent were house wife and 27.6, 15.6, 1.7, 3.3, 0.9, 0.6 and 7.2 percent were son, daughter, father, mother, brothers, sisters and others, respectively (Table 6). Like all other demographic parameters, the percentage values under each category of relationship varied widely among the study locations.

Table 6: Relationship of family members with the respondents at different study locations

Name of Location	Relation with the respondent (In per cent)										
	HHH	Husband	Wife	Son	Daughter	Father	Mother	Brother	Sister	Others	Total
Mithamoin	17.6	-	17.2	32.8	23.0	0.5	2.0	1.0	1.0	4.9	100
Bhurungamari	18.2	1.0	15.7	21.7	10.6	4.0	7.1	1.5	2.0	18.2	100
Murad Nagar	24.0	-	22.0	32.7	11.3	1.3	3.3	0.7	0.7	4.0	100
Patnitala	24.5	0.7	23.8	25.2	9.5	4.8	7.5		0.7	3.4	100
Dhunot	19.7	-	17.6	23.9	12.2	2.1	6.4	3.7	1.1	13.3	100
Shyamnagar	27.5	0.8	24.4	28.2	9.9	-	-	-	-	9.2	100
Galachipa	23.2	0.6	21.9	25.2	18.7	0.6	0.6	-	-	9.0	100
Abhaynagar	26.9	1.5	26.9	26.2	13.8	0.8	0.8	-	-	3.1	100
Fulpur	22.4	0.6	21.7	32.3	22.4		0.6	-	-	-	100
Baliadangi	21.3	1.2	18.3	30.8	15.4	1.8	4.1	1.8	0.6	4.7	100
Kaptai	22.0	-	22.0	25.0	20.7	3.0	3.7	0.6	-	3.0	100
Kabirhat	21.1	-	21.1	28.1	17.0	0.6	1.8	0.6	-	9.9	100
Mean	**22.0**	**0.5**	**20.6**	**27.6**	**15.6**	**1.7**	**3.3**	**0.9**	**0.6**	**7.2**	**100**

4.2.1.5 Status of Education of Respondents' Family Members

The overall percentage of education of the family members of the respondents was 83,5%. Among the study locations, the mean education percentage varied widely from 76.1 to 95.3 percent at Kaptai and Abhaynagar, respectively. Over the districts, 16.5% of the family members never attended school. The largest section of the family members (33.4%) are children and studying in class I-V, 27.5% studied between above primary and below SSC levels while 17.6% attained SSC-HSC level and 5.1% attained graduate and post graduate level of education (Table 7). The education percentage of the respondents' families appears to be somewhat higher.

Table 7: Status of family education of respondents at study locations

Name of Location	Education level of family members (In percentage)						
	Illiterate	Primary	Below SSC	SSC-HSC	Graduate & Above	Total Educated	Total
Mithamoin	16.4	31.8	33.8	15.9	2.0	83.6	100
Bhurungamari	22.1	25.1	23.6	23.1	6.2	77.9	100
Murad Nagar	16.3	32.7	29.9	16.3	4.7	83.7	100
Patnitala	14.7	33.6	26.6	20.3	4.9	85.3	100
Dhunot	21.7	26.6	25.0	19.5	7.0	78.3	100
Shyamnagar	14.5	50.4	22.1	12.3	0.8	85.5	100
Galachipa	11.7	42.9	29.2	16.2	0.0	88.3	100
Abhaynagar	4.7	37.0	31.5	23.6	3.2	95.3	100
Fulpur	15.9	25.5	35.0	14	9.5	84.1	100
Baliadangi	18.5	31.2	11.5	22.2	16.6	81.5	100
Kaptai	23.9	34.4	28.2	11.6	1.8	76.1	100
Kabirhat	12.7	36.1	33.1	15.0	3.0	87.3	100
Total	16.5	33.4	27.5	17.6	5.1	83.5	100

4.2.1.6 Occupation Status of Respondents' Family Members

The occupation status has been viewed in consideration of all family members of the respondents. The primary occupation of 20.8% household members was agriculture out of all respondent family members. 5.1, 0.7, 3.8 and 2.3% family members has secondary occupation such as service, transport, small business and other minor occupation, respectively. While 29.3, 10.1 and 24.9 percent family members were student, dependent and household workers, respectively Table 8.

It may be mentioned that secondary occupation covers a wide range of activities such as rickshaw/van pulling, boat rowing, fisherman/fish farming, livestock rearing, milk, meat and vegetable selling, seasonal business, shopkeeping, small trading, cottage industry, driving vehicles, village physician, black smithy, pottery, carpentry, masoning, plumber, gold smithy, barbering, tailoring, electrician, domestic aid, etc.

Table 8: Occupational status of respondents' family members at different location

Name of Location	Family occupations (Per cent)									
	Agricul-ture	Labor Sell	Student	Depen-dent	Home Work	Service	Trans port	Busi-ness	Others	Total
Mithamoin	21.6	1.0	40.7	10.3	17.2	4.4	0.0	3.4	1.5	100
Bhurungamari	17.7	2.5	24.2	16.2	28.3	4.0	0.0	6.1	1.0	100
Murad Nagar	24.7	1.3	24.0	4.7	26.0	2.0	1.3	4.7	11.3	100
Patnitala (Nipur)	19.7	0.7	25.9	13.6	27.9	6.1	0.7	4.8	0.7	100
Dhunot	17.0	1.1	31.4	14.4	25.0	6.4	0.5	4.3	0.0	100
Shyamnagar	10.7	13.8	20.6	4.6	32.1	6.1	3.1	6.9	2.3	100
Galachipa	11.6	7.1	26.5	11.0	29.0	6.5	1.3	5.8	1.3	100
Abhaynagar	17.7	4.6	26.2	4.6	29.2	12.3	0.0	3.8	1.5	100
Fulpur	19.9	2.5	34.2	9.9	23.0	5.6	0.0	3.7	1.2	100
Baliadangi	28.4	1.8	31.4	12.4	22.5	0.6	0.6	1.8	0.6	100
Kaptai	35.4	1.2	31.1	9.1	14.6	4.3	0.6	0.0	3.7	100
Kabirhat	22.8	2.3	30.4	6.4	28.1	4.7	0.6	1.2	3.5	100
Mean	20.8	3.0	29.3	10.1	24.9	5.1	0.7	3.8	2.3	100

4.2.1.7 Family income of Respondent families

Mean monthly family income is the index living standard. Data showed that over the study location the mean monthly income of respondent families was Tk. 14698 (± Tk. 13032) per family with the per capita income of Tk. 3302 (± 2523). The high standard deviation of both monthly and per capita income suggest varying levels of income both within and across study locations (Table 9). It is evident that the mean monthly income was highest (Tk. 22219 ± Tk. 12831) at Mithamoin while it was lowest (Tk. 7489 ± Tk. 6281) at Baliadangi.

Table 9: Monthly family income of respondent families at different study locations

Name of Location	Monthly family Income (Tk.)		Monthly Per capita income (Tk.)	
	Mean	SD (±)	Mean	SD (±)
Mithamoin	22219	12831	4129	2377
Bhurungamari	15931	10967	2967	1928
Murad Nagar	13772	10607	3529	2622
Patnitala (Nazipur)	12028	9762	3065	2442
Dhunot	16750	18298	3228	3012
Shyamnagar	10242	6619	2765	1689
Galachipa	12444	5005	3106	1627
Abhaynagar	10528	6461	2944	1712
Fulpur	22194	23913	4801	3980
Baliadangi	7489	6281	1640	1177
Kaptai	14986	12703	3376	2500
Kabirhat	17792	11978	4073	2830
Mean	14698	13032	3302	2523

4.2.1.8 Farm Size Distribution of Respondents

Across locations there were only 2.3 percent landless (< 5 decimal), 18.8 percent marginal (>5 - < 49 decimal), 56.7 percent small (50 – 249 decimal), 19.0 percent medium (249-749) and only 3.2 percent large farmers (<750 decimals and above; Table 10). However, it may be observed that there was no landless farmer among the respondents of Bhurungamari, Patnitala (Nazipur), Dhunot, Fulpur, Baliadangi and Kabirhat. Likewise there was no large farmer at Murad Nagar, Shyamnagar, Galachipa, Abhaynagar, Baliadangi and Kaptai. Thus, the small (56.7%) and medium (19%) dominated the respondents. It may be observed that there were large variation within each category across locations (Table 1).

Table 10: Farm size distribution by study location

Name of Location	Farm categories					
	Landless	Marginal	Small	Medium	Large	Total
Mithamoin	2.8	-	27.8	52.8	16.7	100
Bhurungamari	-	22.2	55.6	16.7	5.6	100
Murad Nagar	8.3	25.0	55.6	11.1	-	100
Patnitala	-	16.7	41.7	33.3	8.3	100
Dhunot	-	5.6	61.1	30.6	2.8	100
Shyamnagar	5.6	19.4	72.2	2.8	-	100
Galachipa	2.8	33.3	55.6	8.3	-	100
Abhaynagar	2.8	22.2	72.2	2.8	-	100
Fulpur	-	13.9	61.1	22.2	2.8	100
Baliadangi	-	11.1	80.6	8.3	-	100
Kaptai	5.6	22.2	44.4	27.8	-	100
Kabirhat	-	33.3	52.8	11.1	2.8	100
Total	**2.3**	**18.8**	**56.7**	**19.0**	**3.2**	**100**

4.2.1.9 Land Ownership and Land Utilization Pattern of Respondents

Land is the basic resource for agricultural production. Accordingly, the study intended to assess the ownership of this fundamental resource of the respondents under different land use categories.

The location-wise mean land ownership and land utilization pattern of the respondents is presented in Table 10. On an average the size of the land holding of the respondents was 138.6 decimal/respondent family. Mean area under homestead, own cultivable, orchard plantation, wood plantation, fish pond, fish Gher and permanent fallow was 15.1, 110.8, 3.9, 2.4, 4.9, 0.5 and 0.9 decimals, respectively. However, the net cultivated area per family was found to be 136.9 decimal. However, the size of the homestead varied among the districts considerably and ranged from 9.2 to 23.5 decimals across locations. Likewise, area under other land use category also varied widely among the locations (Table 11).

However, the Net Cultivated area of the respondents ranged from 71.2 to 164.7 decimals. As common scenario, larger farmers shared/leased out the land while smaller farmers shared/leased in lands depending on their convenience.

Table 11: Land Ownership and Land Utilization

Study Location		Land Utilization (Decimal)							
	Homestead	Own Cultivable	Orchard	Woods	Pond	Fish gher	P. Fallow	Total Own	Net Cultivated[1]
Mithamoin	9.2	313.1	0.8	0	13.7	3.7	5.5	346.0	164.7
Bhurungamari	17.0	136.5	8.9	3.6	5.4	0.0	0.7	172.1	155.0
Murad Nagar	10.5	69.7	0.8	1.1	7.1	0.4	0.5	90.1	71.2
Patnitala	14.2	173.8	3.7	3.9	4.1	0	3.7	203.4	100.1
Dhunot	15.1	142.1	6.1	2.1	4.7	0	0	170.1	120.8
Shyamnagar	10.9	13.4	0.1	0	2.1	0	0	26.5	133.4
Galachipa	12.5	92.7	1.8	3.8	5.0	1.1	0	116.9	152.7
Abhaynagar	15.7	35.5	7.4	3.4	3.5	0	0	65.5	88.5
Fulpur	23.5	145.8	2.6	2.8	4.5	0.3	0.9	180.4	142.5
Baliadangi	15.8	112.8	4.9	0.7	2.5	0.3	0	137	157.7
Kaptai	15.0	72.2	6.7	6.1	1.1	0	0	101.1	138.2
Kabirhat	21.5	21.5	3.5	1.8	5.6	0	0	53.9	123.3
Mean	15.1	110.8	3.9	2.4	4.9	0.5	0.9	138.6	136.9

[1]**Own land ± Leased ± Shared**

4.3 Extreme Weather Events Affecting Crops at Different Locations and Seasons

Seventeen extreme weather events (EWEs) were identified that affects crop production and productivity at different times each year. The impacts are sometimes easily visible but in many instances it not noticed instantly. The important EWEs considered in this study included Drought; Cold Wave; Prolong Fogy Days; Prolong Warm Period in Winer; Prolong Rainless Days, especially during Kharif season; Hail Storm; Nor' wester; Heat Wave; Flood; Soil/River Bank Erosion; Prolong Cloudy Period; Sudden Heavy Rainfall; Prolong rainy days; Soil Salinity; Cyclone; Storm Surge; and Land Slide, etc. The farmers' responses of seasonal occurrences of various EWEs and their effect on various crops is discussed below:

4.3.1 Rabi Season

In Bangladesh, the period from 16 October to 15 March is considered as Rabi season. The period coincides with the driest period in Bangladesh but most diversified cropping is practiced during this growing. The major crops grow includes Boro rice, wheat, maize, pulses (lentil, chickpea, pea, grass pea), oilseeds (mustard, groundnut, linseed, sunflower, soybean, etc.), potato, a large number of vegetables, spices and condiments (onion, garlic, etc.) as well as many other crops.

The major EWEs affecting rabi crops includes drought, cold wave, prolong fogy periods, prolong warm period in winter, sudden heavy rainfall, prolong cloudy days (depression), and soil salinity in coastal areas. General impacts of these EWEs briefly discussed below:

Rabi Drought: As mentioned above, the entire rabi season (16 October to 15 March) falls within the driest period of the year and crop growth progresses in progressively increasing dry periods. Accordingly, major cereal crops such as Boro rice, maize, wheat, potato and high value vegetable crops are grown mainly with irrigation. However, a large number low water requiring rabi pulses, oilseeds, etc. are often grown on residual soil moisture under non-irrigated conditions. In case of severe drought, the yield and productivity of these crops is greatly reduced. Thus, winter drought affects almost all crops.

Cold Wave: As a natural phenomenon, spells of extreme low temperature occurs during the winter month. When cold waves appears during flowering stages of oilseeds, pulses, beans, etc. pollen germination and fertilization is hampered to a great extent reducing grain and fruit formation and thereby reduce crop yields. It also drastically reduce growth and development of major crops including Boro rice and maize. In certain fruit crops such as banana (var. Sabri) long exposure to cold wave causes clodding of the pulp.

Prolong Foggy Weather: Prolong foggy weather is often accompanied by extreme cold often hampers pollination and fertilization of major crops like wheat, pulses (chickpea and lentil), oilseeds (mustard and groundnut), flowering vegetables and may cause sterility. I addition, due to lack of photosynthetically active radiation (PAR), accretion of dry matter is greatly reduced resulting in poor crop performance. Such weather condition is also conducive to development and spread of blight diseases of potato and other crops.

Sudden Heavy Rainfall: Though heavy rainfall in Rabi season in not a regular phenomenon, sometimes excessive rainfall in in winter is not uncommon in some years and some locations, especially in the north-eastern region. Since dry land crops (other than Boro rice) is grown in the rabi season, such high rainfall most often becomes detrimental for many rabi crops, especially for pulses and oilseeds in which standing water in the crop field may cause total crop damage. Excessive rainfall often triggers rejuvenation of vegetative growth and reduces crop yield while increases field duration. This may also cause physical damage to crops at near ripening stages and deteriorate product quality.

Prolong Rainy Days: Though not as a regular phenomenon, prolong rainy and cloudy days may occur during rabi season as a climate change adversities related to deep depression in the Sea. Such cases, if happen, may adversely affect standing dryland crops to a great extent. Al most all crops may be affected due to prolong rainy days during the rabi season.

The farmers' perception of occurrences of different EWEs during the rabi season and crops affected at different locations is presented below:

i. Mithamoin (Kishoreganj District)

Mithamoin of Kishoreganj district, that represent primarily haor area of Sylhet Basin (AEZ 21), the major EWEs includes drought, cold wave, prolong fogy period in winter, sudden heavy rainfall and prolong rainy days affects the major crops such as Boro rice, mustard, tomato and potato. The number and percent of respondents opined is presented in Table 12.

Table 12: Farmers' responses on EWEs in relation to different Rabi crops, Mithamoin, Kishoreganj

Name of crops	Important Extreme Weather Events									
	Drought		Cold Wave		Prolong Foggy Days		Sudden Heavy Rain		Prolong rainy days	
	n	%	n	%	n	%	n	%	n	%
Boro Rice	3	8.3	15	41.7	13	36.1	9	25.0	0	0.0
Mustard	8	22.2	4	11.1	11	30.6	15	41.7	5	13.9
Tomato	4	11.1	7	19.4	5	13.9	3	8.3	7	19.4
Potato	5	13.9	7	19.4	6	16.7	0	0.0	4	11.1

ii. Bhurungamari (Kurigram District)

Bhurungamari of Kurigram district represents Tista Meander Floodplain (AEZ 3) covering 9,468 sq km area. The major EWEs prevalent are drought, cold wave, prolong fogy days, prolong warm period in winter, sudden heavy rain and prolong rainy days. Unlike Mithamoin, due to greater cropping diversity, a good number of major crops such as Boro rice, wheat, maize, mustard, chili, Brinjal and potato are affected (Table 13) in this region.

Table 13: Farmers' responses on EWEs in relation to different Rabi crops, Bhurungamari, Kurigram

Name of crops	Important Extreme Weather Events											
	Drought		Cold Wave		Prolong Foggy Days		Prolong Warm Period in Winter		Sudden Heavy Rain		Prolong rainy days	
	n	%	n	%	n	%	n	%	n	%	n	%
Boro Rice	5	13.9	16	44.4	13	36.1	0		3	8.3	0	
Wheat	11	30.6	17	47.2	12	33.3	24	66.7	25	69.4	18	50.0
Maize	7	19.4	3	8.3	5	13.9	7	19.4	9	25.0	11	30.6
Mustard	6	16.7	4	11.1	7	19.4	21	58.3	31	86.1	32	88.9
Chili	6	16.7	7	19.4	16	44.4	13	36.1	34	94.4	35	97.2
Brinjal	5	13.9	4	11.1	9	25.0	20	55.6	31	86.1	32	88.9
Potato	4	11.1	35	97.2	36	100.0	16	44.4	12	33.3	25	69.4

iii. Baliadangi (Thakurgaon District)

The area represents similar ecological conditions like Bhurungamari (Kurigram) under Tista Meander Floodplain (AEZ 3). Most areas have broad floodplain ridges and almost level basins as mentioned earlier. Soil fertility is low to medium but in most places have good moisture holding capacity. This area is prone to early flush flood and river bank erosion and Baliadangi (Thakurgaon) is more prone to both cold wave and intermittent warm period in winter season. The area has moderate to high cropping diversity. The important EWEs affecting rabi crops include drought, cold wave, intermittent prolong warm periods in winter, prolong foggy periods and sudden heavy rainfall. The major crops affected by these EWEs, as reported, are Boro rice, wheat, maize, chili, bottle gourd and potato. Farmers' responses on EWEs in relation to different Rabi crops are presented in Table 14.

Table 14: Farmers' responses on EWEs in relation to different Rabi crops, Baliadangi, Thakurgaon

Name of crop	Important Extreme Weather Events									
	Drought		Cold Wave		Prolong Foggy Days		Prolong Warm Period in Winter		Sudden Heavy Rain	
	n	%	n	%	n	%	n	%	n	%
Boro Rice	7	19.4	8	22.2	11	30.6	0		4	11.1
Wheat	13	36.1	5	13.9	17	47.2	28	77.8	15	41.7
Maize	8	22.2	7	19.4	10	27.8	11	30.6	15	41.7
Chili	5	13.9	6	16.7	24	66.7	8	22.2	22	61.1
Bottle gourd	14	38.9	8	22.2	25	69.4	12	33.3	20	55.6
Potato	6	16.7	26	72.2	34	94.4	9	25.0	14	38.9

iv. Murad Nagar (Comilla District)

Murad Nagar of Comilla district represent the Old Meghna Estuarine Floodplain (AEZ 19). This region occupies a large area of mainly low-lying land overlying deep non-calcareous, estuarine silts between the south of Surma-Kushiara Floodplain (AEZ 20 and 21) and the northern edge of the young Meghna Estuarine Floodplain (AEZ 18). As reported, a good number of crops such as Boro rice, wheat, maize, mustard, chili, Brinjal and potato are affected by rabi drought, cold wave, prolong fogy period, prolong warm period in winter, sudden heavy rain, and prolong rainy days. The number and percent respondent reporting is presented in Table 15.

Table 15: Farmers' responses on EWEs in relation to different Rabi crops, Murad Nagar, Comilla

Name of crop	Important Extreme Weather Events											
	Drought		Cold Wave		Prolong Foggy Days		Prolong Warm Period in Winter		Sudden Heavy Rain		Prolong rainy days	
	n	%	n	%	n	%	n	%	n	%	n	%
Boro Rice	3	8.3	7	19.4	8	22.2	2	5.6	1	2.8	0	
Wheat	5	13.9	9	25.0	15	41.7	21	58.3	24	66.7	15	41.7
Mustard	7	19.4	9	25.0	11	30.6	12	33.3	26	72.2	23	63.9
Lentil	7	19.4	5	13.9	14	38.9	22	61.1	29	80.6	31	86.1
Cabbage	3	8.3	2	5.6	4	11.1	7	19.4	14	38.9	19	52.8
Cauliflower	5	13.9	9	25.0	12	33.3	11	30.6	16	44.4	21	58.3

v. Patnitala (Naogaon District)

The area is represented by *Level Barind Tract (AEZ 25)* having almost level landscape. The predominant soils have a grey, silty, puddled topsoil with ploughpan and soils are low in available moisture holding capacity and slightly acidic in reaction. Diversified cropping is practiced in the area both with and without irrigation. As reported, the major rabi crops affected by various EWEs are Boro rice, maize, wheat, potato, mustard and mango. The important EWEs affecting these crops include drought, cold wave, prolong foggy days, prolong warm period in winter, sudden heavy rain and prolong rainy days (Table 16).

Table 16: Farmers' responses on EWEs in relation to different Rabi crops, Patnitala, Naogaon

Name of crop	Important Extreme Weather Events											
	Drought		Cold Wave		Prolong Foggy Days		Prolong Warm Period in Winter		Sudden Heavy Rain		Prolong Rainy Days	
	n	%	n	%	n	%	n	%	n	%	n	%
Boro Rice	3	8.3	14	38.9	10	27.8	3	8.3	4	11.1	9	25.0
Maize	9	25.0	11	30.6	13	36.1	6	16.7	17	47.2	19	52.8
Wheat	8	22.2	7	19.4	8	22.2	25	69.4	21	58.3	24	66.7
Potato	5	13.9	23	63.9	33	91.7	22	61.1	15	41.7	25	69.4
Mustard	7	19.4	9	25.0	13	36.1	18	50.0	33	91.7	28	77.8
Mango	16	44.4	18	50.0	32	88.9	2	5.6	2	5.6	5	13.9

vi. Dhunot (Bogra District)

Dhunot (Bogra District) represents Karatoya-Bangali Floodplain. The soils are grey silt loams and silty clay loams on ridges and grey or dark grey clays in basins. The eastern half of Bogra and most of Sirajganj districts are included in this zone. The entire area is made up of drought prone covered Barind tract (AEZ 04). However, diversified cropping is practiced both with and without irrigation. Major crops affected during Rabi season includes Boro rice, chili, bitter gourd, tomato, mustard and garlic by different extreme weather events such as drought, cold wave, prolong fogs and sudden heavy rainfall as may be observed from the response of the interviewees the EWEs (Table 17).

Table 17: Farmers' responses on EWEs in relation to different Rabi crops, Dhunot, Bogra

Name of crop	Important Extreme Weather Events											
	Drought		Cold Wave		Prolong Foggy Days		Prolong Warm Period in Winter		Sudden Heavy Rain		Prolong Rainy Days	
	n	%	n	%	n	%	n	%	n	%	n	%
Boro Rice	5	13.9	14	38.9	7	19.4	0	0.0	0	0.0	8	22.2
Chili	5	13.9	6	16.7	24	66.7	8	22.2	22	61.1	5	13.9
Bitter gourd	4	11.1	5	13.9	8	22.2	5	13.9	13	36.1	25	69.4
Tomato	6	16.7	6	16.7	14	38.9	20	55.6	16	44.4	19	52.8
Mustard	8	22.2	6	16.7	17	47.2	22	61.1	28	77.8	30	83.3
Garlic	9	25.0	5	13.9	19	52.8	12	33.3	16	44.4	31	86.1

vii. Abhaynagar (Jessore District)

The region is represented by *High Ganges River Floodplain (AEZ 11)* and *Gopalganj-Khulna Beels (AEZ 14)*. The upper parts of high ridges stand above normal flood level while lower parts of ridges and basin margins are seasonally shallowly flooded. Predominant soils are calcareous dark grey and brown floodplain types. On the other hand AEZ 14 occupies extensive low-lying areas and subject to moderate to severe drought in the dry season and moderate to deep flooding during monsoon. As reported, the major rabi crops affected by different EWEs are Boro rice, wheat, mustard, lentil and potato. Farmers' responses on EWEs in relation to different rabi crops is presented in Table 18.

Table 18: Farmers' responses on EWEs in relation to different Rabi crops, Abhaynagar, Jessore

Name of crop	Important Extreme Weather Events											
	Drought		Cold Wave		Prolong Foggy Days		Prolong Warm Period in Winter		Sudden Heavy Rain		Prolong Rainy Days	
	n	%	n	%	n	%	n	%	n	%	n	%
Boro Rice	11	30.6	15	41.7	4	11.1	0	0.0	4	11.1	0	0.0
Wheat	7	19.4	9	25.0	8	22.2	30	83.3	12	33.3	18	50
Mustard	8	22.2	16	44.4	12	33.3	11	30.6	28	77.8	25	69.4
Lentil	6	16.7	20	55.6	21	58.3	15	41.7	30	83.3	28	77.8
Potato	4	11.1	29	80.6	31	86.1	14	38.9	15	41.7	32	88.9

viii. Fulpur of Mymensingh District

The region is represented by *Northern and Eastern Piedmont Plains (AEZ 22)* and *Old Brahmaputra Floodplain (AEZ 9)*. The region has broad ridges and basins with irregular relief, especially near the old and present river channels. Soils are predominantly silt loams to silty clay loams on the ridges and clay in the basins. General fertility level is low. The region is prone to Nor-Wester and Hail storm that causes crop damage, especially to standing boro rice causing lodging and grain shattering. The major EWEs prevalent in the region during rabi season are similar to those of other regions. The farmers' responses on EWEs in relation to major rabi crops such as Boro rice, maize, mustard, graspea, cauliflower, sweet gourd, brinjal and potato is presented in Table 19.

Table 19: Farmers' responses on EWEs in relation to different Rabi crops, Fulpur, Mymensingh

Name of crop	Important Extreme Weather Events											
	Drought		Cold Wave		Prolong Foggy Days		Prolong Warm Period in Winter		Sudden Heavy Rain		Prolong Rainy Days	
	n	%	n	%	n	%	n	%	n	%	n	%
Boro Rice	3	8.3	18	50.0	1	2.8	0	0.0	0	0.0	2	5.6
Maize	7	19.4	13	36.1	7	19.4	0	0.0	21	58.3	15	41.7
Mustard	5	13.9	9	25.0	16	44.4	14	38.9	27	75.0	32	88.9
Grass pea	2	5.6	5	13.9	3	8.3	12	33.3	22	61.1	29	80.6
Cauliflower	6	16.7	7	19.4	17	47.2	21	58.3	15	41.7	30	83.3
Sweet gourd	9	25.0	8	22.2	9	25.0	18	50.0	12	33.3	17	47.2
Brinjal	6	16.7	4	11.1	5	13.9	6	16.7	11	30.6	22	61.1
Potato	5	13.9	28	77.8	30	83.3	0	0.0	23	63.9	35	97.2

ix. Shyamnagar (Satkhira District)

Shyamnagar (Satkhira District) falls under coastal saline area represented by the *Ganges Tidal Floodplain (AEZ 13)* covering about 17,066 sq km area of tidal floodplain land in the southwest of the country. The greater part of this region has smooth relief having large areas of salinity. Non-calcareous grey floodplain soil is the major component of general soil types. The area is prone to Cyclone and Storm Surge as well as seasonal flooding. Being saline ecology, cropping diversity is low. Vast area is planted to single crop of T. Aman rice. In non-saline to less saline areas, some Boro rice, wheat potato and mustard is grown along with some other minor crops. The major EWEs affecting crops and cropping are drought, prolong foggy period, prolong warm period in short winter, sudden heavy rain, prolong rainy days and soil salinity. Farmers' responses on appearance of EWEs on Rabi crops, Shyamnagar, Satkhira is presented in Table 20.

Table 20: Farmers' responses on EWEs in relation to different Rabi crops, Shyamnagar, Satkhira

Name of crop	Important Extreme Weather Events											
	Drought		Prolong Foggy Days		Prolong Warm Period in Winter		Sudden Heavy Rain		Prolong Rainy Days		Soil Salinity	
	n	%	n	%	n	%	n	%	n	%	n	%
Boro Rice	4	11.1	12	33.3	0	0.0	0	0.0	5	13.9	9	25.0
T.Aman Rice 19	7	19.4	0	0.0	0	0.0	25	69.4	0	0.0	7	19.4
Wheat	8	22.2	11	30.6	23	63.9	27	75.0	18	50.0	6	16.7
Potato	6	16.7	32	88.9	23	63.9	20	55.6	15	41.7	9	25.0
Mustard	7	19.4	9	25.0	21	58.3	33	91.7	30	83.3	9	25.0

x. Galachipa (Patuakhali District)

Galachipa (Patuakhali District) also represent coastal saline area under the *Ganges Tidal Floodplain (AEZ 13)* and have more or less similar ecological conditions except that the level of soil salinity is slightly lower than Satkhira. The area has relatively higher cropping diversity during the dry season. As reported, the major crops affected by different EWEs such as drought, prolong foggy periods, prolong warm period in short winter, sudden heavy rainfall and prolong rainy days mainly due to proximity to the ocean, soil salinity include T.Aman rice, B. Aman rice, mustard, grasspea, Mungbean and watermelon. Farmers' responses on the EWEs in relation to different Rabi crops is given in Table 21.

Table 21: Farmers' responses on EWEs in relation to different Rabi crops, Galachipa, Patuakhali

Name of crop	Important Extreme Weather Events											
	Drought		Prolong Foggy Days		Prolong Warm Period in Winter		Sudden Heavy Rain		Prolong Rainy Days		Soil Salinity	
	n	%	n	%	n	%	n	%	n	%	n	%
T.Aman Rice	5	13.9	0	0.0	0	0.0	0	0.0	0	0.0	3	8.3
B. Aman Rice	7	19.4	0	0.0	0	0.0	0	0.0	0	0.0	18	50.0
Mustard	9	25.0	30	83.3	13	36.1	32	88.9	33	91.7	13	36.1
Graspea	4	11.1	3	8.3	9	25.0	18	50.0	16	44.4	1	2.8
Mungbean	0	0.0	4	11.1	0	0.0	14	38.9	15	41.7	4	11.1
Watermelon	6	16.7	20	55.6	7	19.4	23	63.9	24	66.7	9	25.0

xi. Kabirhat (Noakhali District)

The area represents *Young Meghna Estuarine Floodplain (AEZ 18)* covering an area of 9,269 sq km. This region occupies young alluvial land in and adjoining the Meghna estuary. Calcareous alluvium and non-calcareous grey floodplain soils are the dominant general soil types. Soil fertility is medium but low in N and organic matter. The area experiences new land formation through new alluvial deposits along the coastline carried by BGM river system. Accordingly, the region has low elevation and mild soil salinity. In relatively developed areas, quite a good number of rabi crops are grown. Farmers' responses on EWEs in relation to these crops is given in Table 22.

Table 22 : Farmers' responses on EWEs in relation to different Rabi crops at Kabirhat

Name of crop	Important Extreme Weather Events													
	Drought		Cold Wave		Prolong Foggy Days		Prolong Warm Period in Winter		Sudden Heavy Rain		Prolong Rainy Days		Soil Salinity	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Boro Rice	2	5.6	7	19.4	6	16.7	0	0.0	4	11.1	3	8.3	0	
Mustard	6	16.7	4	11.1	8	22.2	5	13.9	22	61.1	25	69.4	6	16.7
Groundnut	10	27.8	4	11.1	7	19.4	0	0.0	10	27.8	21	58.3	7	19.4
Lentil	7	19.4	6	16.7	11	30.6	13	36.1	17	47.2	28	77.8	9	25.0
Mungbean	3	8.3	5	13.9	14	38.9	12	33.3	11	30.6	20	55.6	6	16.7
Chili	7	19.4	9	25.0	15	41.7	6	16.7	20	55.6	24	66.7	8	22.2
Bitter gourd	6	16.7	9	25.0	5	13.9	0	0.0	9	25.0	0	0.0	11	30.6
Tomato	5	13.9	6	16.7	7	19.4	3	8.3	13	36.1	18	50.0	14	38.9
Brinjal	5	13.9	7	19.4	7	19.4	0	0.0	20	55.6	19	52.8	9	25.0

xii. Kaptai (Rangamati District)

The area represents *Northern and Eastern Hills (AEZ 29)* having complex relief. In general the hill slopes are very steep and few low hills have flat summits. Brown Hill Soil is the predominant general soil type of the area. Organic matter content and general fertility level are low. This region experiences high rainfall and hill slopes are vulnerable to occasional landslides. The crops grown in hilly areas are somewhat different than those in the floodplain regions. The major crops are Boro rice (in hill foot and valley), ginger, brinjal, papaya and banana. Farmers' responses on EWEs in relation to these crops are given in Table 23.

Table 23: Farmers' responses on EWEs in relation to different Rabi crops, Kaptai, Rangamati

Name of crop	Important Extreme Weather Events											
	Drought		Cold Wave		Prolong Foggy Days		Prolong Warm Period in Winter		Sudden Heavy Rain		Prolong Rainy Days	
	n	%	n	%	n	%	n	%	n	%	n	%
Boro Rice	7	19.4	9	25.0	9	25.0	0	0.0	5	13.9	5	13.9
Ginger	5	13.9	9	25.0	14	38.9	0	0.0	9	25.0	10	27.8
Brinjal	13	36.1	4	11.1	11	30.6	7	19.4	11	30.6	21	58.3
Papaya	16	44.4	6	16.7	9	25.0	0	0.0	9	25.0	8	22.2
Banana	0	0.0	3	8.3	6	16.7	0	0.0	0	0.0	4	11.1

Crop-wise Farmers' Responses on Different Environmental Events on Rabi Crops

Analysis of farmers' responses showed that drought, cold wave, prolong foggy period, sudden heavy rainfall and prolong rainy days (triggered by depression) affected various rabi crops including Boro and T. Aman rice, wheat, maize, mustard, lentil, potato, tomato, Cole crops (cabbage and cauliflower), brinjal, gourds (sweet gourd, bottle gourd, bitter gourd), chili, ginger, banana, papaya, watermelon and mango. The cumulative number of respondents responding against drought for different crops ranged from 6 (weighted average of 16.7%) in water melon to 66 (weighted average of 20.37%) in mustard. However, for Boro rice, a total of 53 (13.38% weighted average) respondents reported. Cold wave affected all crops (other than T. Aman rice). The number of farmers responding ranged from 26 (24.07%) in tomato to 193 (76.59%) in potato. Most number of respondents 155 (71.76%) opined that sudden heavy rain fall affects wheat most followed by mustard 136 (41.98%). Prolong rainy days occasionally occurring due to depression also affects the major crops wheat, and mustard to a considerable extent (Table 24).

Table 24: Farmers' responses on impacts of weather events on different Rabi crops

Name of crops	Important Extreme Weather Events									
	Drought		Cold Wave		Prolong Foggy Days		Sudden Heavy Rain		Prolong rainy days	
	n	%	n	%	n	%	n	%	n	%
Boro rice	53	12.27	135	31.25	82	18.98	14	3.24	30	6.94
T. Aman rice	12	2.78	-	0.00	0	0.00	25	5.79	0	0.00
Wheat	52	12.04	58	13.43	83	19.21	155	35.88	115	26.62
Maize	31	7.18	34	7.87	35	8.10	24	5.56	62	14.35
Mustard	66	15.28	95	21.99	99	22.92	136	31.48	227	52.55
Lentil	20	4.63	31	7.18	46	10.65	50	11.57	76	17.59
Potato	35	8.10	180	41.67	193	44.68	81	18.75	98	22.69
Tomato	15	3.47	19	4.40	26	6.02	26	6.02	36	8.33
Cole crops*	14	3.24	18	4.17	33	7.64	39	9.03	45	10.42
Brinjal	30	6.94	16	3.70	30	6.94	39	9.03	64	14.81
Gourds	33	7.64	25	5.79	39	9.03	35	8.10	41	9.49

Name of crops	Important Extreme Weather Events									
	Drought		Cold Wave		Prolong Foggy Days		Sudden Heavy Rain		Prolong rainy days	
	n	%	n	%	n	%	n	%	n	%
Chili and Ginger	28	6.48	37	8.56	93	21.53	35	8.10	107	24.77
Banana &Papaya	16	3.70	9	2.08	15	3.47		0.00		0.00
Watermelon	6	1.39	20	4.63	7	1.62	23	5.32	24	5.56
Mango	16	3.70	18	4.17	32	7.41	2	5.6	2	0.46

***Cabbage and Cauliflower*

The data presented above suggests that the greater proportion of respondents either did not have any problems with the concerned weather events or were not adequately knowledgeable both on the extreme environmental events and their consequences on various crops they are growing during the Rabi season.

4.3.2 Kharif-I Season

The period from 16 March to 15 July is considered as Kharif-I season. Kharif-I season generally starts with the start of pre-monsoon rainfall after a prolong dry period. Inadequate pre-monsoon rainfall often adversely affects establishment and subsequent performance of *Kharif-I* crops at different locations, especially in low rainfall areas. In general, crop diversity is greatly reduced in Kharif-I season as compared to Rabi season. The major crops grown during this period are broadcast and transplanted Aus rice (HYV), Jute, Mungbean (HYV), Blackgram (MV), Sesame (LIV) and Groundnut and a good number of summer vegetable along with Boro rice continued from rabi season.

The major EWEs affecting Kharif-I crops includes drought, nor'wester, hailstorms, heat waves, sudden heavy rainfall, cyclone and intrusion of saline water in coastal areas.

Kharif-I Drought: Bangladesh experiences a unimodal rainfall distribution pattern. With the cessation of monsoon rainfall in September-October (depending on rainfall regime and year), the entire rabi season (16 October to 15 March) falls within the dry period that progresses in to the Kharif-I season (16 March to 15 July) although pre-monsoon rain may start toward the end of March to the end of April. Inadequate pre-monsoon rainfall adversely affects establishment and subsequent performance of *Kharif-I* crops. The vast area of central and north-western (except Rangpur region), Bangladesh receives substantial amount of pre-monsoon rainfall by late April to early May. During this period, almost all non-irrigated Kharif-I crops suffers from moderate to severe drought with consequence effects of crop performance. The impact of Kharif-I drought is more pronounced in the regions represented by Karatoya-Bangali Floodplain (AEZ 4), Level Barind Tract (AEZ 25), High Barid Tract (AEZ 26), North-Eastern Barind Tract (AEZ 27), Madhupur Tract (AEZ 28) and High Ganges River Floodplain (AEZ 11).

Hailstorm: Any thunderstorm which produces hail that reaches the ground is known as a hailstorm. Hail has a diameter of 5 mm or more. Hailstones can be very large or very small, depending on how strong the updraft is: weaker hailstorms produce smaller hailstones than stronger hailstorms. Hail forms in strong thunderstorm clouds, particularly those with intense updrafts, high liquid water content, great vertical extent, large water droplets, and where a good portion of the cloud layer is below freezing 0 °C (32 °F). Hailstorms is often accompanied by Nor'wester and tornado. Hail is primarily an afternoon or evening phenomenon. When hailstorms sweep across, it causes agricultural losses worth millions. However, In Bangladesh, hailstorm is sporadic and localized in nature. Depending on severity, it causes severe damage to standing Kharif-I crops including Boro and Aus rice, maize, chili, jute, various summer vegetables, pulses like mungbean and cowpea and various fruit crops such as watermelon, mango, litchi, papaya, banana, etc.

Nor'wester (Kal-Baishakhi) is a sort of thunderstorm that generally blows over Bangladesh usually in April-May from a northwesterly direction, locally known as Kal-baishakhi. Nor'wester thunderstorm coincides with the setting in of the summer season. It grows when the atmosphere becomes sufficiently unstable because of localized surface heating. The difference between an ordinary shower and this type of storm is that it is always associated with thunder and lightning. Nor'westers are more frequent in the late afternoon because of the influence of surface heating in producing convection currents in the atmosphere. Nor'westers during February-end to March these days are a common occurrence. These untimely catastrophes take the rural people off guard, turning them awfully helpless. Nor'wester with hailstorm cause severe damage to mature Boro crop of vast areas, damages tree crops as well as field crops along the path of Nor'wester. Since Nor'wester comes after prolong drought, it is often beneficial for jute, rice, other crops and tea cultivated in Bangladesh.

Heat Wave: It is a prolonged period of abnormally hot weather. A heat wave occurs when a system of high atmospheric pressure moves into an area. In such a high-pressure system, air from upper levels of atmosphere is pulled toward the ground, where it becomes compressed and increases in temperature. Although heat wave is an occasional phenomenon, it causes severe crop damage when it occurs during prolong drought. In severe cases, the scorching heat often burn out rice and other crops in early growth stages. Occurrence of heat waves in summer affects productivity of a wide range of crops.

Sudden Heavy Rainfall: Sudden and unexpected heavy fall, usually greater than 100 mm in 24 hours, is a form of extreme weather events. This is, gradually, becoming one of the most frequent and severe weather hazards. Sudden heavy rain over wide area often may cause flush floods and water logging that may cause severe crop damage.

Cyclone: Tropical revolving storms are called "Cyclones". The coastal regions of Bangladesh are subject to damaging cyclones almost every year. They generally occur in early summer (April-May) or late rainy season (October-November). Cyclones originate from low atmospheric pressures over the Bay of Bengal. These intense storms move across shallow shelf seas; the water is being piled-up along the coast as a surge. In most cases the mixture of these effects creates most dreadful effects in the coastal regions - a gradual rise in the regional sea level produces enhanced landward penetration of surges and storm waves.

The respondents of household survey recognized drought, hailstorm, Nor'wester, heat wave, sudden heavy rainfall and tropical cyclone as the major weather events causing crop damages at various scale depending on the time of their occurrences and severity. Farmers' responses on the effect of adverse weather events in relation to major Kharif-I crops at different locations is given in Table 25.

Table 25: Farmers' responses on EWEs in relation to different Kharif-I crops at different locations

Location	Percent Respondents within Location						
	Name of crop	Drought	Hailstorm	Nor'wester	Heat Wave	Sudden Heavy Rain	Cyclone
Mithamoin	Boro Rice	6.3	16.7	11.1	-	100*	-
	Maize	19.4	11.1	5.6	-	16.7	
	Chili	13.9		6.3	-	61.1	
Bhurungamari	Maize	47.2		6.3	25.0		
	Chili	36.1	44.4				
	Jute	25.0			11.1		
Avoy`nagar	Boro Rice	33.3	19.4	13.9			

Location	Percent Respondents within Location						
	Name of crop	Drought	Hailstorm	Nor'wester	Heat Wave	Sudden Heavy Rain	Cyclone
	Aus Rice	33.3	6.3	13.9		19.4	
	Jute	44.4			11.1		
	S. Tomato	19.4				33.3	
Murad Nagar	Boro Rice	60.0	20.0	33.3			
	Aus Rice	60.0	33.3	33.3			
	B. Aman Rice	13,9					
	Maize	33.3	13.9	66.7	19.4	25.0	
	Mango	8.3	13.9	13.9	13.9		
Dhunot	Boro Rice	25.0	19.4	11.1			
	Jute	22.2			6.3		
	Pointed Gourd	11.1			33.3		
Shyamnagar	Boro Rice	22.2		13.9			100*
	Jute	13.9					
Galachipa	B. Aman Rice	6.3					
	Mungbean	88.9	6.3	6.3			100*
	Felon	58.3					
	Watermelon	11.2	80.0				100*
Fulpur	Boro Rice	38.1	9.5	4.8			
	Jute	25.0					
	T. Aus Rice	80.0		13.9	33.3	33.3	
Baliadangi	Boro Rice	80.0	20.0	22.4			
	Aus Rice	33.3		66.7		38.1	
	Maize	11.2	6.3	90.0	11.1	58.3	
	Mungbean	11.2		90.0		88.9	
	Chili	50.0		50.0			
	Jute	20.0	20.0	46.7			
Kaptai	Aus Rice	19.4		11.2		88.9	
	Aram	40.0				40.0	
	Mango	8.3	13.9	77.8			
	Litchi	6.3	6.3				50.0
	Papaya	33.3	30.6	80.6			80.6
	Banana	33.3	30.6	33.3			75.0
Kabirhat	Boro Rice	100.0					
	Sweet gourd		100.0				

It may be observed that drought affects all major Kharif-I at all locations as reported by the respondent. The crops vulnerable to hailstorms and Nor'wester are Boro and Aus rice, maize, jute and chili. Very few crops are affected by other environmental events.

4.3.3 Kharif-II Season

The period from 16 July to 15 October is considered as Kharif-II season. Kharif-II season coincides with full monsoon season in Bangladesh and experiences a large amount of rainfall. Accordingly, the cropping diversity is greatly reduced and the only major crop grow during this period is T. Aman rice. In some areas, the B. Aman rice and jute sown during Kharif-I season is continued during Kharif-II season.

Early onset of heavy rainfall within Bangladesh and beyond boarders often may cause early flush flood that may destroy some standing Kharif crops including T. Aman seedlings. Due to heavy downpour and onrush of monsoon water from the upper stream often cause moderate to devastating floods over large part of the country and causes moderate to total damage to T. Aman crop. While early cessation of monsoon rainfall put T. Aman rice in moderate to severe drought and affects establishment and performance of succeeding crops with great yield reductions. Prolong post-monsoon dry period adversely affects productivity and quality of tree crops (e.g., mango, guava, litchi, etc.).

The major EWEs affecting Kharif-II crops includes flood, drought, prolong rainless days, cyclone, sudden heavy rainfall and prolong rainy days. Farmers' responses on EWEs in relation to major Kharif-II crops at different locations is given in Table 25.

Kharif-II Drought: Although the Kharif-II season within the peak monsoon period, early cessation of monsoon rainfall in September-October, the standing crops, especially rain-fed T. Aman rice suffers from water shortages. This period coincides with the flowering stage of LIVs and early grain growth stages of HYVs resulting in moderate to serious yield reduction, if supplementary irrigation is not provided. It may be mentioned that the distribution pattern of rainfall over the year is increasingly becoming erratic making the situation more uncertain. Post monsoon drought also makes crop production more irrigation dependent resulting in excess abstraction of ground water resulting in increased cost of production in one hand and depletion of ground water reserve on the other.

Prolong Rainless Days: Although Kharif-II is a wet season, due to climate change the rainfall distribution is progressively becoming erratic even during the monsoon. During these days, it is often noticed that there are spells of prolong (10-15 days) rainless period, especially during late monsoon. During reproductive growth stages (booting, flowering and grain growth), such short spell of rainless period adversely affects the growth and development of rain-fed T. Aman rice. This effect is especially pronounced in relatively low rainfall areas of Barind Tracts as well as in High Ganges floodplain areas. In saline areas, under such rainless period, the standing T. Aman rice is affected adversely due to rise of salinity due to presence of water table (saline) at shallow depth.

Sudden Heavy Rain: As in Kharif-I season, usually after prolong rainless periods, sudden heavy rain occurs during the Kharif-II season as well. Such often exceeding 100 mm or more in a day may cause flush floods in otherwise non flooded land types with consequent crop damages even in relatively shallow basin areas. This is also considered as an unexpected weather event.

Prolong Rainy Days: During Kharif-II season, this is a depression induced weather event predominantly occurring during late monsoon and may last even more than a week and often accompanied by high winds. Due to continued overcast sky, crop growth is hampered due to serious reduction of photosynthesis. On the other hand, high wind may cause physical damage to crops, especially T. Aman rice as well as increases the rate of respiration. As a result crop yield is adversely affected. Heavy downpour often results widespread flooding in low lying areas.

Flood: Bangladesh is prone to flooding due to being situated on the Ganges Delta and the many distributaries flowing into the Bay of Bengal. Coastal flooding, combined with the bursting of river banks is common, and severely affects the landscape and society of Bangladesh. Each year in Bangladesh about 26,000 square Km (around 18% of the country) is flooded. During severe floods the affected area may exceed 75% of the country, as was seen in 1998. While the issue of flooding and the ongoing efforts to limit its damages are prevalent throughout the entire country, several types of floods have recently occurred regularly, affecting different areas in their own distinct way. These flood types include: (i) flash floods in hilly areas; (ii) monsoon floods during monsoon season; (iii) normal bank floods from the major rivers BGM), and rain-fed floods.

Generally, the early flush floods occurs for short period and it often causes widespread damage to standing Aus rice, jute and various early summer vegetables. The flush flood in the north-eastern haor area often causes partial damage to total failure of Boro rice, the only crop of the region. Flush flood during June-July damages standing crops in low lying areas and damages T. Aman seedlings. Excessive rainfall, on rush of water from upstream (India) and bursting of river banks causes late flood during July-August and causes prolong water logging. The late flood often causes almost irreparable damages to crops.

The responses of the farmers of household survey showed that the major crops affected during Kharif-II season is T. Aman rice as cropping diversity during this season is extremely narrow. The crop is more or less affected by almost all the listed weather events (Table 26).

Table 26: Farmers' responses on EWEs in relation to different Kharif-II crops at different locations

Location	Percent Respondents within Location					
	Crop	Drought	Prolong Rainless Days	Flood	Sudden Heavy Rain	Prolong rainy days
Bhurungamari	T.Aman Rice	3.6	75.0	10.7		10.7
Murad Nagar	T.Aman Rice		50.0	16.7	16.7	16.7
Patnitala	T.Aman Rice			85.7		
Dhunot	T.Aman Rice	7.7	15.4	7.7	23.1	38.5
Shyamnagar	B. Aman Rice			50.0	50.0	
	T.Aman Rice			85.7		
Galachipa	B. Aman Rice			100.0		
	T.Aman Rice	38.5	53.8			7.7
Abhaynagar	B. Aman Rice	7.7		61.5		30.8
	T.Aman Rice	38.5	53.8			7.7
Fulpur	T.Aman Rice	38.5	53.8			7.7
	Bitter gourd					
Baliadangi	T.Aman Rice	11.1	83.3	2.8		
	Chili	10.8	81.1	2.7		100.0
Kaptai	T.Aman Rice	100.0				
Kabirhat	T.Aman Rice	11.6	56.3	0.9	15.2	3.6
	Aram	100.0				
	Chili					100.0

4.3.4 Respondents' Familiarity with Extreme Weather Events

The respondents' responses on familiarity with different extreme weather events (EWEs) were assessed. Farmers' responses of all locations were aggregated and average values have been presented. It was observed that the average percent of respondents responding at different locations ranged from 39.2 to 66.7. The rest of the respondents were ignorant about extreme weather events. The number of respondents reporting at different locations ranged from 12.56 to 24.0. While average number of extreme environmental events reported ranged from 6 to 21 (Fig. 3).

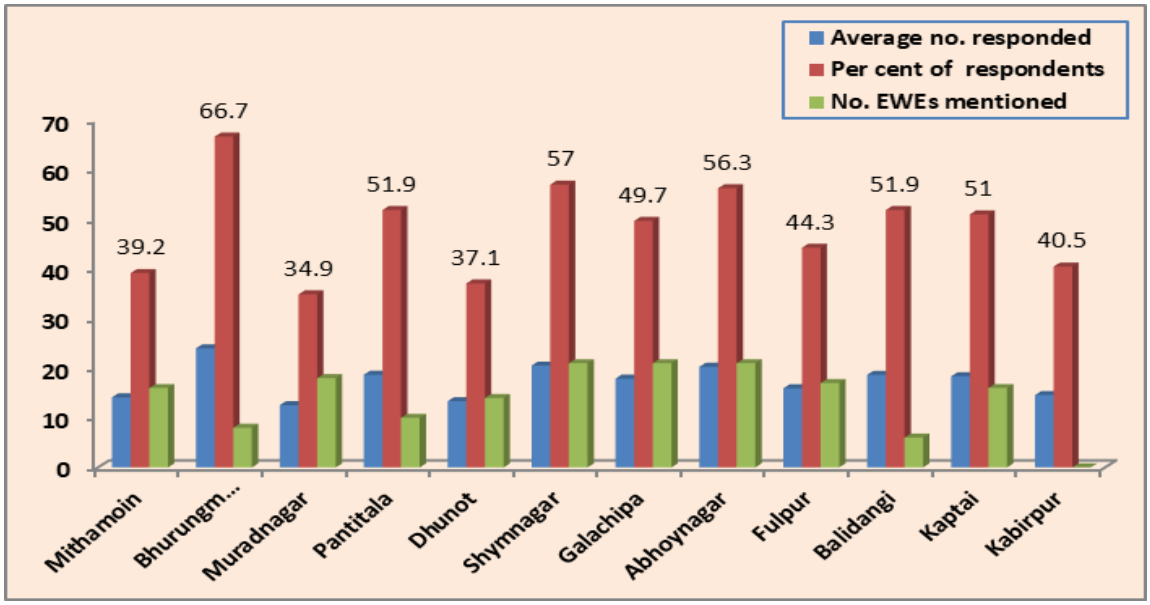


Fig. 3. Respondents' familiarity with EWEs

4.3.5 Benefits of Agro-meteorological Advisory Services for the Respondents

In response to the question as to how and to what extent the agro-meteorological advisory messages/forecasts benefit crop production, farmers' responses are summarized in table 26. It may be observed that 36 (8.6%) respondents never received any advisory messages, 14 (3.3%) has no idea of advisory services on crops. 27 (6.4%) respondents opined that the messages they receive are not useful and to another section of 12 (2.9%) respondents the messages were difficult to understand. Interestingly, 204 (48.4%) respondents opined that the messages are useful in selecting the crops to be grown. There were other responses as well (Table 27). The different types and diversified nature of responses suggest that the respondents are not sufficiently aware about the agrometeorological advisory services as well as the technical contents and usefulness of the advisory services.

Table 27: Benefits of agro-meteorological advisory services for the respondents

Responses of Farmers (Averaged over Locations)	Respondent Responded	
	N	%
No forecast received	36	8.6
No idea	14	3.3
Messages not useful	27	6.4
Difficult to understand messages	12	2.9
Useful for choosing crops to be grown	204	48.4
Useful in choosing appropriate crop variety	24	5.7
Useful in protecting seedlings from cold	20	4.8
Get advisory on what crop to be grown in what weather	5	1.2
Can be aware on special cares in crop production	29	6.9
Can use fertilizer and pesticide judiciously	6	1.4
Helpful in early harvesting and storing of crop	39	9.3
Can stop transplantation of seedling in case of rain forecast	5	1.2
Total	**421**	**100**

4.3.6 Status of receipt of Agro-meteorological Advisory Services by the Respondents

Farmers receive agrometeorological advisory messages from DAE and other sources. It was reported that the average number of respondents receiving messages ranged from 7.73 to 24.0 at different locations. Similarly, the percent respondents receiving messages ranged from 19.77 to 60.23. The average number of extreme weather events mentioned by the respondents ranged from 6 to 21 at different locations (Fig. 4).

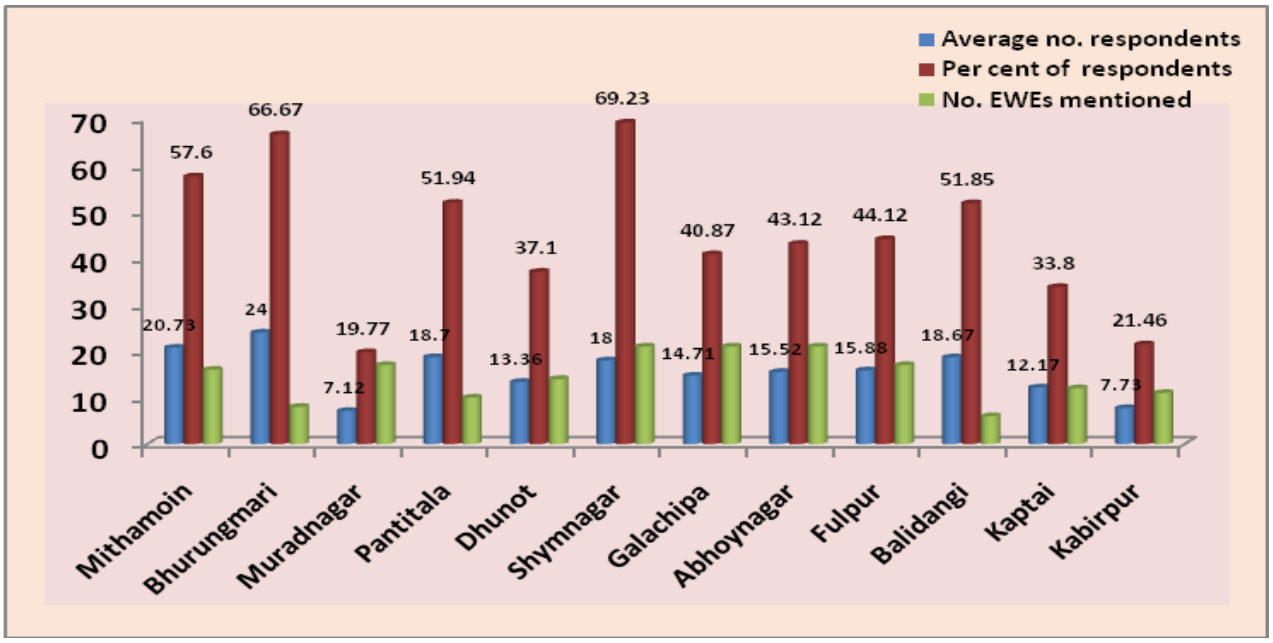


Fig.4. Receipt of Weather Advisory Messages by the Respondents

4.3.7 Types and Sources of Agrometeorological Advisory Messages Received

Although there are a good number of harmful weather events, the forecasts and relevant advisory messages of all these events are often not received by the farmers. The forecasts often received are concerned with major EWEs that may have devastating impacts on crops, life and livelihood. The major weather events forecasted include Drought, Cold Wave, Hailstorm, Nor'wester, Thunder Storm, Cyclone, Depression, Floods, Soil/River Bank Erosion, Prolong rainy days, Storm Surge, Land Slide, etc. Farmers receive these forecast and occasionally advisory messages from DAE, BMD, Local Administration (DC/UNO) and NGO workers (Table 28). It may be observed that DAE serves as an important source of Agrometeorological Forecasts and Advisory Messages.

Table 28: Types and Sources of Agrometeorological Advisory Messages Received

Name of events forecasted	Source of Message			
	DAE	BMD	Local Administration	NGO/ Others
Drought	61.6	33.3	0.8	4.3
Cold Wave	55.9	41.5	0.6	2.1
Prolong Fogy Days	56.4	40.7	0.8	2.1
Hailstorm	45.5	48.9	3.4	2.2
Nor'wester	44.0	52.0	3.0	1.0
Thunder Storm	33.5	59.6	5.7	1.3
Cyclone	29.6	65.2	4.8	0.4
Depression	28.0	64.8	1.7	5.5

Name of events forecasted	Source of Message			
	DAE	BMD	Local Administration	NGO/ Others
Early Flood	46.2	38.2	8.1	7.5
Late Flood	43.2	37.3	7.6	11.9
Soil/River Bank Erosion	30.4	41.1	7.1	21.4
Prolong rainy days	40.5	35.0	9.2	15.3
Storm Surge	46.7	34.2	12.5	6.7
Land Slide	44.9	34.6	7.1	13.4

4.3.8 Means of Receiving Agrometeorological Forecasts and Advisory Messages

According to farmers' responses, it is evident that the major means of receiving Agrometeorological Forecasts and Advisory Messages are SAAOs of DAE, television, radio, mobile phone, neighbor, newspaper and NGO workers. However, television and radio appears to be the most important means of receiving agrometeorological forecasts and advisory messages (Table 29).

Table 29: Means of Receiving Agrometeorological Forecasts and Advisory Messages

Name of events forecasted	Percent of Respondents reporting						
	DAE SAAOs	Television	Radio	Mobile phone	Neighbor	News paper	NGO Worker
Drought	37.9	45.7	8.1	4.3	3.6	0.2	
Cold Wave	24.6	53.8	13.5	4.3	2.7	0.8	
Prolong Fogy Days	14.8	62.4	12.4	4.0	6.0	0.4	
Hailstorm	27.9	48.4	12.8	5.4	4.9	0.5	
Nor-wester	25.9	48.0	15.9	5.5	3.8	0.4	
Thunder Storm	5.1	61.1	23.1	6.0	2.6	0.4	1.3
Cyclone	2.9	57.3	29.7	5.0	3.8		1.3
Depression	2.5	57.8	27.0	2.5	8.4	1.7	
Early Flood	25.3	37.9	19.8	5.5	9.9	1.6	
Late Flood	6.7	45.0	20.8	3.3	16.7	7.5	
Soil/River Bank Erosion	6.3	35.1	19.8	7.2	24.3	3.6	3.6
Prolong rainy days	9.1	50.6	17.7	3.0	12.8	4.3	2.4
Storm Surge	3.3	61.7	25.0	5.0	0.8	3.3	0.8
Land Slide	3.9	65.6	16.4	3.1	10.2	0.8	

4.3.9 Usefulness of Agrometeorological Messages to the Respondents

Similar to rreceipt of Weather Advisory Messages by the Respondents, 7.45 to 24.9 number of respondents considered that the messages were useful. That is, it was useful to 20.63 to 66.67 percent respondents. The number of useful EWEs mentioned by respondents ranged from 6-21 (Fig. 5)

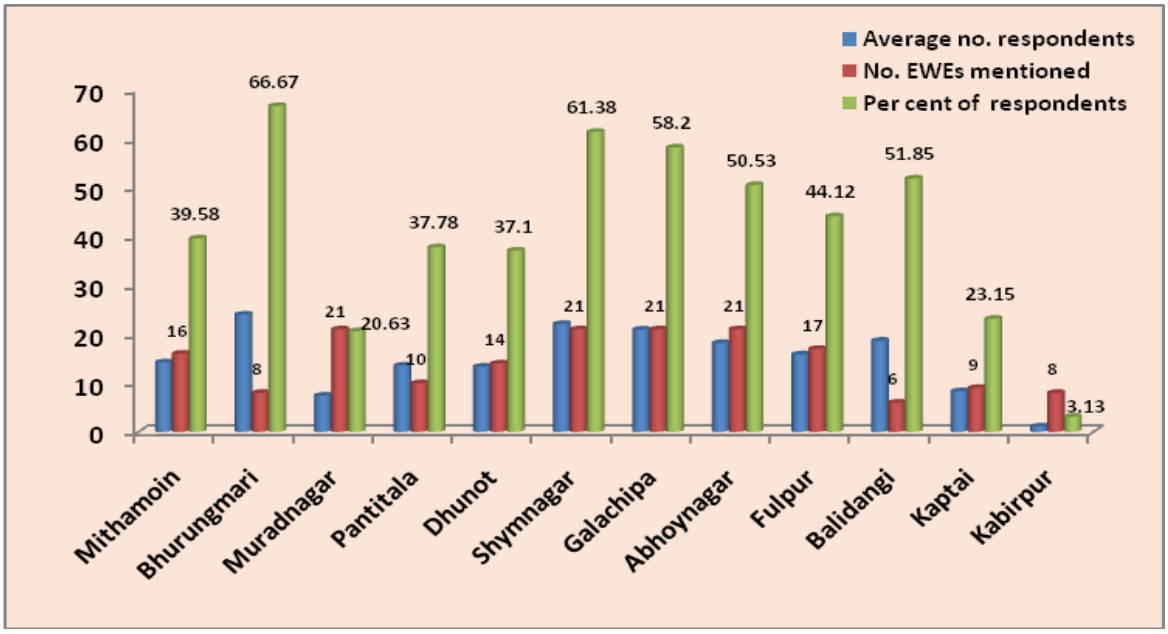


Fig.5. Usefulness of messages to the farmers

4.3.10 Mechanism of Crop Damage by Important Environmental Events

The nature and mechanism of crop damage by important EWEs are different on different crops and cropping seasons. They affect crops in different ways such as failure of seed germination, physical damage, breaking, lodging and uprooting crop plants, total crop damage in many different ways including flooding and submergence, causing disease outbreaks, favoring insect pest and weed infestation, grain shattering, fruit dropping, product quality degradation, and so on. However, the nature and extent of crop damage by different EWEs may vary widely from location to location and year to year depending on their occurrences and severity. Farmers' responses on nature and mechanism of crop damage by important Environmental Events on cereal crops is given in Table 25.

4.3.10.1 Mechanism of damage in major cereal crops

It has been reported by the respondents that the major cereal crops such as Boro Rice, Aus Rice, T.Aman Rice, B. Aman Rice, Wheat and Maize is affected by environmental events through germination failure, restricted growth, breaking and lodging, disease outbreak, insect pest infestation, grain shattering and quality degradation of the grains. The extent of damage is most severe due to germination failure probably due to lack of adequate soil moisture at seed sowing or excessive moisture causing seed borne diseases; restricted growth, probably related with drought, breaking or lodging of plants due to high wind and nor'wester as well as thunderstorm. Increased disease and insect pest infestation favored by weather conditions also cause considerable damage to different cereal crops at different degrees (Table 30).

Table 30: Mechanism of damage in major cereal crops as affected by important weather events

Name of crop	Percent Respondents (Who Responded)						
	Germination failure	Growth Restricted	Breaking/ lodging	Disease outbreak	Insect Pest infestation	Grain Shattering	Quality degradation
Boro Rice	16.0	21.4	19.6	19.2	7.1	5.0	8.5
Aus Rice	13.3	26.7	33.3	6.7	13.3	6.7	13.3
T.Aman Rice	19.0	20.9	25.6	10.4	14.7	1.9	3.8
B. Aman Rice	4.4	26.7	40.0	11.1	6.6	2.2	8.9
Wheat	28.1	22.8	26.3	10.5	-	11.3	3.5
Maize	8.3	30.0	45.0	8.3	1.7	3.3	1.7

4.3.10.2 Mechanism of damage in major oilseed, pulse and spice crops

Important oilseed, pulse and spice crops affected, as reported were Mustard, Lentil, Grass pea, Mungbean, Chili and Coriander. These crops are also affected in more or less similar manner as that of cereal crops discussed above. However, these crops are more severely affected through restricted growth, probably due to prolong drought. It may be mentioned that these crops are grown in the rabi (dry) season under rain-fed/non-irrigated conditions. Disease outbreak, weed infestation and quality degradation also cause considerable damage to these crops (Table 31).

Table 31: Mechanism of damage in major oilseed, pulse and spice crops as affected by important weather events

Name of crop	Percent Respondents (Who Responded)							
	Germination failure	Growth Restricted	Breaking/ lodging	Disease outbreak	Insect Pest Infestation	Weed infestation	Grain Shattering	Quality degradation
Mustard	13.9	30.6	-	5.6	2.8	-	11.1	8.3
Lentil	38.7	38.7	-	9.7	-	6.5	-	-
Grass pea	30.4	34.8	-	21.7	4.3	-	-	4.3
Mungbean	4.5	36.4	-	4.5	-	9.1	-	18.2
Chili	12.8	41.0	15.4	7.7	-	5.1	-	2.6
Coriander	-	40.0	-	-	20.0	20.0	-	-

4.3.10.3 Mechanism of damage in potato and major vegetables

A large number of vegetables and potato suffers considerable damage due to various weather events through germination failure, physical damage, restricted growth as well as disease and insect pest outbreak. However, the physical damage, mostly associated with nor'wester and thunderstorm, as well as restricted growth and disease and insect pest infestation are the major means of crop loses (Table 32).

Table 32: Mechanism of damage in potato and major vegetables as affected by important weather events

Name of crop	Percent Respondents (Who Responded)				
	Germination failure	Physical Damage	Growth Restricted	Disease outbreak	Insect Pest infestation
Potato	28.6	28.6	-	28.6	7.1
Brinjal	7.1	14.3	42.9	28.6	28.6
Tomato	-	11.1	33.3	55.6	-
Cauliflower	-	33.3	-	66.7	14.3
Sweet gourd	14.3		71.4	-	14.3
Bottle gourd	16.7	33.3	33.3	16.7	11.1
Pointed Gourd	-	20.0	-	40.0	-
Country bean	7.1		75.0	25.0	33.3
Indian Spinach	14.3	28.6	57.1	-	14.3

4.3.10.4 Mechanism of damage in fruit and other crops

The major fruit crops subjected to damages due to adverse weather conditions, as reported, are Watermelon, Papaya, Banana, Litchi and Mango. These crops are vulnerable to damages due to breaking of trees and branches and fruit drops due to hailstorms and nor'wester. Crops like banana and mango also affected by diseases at different degrees (Table 33).

Table 33: Mechanism of damage in fruit and other crops as affected by important weather event

Name of crop	Percent Respondents (Who Responded)					
	Germination failure	Physical Damage	Breaking/ lodging	Complete damage	Disease outbreak	Fruit Drop/Rot
Watermelon	-	33.3	-	33.3	-	33.3
Papaya	-	33.3	50.0	25.0	-	25.0
Banana	-	27.3	45.5	18.2	9.1	-
Litchi	-	7.1	16.7	33.3	-	50.0
Mango	-	7.1	18.2	18.2	9.1	54.5
Jute	23.3	20.0	56.7	-	18.2	-

4.3.11 Status of Farmers Knowledge and Skills to Benefit from Available AMASs in crop production

Farmers' responses on the knowledge and skills for utilizing available agromet services are summarized in Table 10. It was observed that out of 517 responses, 368 (71.2%) respondents opined that they do not have any idea about available agrometeorological services (Table 34).

Table 34: Knowledge and skills farmers to benefit from available agro-met services

Responses of farmers averaged over locations	Respondent Responded	
	N	%
No idea about it	368	71.2
Technical knowledge	60	11.6
Knowledge on what to do during bad weather	50	9.7
Advisory on what crops to be grown in what season	39	7.5
Total	**517**	**100**

4.3.12 Knowledge and skills Needed by the Respondents to Benefit from Agrometeorological Advisory Services in crop production

The respondents were asked about the specific knowledge and skills they need to be able to benefit from available Agrometeorological Advisory Services in crop production. In response they mentioned that they have the need of knowledge and skills in seed preservation, fertilizer application, pest control etc.; technical knowhow of crop production; knowledge on what to do during bad weather, knowledge on crop and season specific advisories; and techniques on preparation of organic manures (Table 35). However, it seems that there is a need for the farmers to understand about the extreme or abnormal weather events occurring in different cropping seasons and their consequences on crop performance and productivity. At the same time, there is a need to understand the means to cope up with abnormal weather events to minimize crop losses wherever possible.

Table 35: Knowledge and skills needed by the respondents to benefit from available Agrometeorological Advisory Services in crop production

Location	Seed preservation, fertilizer application, pest control etc.	Technical knowhow of crop production	Knowledge on what to do during bad weather	Knowledge on crop and season specific advisories	Techniques on preparation of organic manures
Mithamoin	54.2	18.8	6.3	18.8	2.1
Bhurungamari	94.6	5.4	0	0	0
Murad Nagar	82.9	7.3	7.3	2.4	0
Patnitala (Nazipur)	43.9	29.3	9.8	7.3	9.8
Dhunot	100	0	0	0	0
Shyamnagar	100	0	0	0	0
Galachipa	97.3	2.7	0	0	0
Abhaynagar	94.6	0	0	0	0
Fulpur	48	2	40	10	0
Baliadangi	61.9	23.8	2.4	9.5	2.4
Kaptai	35.5	19.4	30.6	12.9	0
Kabirhat	60	20	0	18	2

4.3.13 Respondents' Perceived Training Needs

In response to the question on the subject matter of the training needed by the farmers to understand and utilize the agrometeorological advisory services, about 399 proposed training on coping mechanism from weather calamities, 256 respondents proposed training to enable them to understand natural calamities and 180 respondents proposed for training on technical aspects of agrometeorological advisory service. However, 18 respondents had no opinion (Table 36).

Table 36: Subject matter areas of training as suggested by farmers

Responses of farmers averaged over locations	Number(N) responded
Coping mechanism with calamities	399
Understanding natural calamities	260
Technical aspects of Agro meteorological advisory service	180
Selection of appropriate crops and varieties in different seasons to avoid/minimize crop loss	8
Insect pest and disease outbreak in relation to different extreme weather events and their management.	5
Don't know	18

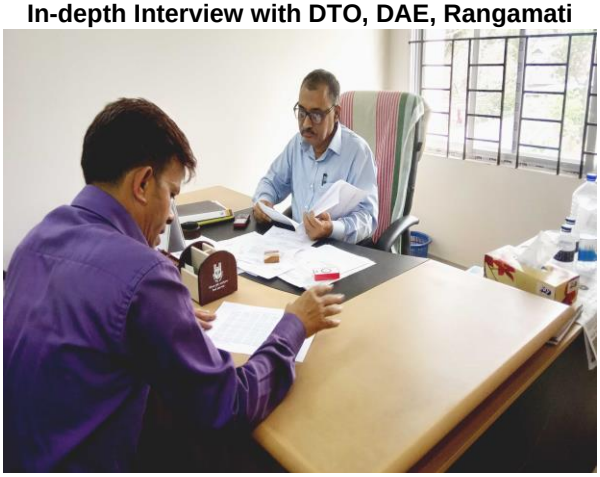
4.4 In-depth Interview of District Training Officers of Selected Districts

In-depth interviewing is a qualitative research technique that involves conducting intensive individual interviews with a small number of respondents to explore their perspectives on a particular idea, program, or situation. In the context of the present assignment, the in-depth interviews of 28 District Training Officers (DTOs) of selected districts were carried out to understand the existing status of agrometeorological information and advisory service delivery from the district down to the farmers. The study also attempted to identify important weather events causing crop damage. It also included identification of critical training needs of DAE officers from the district down through the ranks to the SAAOs and farmers to streamline and improve the agrometeorological information and advisory services delivery. The major finding of the study is presented below:

In-depth Interview with DTO, DAE, Naogaon

In-depth Interview with DTO, DAE, Rangamati

In-depth Interview with DTO, DAE, Joypurhat



In-depth Interview with DTO, DAE, Sylhet

4.4.1 Important EWEs Affecting Major Crops in Different Locations

The study revealed that a large number of weather events cause significant damages to a large number of crops. These weather events, as reported include drought, cold waves, prolong fogy days, warm period in winter, nor'wester & hailstorms, cyclone, heat waves, floods, prolong cloudy period, sudden heavy rain, prolong rainy days, and soil salinity. Major crops affected are Boro, T. Aman and B. Aman rice, wheat, maize, mustard, chickpea, lentil, mung bean, onion, garlic, chilli, cabbage, cauliflower, bitter gourd, bottle gourd, potato, tomato, Brinjal, watermelon, mango, litchi, banana, papaya, and guava. Percent respondent (N=28) reporting damages in different crops by various weather events is given in Table 37.

Table 37: Important weather events causing crop damage at different locations

Name of Crop	Important EWEs Causing Crop Damage (Percent Respondents Reporting)					
	Drought	Cold Wave	Prolong Fogy Days	Warm Period in Winter	Nor'wester & Hailstorm	Cyclone
Boro Rice	10.7	82.1	75.0	0.0	82.1	10.7
T. Aman Rice	64.3	0.0	0.0	0.0	0.0	10.7
B. Aman Rice	50.0	0.0	0.0	0.0	0.0	7.1
Wheat	53.6	25.0	28.6	71.4	14.3	10.7
Maize	71.4	32.1	21.4	10.7	67.9	25.0
Mustard	57.1	25.0	32.1	25.0	0.0	0.0
Chickpea	10.7	7.1	7.1	25.0	0.0	0.0
Lentil	50.0	14.3	32.1	60.7	0.0	0.0
Mung bean	21.4	0.0	7.1	0.0	17.9	7.1

Name of Crop	Important EWEs Causing Crop Damage (Percent Respondents Reporting)					
	Drought	Cold Wave	Prolong Fogy Days	Warm Period in Winter	Nor'wester & Hailstorm	Cyclone
Onion	10.7	25.0	17.9	10.7	7.1	0.0
Garlic	25.0	21.4	21.4	14.3	10.7	0.0
Chili	17.9	25.0	21.4	25.0	46.4	17.9
Cabbage	17.9	17.9	10.7	10.7	0.0	0.0
Cauliflower	10.7	39.3	21.4	17.9	0.0	0.0
Bitter gourd	21.4	0.0	0.0	0.0	60.7	17.9
Bottle gourd	25.0	32.1	25.0	14.3	42.9	21.4
Potato	32.1	57.1	50.0	53.6	0.0	0.0
Tomato	25.0	71.4	42.9	42.9	0.0	0.0
Brinjal	21.4	14.3	10.7	0.0	32.1	17.9
Watermelon	7.1	17.9	14.3	10.7	17.9	7.1
Mango	25.0	17.9	25.0	10.7	82.1	10.7
Litchi	21.4	7.1	14.3	0.0	28.6	0.0
Banana	10.7	0.0	0.0	0.0	35.7	10.7
Papaya	21.4	0.0	7.1	0.0	25.0	7.1
Guava	7.1	0.0	0.0	0.0	17.9	3.6

Table 37: Contd.

Name of Crop	Important EWEs Causing Crop Damage (Percent Respondents Reporting)					
	Heat Wave	Flood	Prolong Cloudy Period	Sudden Heavy Rain	Prolong Rainy Days	Soil Salinity
Boro Rice	0.0	75.0	0.0	21.4	32.1	10.7
T. Aman Rice	0.0	50.0	0.0	32.1	14.3	7.1
B. Aman Rice	7.1	39.3	0.0	21.4	14.3	0.0
Wheat	0.0	0.0	28.6	60.7	46.4	10.7
Maize	25.0	0.0	14.3	42.9	35.7	10.7
Mustard	0.0	0.0	14.3	85.7	85.7	7.1
Chickpea	0.0	0.0	10.7	25.0	25.0	0.0
Lentil	0.0	0.0	17.9	82.1	82.1	10.7
Mung bean	17.9	0.0	14.3	64.3	50.0	7.1
Onion	0.0	0.0	25.0	67.9	75.0	10.7
Garlic	0.0	0.0	28.6	60.7	64.3	10.7
Chili	17.9	0.0	14.3	46.4	57.1	7.1
Cabbage	0.0	0.0	14.3	32.1	17.9	7.1
Cauliflower	0.0	0.0	32.1	39.3	25.0	10.7
Bitter gourd	10.7	7.1	10.7	25.0	17.9	7.1
Bottle gourd	14.3	0.0	17.9	10.7	14.3	10.7
Potato	0.0	0.0	64.3	78.6	53.6	7.1
Tomato	0.0	0.0	53.6	57.1	71.4	10.7
Brinjal	7.1	0.0	21.4	28.6	42.9	7.1
Watermelon	17.9	0.0	25.0	35.7	57.1	3.6
Mango	32.1	0.0	46.4	0.0	25.0	0.0
Litchi	25.0	0.0	17.9	0.0	17.9	0.0
Banana	0.0	0.0	0.0	0.0	0.0	0.0
Papaya	0.0	0.0	0.0	0.0	25.0	0.0
Guava	0.0	0.0	0.0	0.0	17.9	0.0

It may be mentioned that cyclone and storm surge causes considerable damage to Boro, T. Aman and B. Aman rice in coastal areas.

4.4.2 Sources of Agrometeorological Information

In the present context, the sourcing and utilization of agrometeorological data and information is one of the major responsibility of the Office of Deputy Director of Agriculture Extension (DDAE) under the leadership and supervision of District Training Officer (DTO). The major sources of agrometeorological information, as reported by DTOs are DAE Headquarter (AMISDP), Bangladesh Meteorological Department (BMD), Mass media, internet and local messages as opined by 60.71, 50.0, 53.57, 28.57 and 3.57 percent of the respondents respectively (Fig. 6).

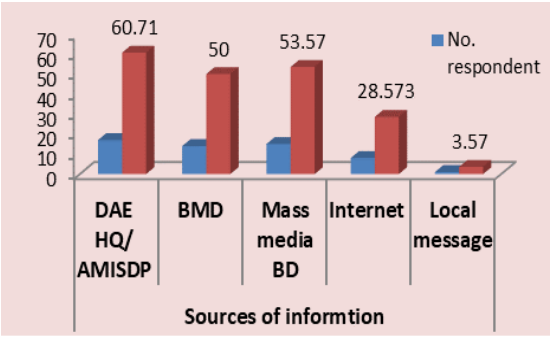


Fig. 6. Sources of Agrometeorological Information

4.4.3 Status of Using Agrometeorological Information

Preparation of agrometeorological advisory messages for dissemination to the farmers is another important responsibility of DDAE offices of DAE. It may be mentioned that development of good quality agrometeorological advisory messages needs using quality and up-to-date agrometeorological information. About 86 percent respondents reported that they are using up-to-date data and information from the sources mentioned above and shown in Fig. 7.

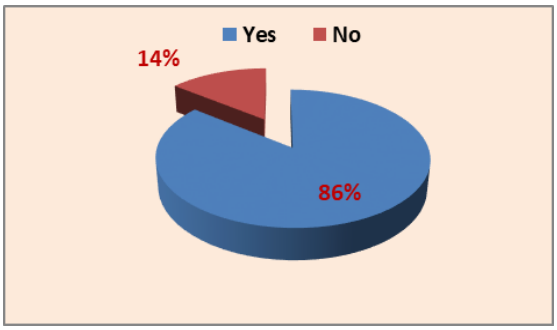


Fig. 7. Use of Agro-met data for preparation message

4.4.4 Adequacy of Agrometeorological Services

The respondents were asked if the Agrometeorological Services presently provided to the clients is adequate. About 89 percent of the respondents opined that the present level of Agrometeorological Services is not adequate and up to the mark. While only 11 percent of the respondent feels the preset services is adequate to meet the requirement of the target beneficiaries (Fig. 8).

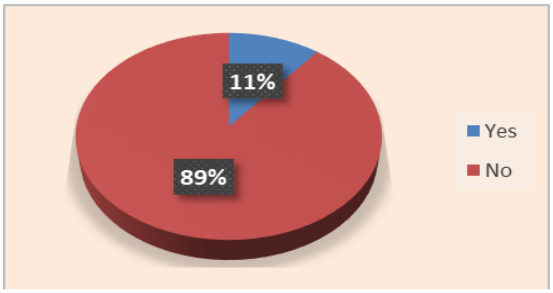


Fig. 8. Agrometeorological service adequacy

4.4.5 Means of Improving Agrometeorological Advisory Services

As discussed above, most of the DTOs considers that the present level of Agrometeorological Advisory Services provided by the DAE is not adequate. The respondents suggested a good number of measures to improve the AMASs. These included accurate messaging, staff and farmer training, local messaging by DAE, linking resources, ICT based equipment and skill, farmers' awareness, informing in advance, local TV bulletin and public awareness. Percent respondents suggesting are 25.0, 60.71, 32.14, 3.57, 53.57, 3.57, 7.35, 7.14 and 10.71,

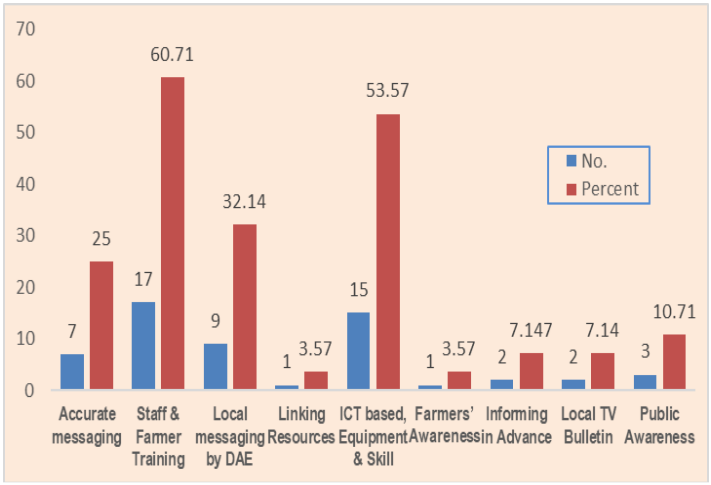


Fig. 9. Means of Improving Advisory Services

repectively. It becomes apparent that starting AMISDP activities, ICT based equipment support and local massaging would be the most important means for improving the present state of Agro-meteorological Advisory Services (Fig. 9).

4.4.6 Status of Development of Agrometeorological Advisory Messages

Development of appropriate advisory messages is a precondition of good quality Agrometeorological Advisory Services. It was reported that about 67.86 percent messages are developed at DAE Headquarters and BMD while only 35.71 percent advisory messages are developed locally by the DDAE offices. This implies that there is an urgent need to develop capacity of DAE district offices to source quality agrometeriorological information, analyze them and develop appropriate, localized advisory messages for dissemination at appropriate times.

4.4.7 Need for Coordination and Cooperation among Stakeholders

It has been felt that strong coordination and cooperation among the relevant stakeholders is needed for the development of an effective AMIS. The major means/areas of coordination and cooperation as identified are Central Coordination (64.29%), Data Sharing (25.0%), executing Memorandum of Understanding among stakeholders (7.24%), organizing workshops (3.7%) and Government directives (3.57%). It is important to note that while cooperation and coordination ensures better utilization of resources, there is no alternative to capacity building of concerned DAE personnel and networking with relevant stakeholders (Fig. 10).

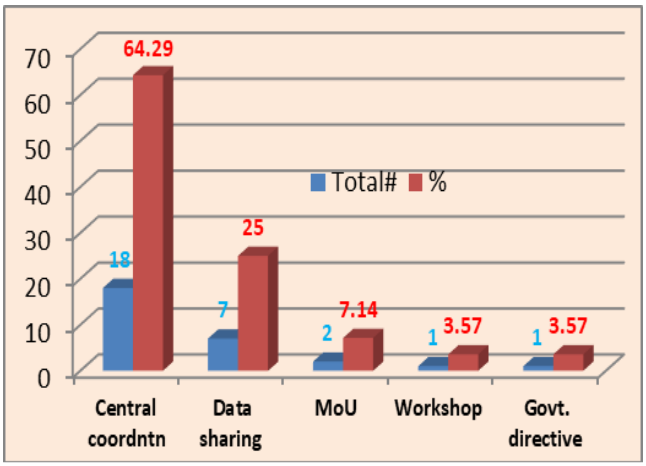


Fig. 10. Coordination and cooperation among stakeholders

4.4.8 Status of Using Media in Dissemination of Agrometeorological Advisory Messages

To benefit the target clients, it is essential to disseminate advisory messages at appropriate times through proper media so that the messages reach the target farmers at appropriate times to better utilize the messages to their benefit. The opinion on current dissemination media is presented in Table 38.

Table 38: Suggested media for dissemination

Media	% Respondents
Mobile Phone	96.43%
Leaflets	42.86%
Verbal	21.41%
Mass Media	10.71%
Miking	10.71%

4.4.9 Method Used for Disseminating Agrometeorological Advisory Services

As reported by the respondents, presently used methods of disseminating agrometeorological advisory services include individual contact, group meeting, field visit, field days, shared in other training and public circulation. This was reported by 89.29, 82.14, 3.57, 3.57, 3.57 and 3.57 percents, respectively. It may be noted that as of now, individual contact and group meeting appear to be the main means of disseminating messages, both of which are cumbersome and time-consuming processes. Thus, there is a need to modernize the dissemination process by using modern means of communication.

4.4.10 Status of Staff Capacity for AMI Services

Only 10.71% of respondents reported that the present capacity of DAE staff for AMI services is adequate. Nonetheless, vast majority of 89.29% of respondents opined the present staff capacity is inadequate to provide a satisfactory agrometeorological advisory service to the clients. In fact, it was reported that there are deficiencies right from sourcing up to date agrometeorological information, data processing and message developing capacity at district offices of DAE.

4.4.11 Training Needs of DAE Personnel to Provide Satisfactory Agrometeorological Services

To be able to provide satisfactory agrometeorological advisory services, the respondents confirmed that, there is no alternative to build capacity of concerned DAE personnel through appropriate training. The major areas of training suggested by the respondents were (i) extreme weather events and their effects on crops, (ii) digitalizing AMIS, (iii) technologies and techniques of mitigating/managing the impacts of various EWEs, (iv) sourcing and processing of agrometeorological data, (v) developing appropriate advisory messages, (vi) means and methods of disseminating AMIS, (vii) training for development of trainers.

4.4.12 Timeliness of AMIS Messages

About 82.14% of the respondents considered that the AMISs are not delivered on time for one reason or another. It appears that the staff capacity for timely development and delivery of messages need to be improved through appropriate training of DAE personnel as well as modern dissemination technologies such as ICT, mobile apps, internet, etc.

4.4.13 Factors Hindering Timeliness of Delivery of AMIS Messages

About 32.14% of respondents consider that the messages are sent late while 46.43, 42.86, 10.71 and 14.29 percent of respondents consider that lack of skills, weak networking/lack of digitalization, weak transport and lack of manpower respectively are major hindrances for the timely delivery of agrometeorological service messages. This implies that skill development, strong networking, digitalized services and adequate manpower and transport facilities are essential for timely delivery of AMIS messages.

4.4.14 Suggested Dissemination Mechanisms to Improve Service Delivery

To be able to benefit from agrometeorological services of the DAE, the dissemination mechanism should include, among others, text messaging, television bulletins, short leaflets and in urgent cases, announcements over loudspeakers at public places/gatherings. These techniques may be very useful in case of anticipated severe consequences of likely extreme environmental events.

4.4.15 Suggested Means for Farmers' Capacity Building

Unless farmers' capacity is developed in understanding and utilizing the agrometeorological messages, the benefits of agrometeorological services are hard to realize. To develop farmers' capacity, 92.86% of respondents consider farmers' training on different aspects of EWEs and coping with their impacts to be of paramount importance. In addition, raising public awareness on EWEs and its impact on crop production and productivity as well as the importance of managing the impacts is considered important by 28.57% of respondents. Besides, workshop/group meeting, advice via voicemail, etc. are also suggested.

4.4.16 Areas of Training Suggested for Farmers

As part of farmers' capacity building to understand and utilize the agrometeorological messages and services, most of the respondents suggested for farmers' training on EWEs and management (89.29%), use of mobile apps (25%) and understanding and using the messages (42.86%).

4.4.17 Respondents' Recommendation for Improving Existing AMAS

The respondents made the following recommendations to improve DAE's agrometeorological advisory services:

(i) Imparting training to DAE personnel on Extreme Weather Events in terms of their occurrences and impacts on crop production and productivity;

(ii) Providing intensive capacity development training of DAE personnel on sourcing agrometeorological information, analysis and development of advisory messages;

(iii) Developing DAE's own AMIS system and operational manpower;

(iv) Providing adequate funding and logistic support;

(v) Authentic/accurate, inclusive and timely messaging;

(vi) Ensuring delivery of messages to farmer beneficiaries directly;

(vii) Delivering messages through user friendly means and methods;

(viii) Intensifying field level services of AMISDP and its institutionalization;

(ix) Developing and institutionalizing UP based AMAS delivery; and

(x) Providing training to the farmers for their capacity development to understand and utilize agrometeorological advisory messages

4.5 Key Informant Interview of Deputy Directors of Agriculture Extension of Selected Districts

Key Informant Interview (KII) is a type of qualitative in-depth interview. Here preconceived questions are forgone, instead focused on the dynamic flow of conversation between researcher and participant(s). The researchers would immerse themselves within a group, asking questions and conversing with individual subjects with the hope of uncovering key pieces of information. Key Informant Interviews are designed to explore a topic before digging for the details. Thus, it's often the first step: researching what needs to be researched.

Key informants are experts. Thus, researchers only use key informant interviews when they can secure a participant with unique knowledge of a topic. The Deputy Directors of Department of Agricultural Extension (DDAE) at the district levels of DAE are the administrators, decision makers and implementers of the AMAS activities for DAE. Thus, they are the key experts involved in the process of implementation of AMAS as well as finding the gaps between the needs and present level of knowledge, attitude and skills of DAE staff and farmers. Thus in all 28 selected districts' DDAEs were interviewed individually to find the areas needed to assess training needs of concerned officials and farmers. The salient findings are illustrated below:

KII with Deputy Director, DAE, Rangpur

KII with Deputy Director, DAE, Magura

KII with Deputy Director, DAE, Sylhet

KII with Deputy Director, DAE, Satkhira

4.5.1 The Sources of Information for AMAS

The sourcing of agrometeorological data and information relevant to farmers needs bears much importance as to be relied on and best utilize them to meet the field demands. It is one of the major responsibilities of the Office of the Deputy Director of Agricultural Extension (DDAE) done under the coordination of concerned Deputy Director. The major sources of agro-meteorological information reported by DDs are AMISDP, BMD, and mass media, covering 54, 25, and 11 percent, respectively (Fig. 11). Some other minor sources also used like social media and personal messages. Mass media includes TV channels, radio, newspapers, and social media such as mainly face book and other web based links.

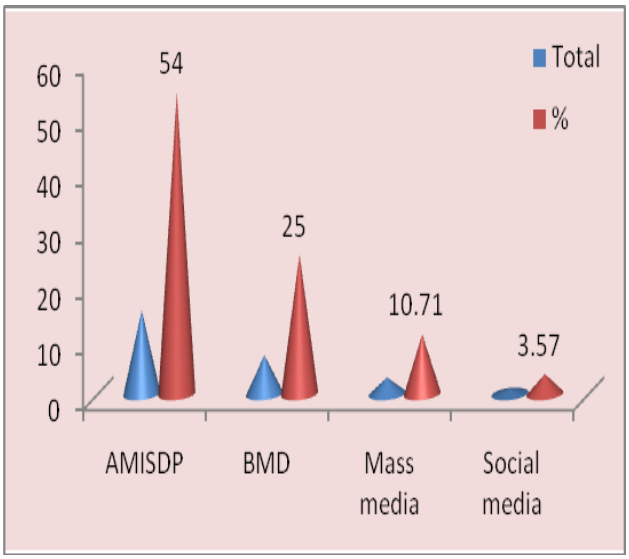


Fig. 11. Sources of Information for AMAS

4.5.2 Occurrences of Adverse/Extreme Weather Events over the Study Area

Though the extreme weather evens (EWEs) are many in number, the spreads are not common in each AEZs of the country. However, some are fairly common and some are much localized. The major EWEs faced by farmers as reported by DDAEs are sudden heavy rain, drought, flood, hailstorms, cold waves, prolonged foggy days, prolonged rainy days and nor'westers as opined by 19, 17, 17, 14, 13, 11, 7, and 6 percent of respondents, respectively (Fig. 12).

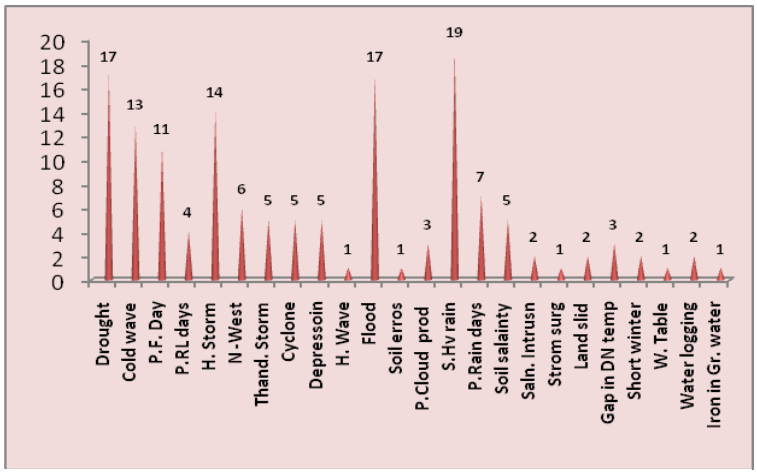


Fig. 12. Spread of EWEs over the study area

4.5.3 Crops Affected by EWEs in Rabi Season

Crop loss by adverse weather events/natural disasters is an issue of great concern in Bangladesh. Only flood damages about 4 percent crops of Boro rice, which is the major victim of climatic hazards. The most losses done by EWEs in Rabi season of current study is also Boro rice as reported by most of the respondents (93 %). The vegetable crops follow the Boro rice (75%), then pulses (43%) and oilseeds (39%). Other important losses done are in wheat (25%) and maize (21%) followed by spices (11%), condiments (11%) and watermelon (11%) as shown in Figure 13.

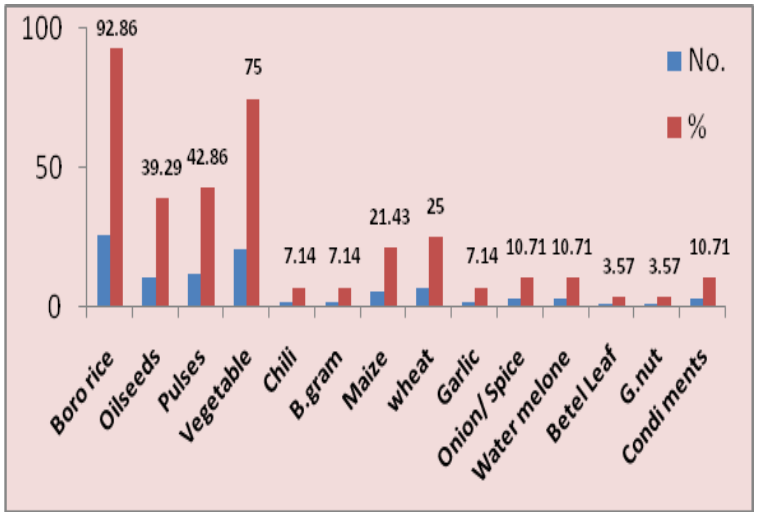


Fig. 13. Major crops affected by EWEs in Rabi season over the study area

4.5.4 Crops Affected by EWEs in Kharif-I Season

Among the Kharif-I (16 March 15 June) crops, T. Aus rice was reported to be most affected followed by vegetables, maize, jute, fruits, banana, mungbean, and papaya as responded by 64.29, 50.00, 25.00, 25.00, 25.00, 14.29, 14.29, and 10.71 percent of key informants, respectively (Fig.14). The damage is done mostly by drought, sudden heavy rain, hail storms and nor'wester as reported under section 3.5.2. The number of crops affected, was observed less than the Rabi season, probably due to relatively lower cropping diversity as compared to Rabi season.

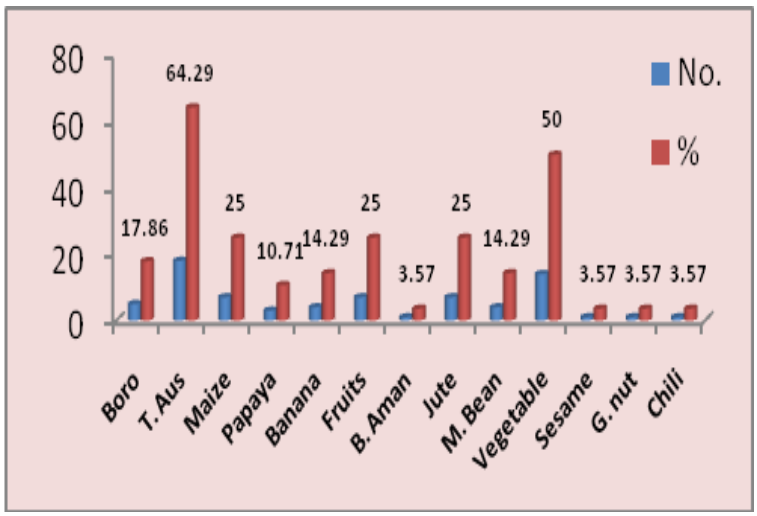


Fig. 14. Major crops affected by EWEs in K-I Season

4.5.5 Crops Affected by EWEs in Kharif-II Season

The number of crops affeted by EWEs in study area were found further lesser than other two seasons being less diviersification of crops in the season. Only four crops were mentioned by a good number of the respondents (Fig. 15). The most crop mentioned by respondents was T. Aman rice followed by vegetable,jute then fruits as opined by 69.29, 25.00, 14.29 and 10.71 percent respondents. The EWEs found responsible for these damages were floods, sudden heavy rain, and prolonged rainy days as found under section 3.5.2.

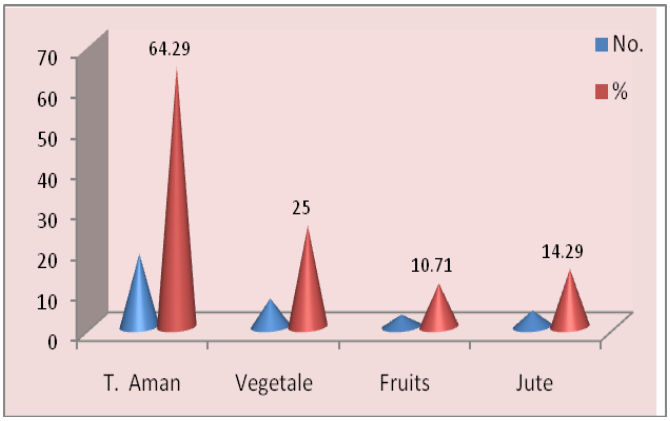


Fig.15. Crops affected by EWEs in K-II season

4.5.6 Channels used for Dissemination of Agrometeorological information (AMI)

Proper dissemination of information carries high importance to reap best benefit from it. The AMISDP needs to use the most effective channels to maximize the advantage from the system. The dissemination channels presently used, as reeported are mobile phones, personal communications, group sharing, leaflets, TV channels and miking as responded by 92.86, 53.57, 39.29, 32.14, 21.43 and 10.71 percent of the respondents, respectively. Other chalnnels, though presently under-used are FIAC center and input dealers responded by 7.14 and 3.57 percent of the respondents (Fig. 16). It seems that FIAC center and input dealers have high potential for effective dissemination of AMIS through equiping them with apprpriate information, skills, and equipment.

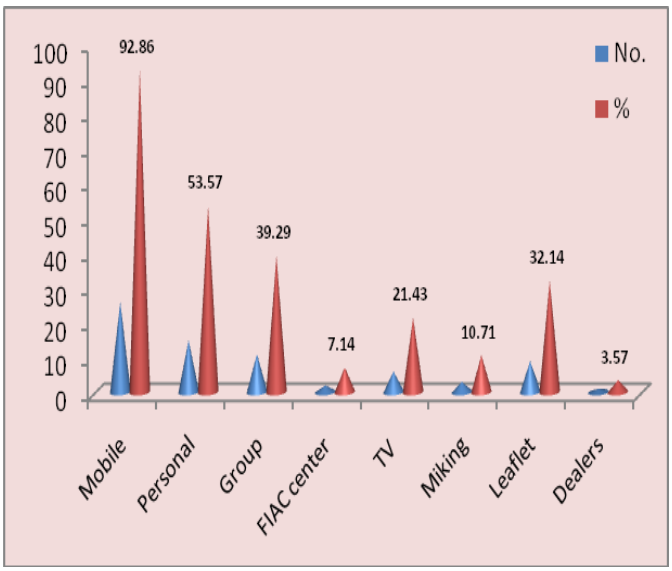


Fig.16. Present Channels of disseminating AMI

4.5.7 Main Contents of AMI Messages

The content of messages provided by DAE are still limited to two broad areas namely, forcasting of adverse/extreme weather events as and when arises, and the pre- and post event management of the events. The first one is opined by most respondents (82.14%) and the second one, management issues are still not well dealt as indicated by fewer number of respondents (25.00%) as shown in Fig.17. As AMSIDP is yet to start field operatin of its project activities, the contents are, seemingly limited to a few. This need to be strengthened according to needs of the client farmer groups.

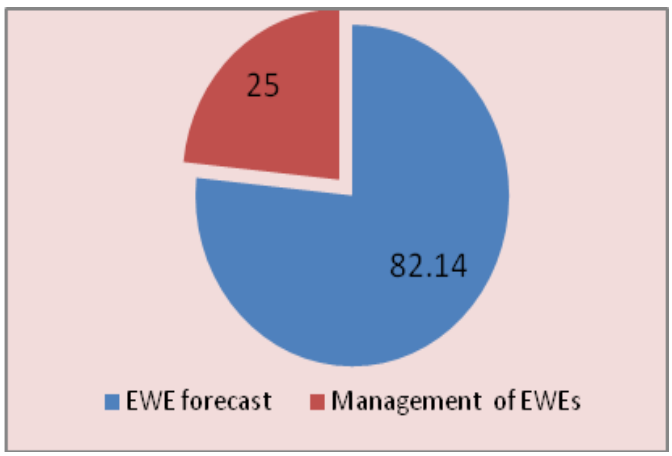


Fig.17. Main contents of AMAS messages

4.5.8 Adequacy of AMAS to Farmers

As mentioned in previus sections, the agrometeorological advisory services are not yet adequate as opined by the key informants. The vast majority of the respondents (89.29%) considers that the present level of services is inadequate in the context of the clients' needs and wide range of addressable issues (Fig.18). Few respondent's openion on the adequacy of present services might be due to lack in understanding on the quality and level of services need to be offered. Because full understanding of the detail of agrometeorological issues related to agriculture is yet to be developped through experience and appropriate training. Thus a big gap remains to be bridged to reach the desired level of service quality of DAE.

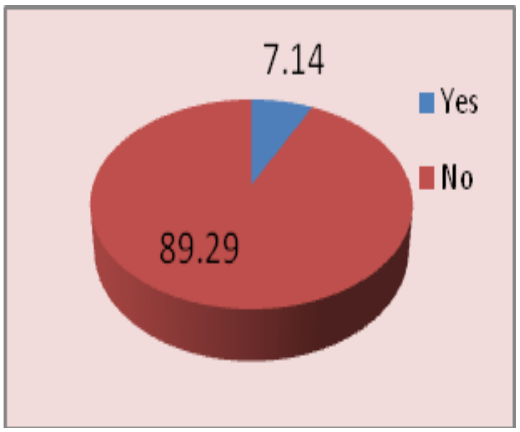


Fig.18. Adequacy of AMI Services to farmers

4.5.9 Reasons for Deficiencies in Present AMISs

When asked about the reasons for the statement that the AMAS was not adequate, the respondents identified at least five important reasons. The first one is non-inclusiveness of the messsages followed by lack of expertise in DAE, not being on time, lack in logistic support and not location specific- opined by 75.00, 46.43, 35.71, 32.14, 25.00 and 14.29 percent respondents, respectively. Among others are, lack in farmers awareness (10.71%), messages not sent directly to farmers (3.57%), and less organized messaging system (3.57%). The responses are summerized in Table 39.

Table 39: Causes of the services not being adequate

Suggestions made	Number of Key informants opined	Percent of respondents
DAE lack expertise	13	46.43
Non-inclusive messages	21	75.00
Lack authenticity of messages	7	25.00
Not location based	4	14.29
Lack timeliness	10	35.71
Farmers' are not aware	3	10.71
Lack logistic support	9	32.14
Messages not directly to farmers	1	03.57
Disorganized system	1	03.57

4.5.10 Measures to Improve AMAS

The experienced respondents suggested several means to improve and upgrade the the present level of AMAS. The suggestions made was to train DAE personnel through the different ranks, operatinalizing digital messaging system, providing adequate logistic support, farmers' training for awareness building and capacity development, need based messaging, public awareness building, direct messaging to farmers from DAE HQ and districts, user friendly messages, and linking stakeholders as opined by 85.71, 71.43, 50.00, 39.29, 28.57, 25.00, 17.86, 10.71, 10.71 percent informers, respectively (Table 40).

Table 40: Suggested measures to fill up the gaps in AMAS

Suggestions made	Number of Key informants opined	Percent of respondents
Inclusive messaging	8	28.57
Messages are user friendly	3	10.71
Train DAE field staff	24	85.71
Train farmers	11	39.29
Digital messaging	20	71.43
Improving logistic support	14	50.00
Involve public representative	3	10.71
Involve input dealers	1	03.57
Direct messaging from HQ to fields	5	17.86
Massive public awareness	7	25.00
Upozila based messaging	2	07.14
Linking stakeholders	3	10.71
Technology to mitigate EWEs	1	03.57

4.5.11 Areas of Training and Communication forDdistrict Level Officials

After revealing of the need for training to DAE staff, the interviewees were asked about the types of training needed at different levels. They suggested five important areas i.e. knowledge on details of EWEs, skill training in digital messaging system, orgnizing localized messaging system, climate smart agriculture and on linking process with the relevant stakeholders for district level officials (Fig.19).

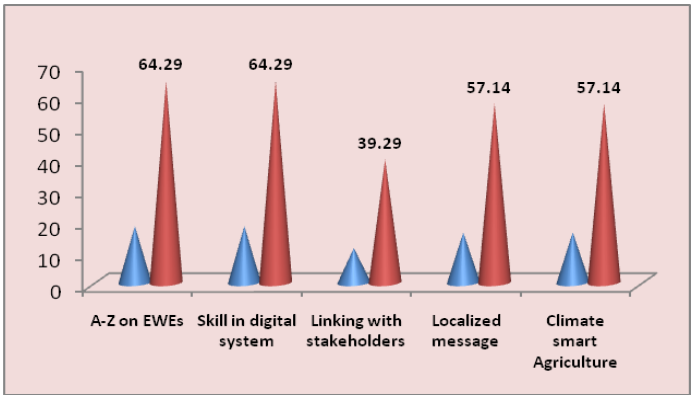


Fig.19. Area of training at District level

4.5.12 Areas of Training for Upazila Level Officials

The areas of training for Upazila level officials were suggested to be skill in digital messaging system followed by practical oriented training on EWEs, developing localized messaging and climate smart agriculture as was with district officials except linking stakeholders (Fig. 20). These were opined by 89.29, 71.43, 67.86 and 42.86 percent of respondents, respectively.

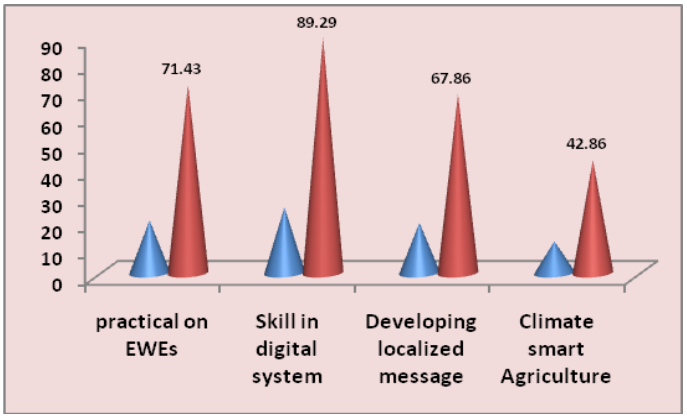


Fig.20.Areas of training for Upazila level officials

4.5.13 Areas of Training at Block Level Officers

According to the understandings of Deputy Directors, the Sub-Assistant Agriculture Officers (SAAOs) need training in understanding messages, smart delivery system of agrometeorologicat advises, operating digital and other relevant equipment including smart cell phones, and managing effects of adverse/ extreme weather effects on the crops and properties of the client farmers. The first two were emphasized by 85.71 percent respondents each, the third and fourth areas were suggested by 46.4 and 14.29 percent respondents, respectively (Fig. 21).

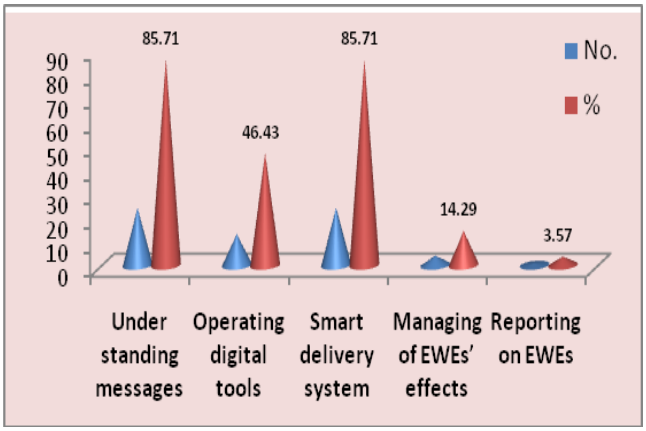


Fig. 21. .Areas of training at Block level officers

4.6 Focus Group Discussion with Sub-Assistant Agriculture Officers (SAAOs)

A focus group discussion (FGD) is an effective means to gather together people from similar backgrounds or experiences to discuss specific topics of interest. It is one of the most common methods of qualitative data/information collection. The FGD uses group dynamics where issues of interest are raised and discussed about participants' perceptions, attitudes, beliefs, opinion or ideas on the issues. In the context of the present assignment, the FGDs were carried out with the SAAOs of DAE in 12 hotspots under different agro-ecological regions as detailed in section 4.1. The main findings of the study are stated below:

Focus Group Discussion of SAAOs Dhunot

Focus Group Discussion of SAAOs Mithamoin

Focus Group Discussion of SAAOs Baliadangi

Focus Group Discussion of SAAOs Kaptai

4.6.1 Personal Awareness on the System of AMI Services

Most of the participating SAAOs (75%) feel they are aware of present agro-meteorological advisory services provided by DAE. Elaborate discussion on the issue revealed that though the majority of the participants are apparently aware of agro-meteorological advisory services of DAE, it seemed that they are yet to be fully clear about the entire process and services. Another 16.76 percent of the participants opined that they are partially aware while 8.33 percent reported that they are not aware about the agro-meteorological advisory services (Fig.22).

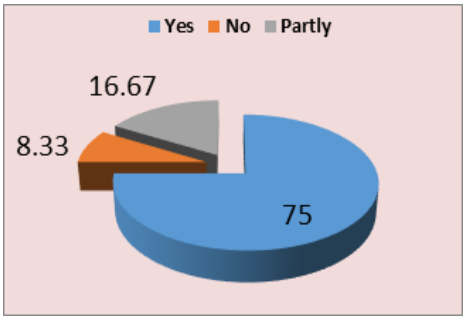


Fig. 22. Personal Awareness on the system of AMI services

4.6.2 Personal Involvement of SAAOs in AMIS

The SAAOs are directly involved in block level extension activities of DAE. To understand the SAAOs involvement in the comparatively newer area of responsibility they were asked about the level of their involvement in agro-meteorological advisory service activities. About 83.33 percent of the respondents claimed that they are actively taking part, especially in disseminating the forecasts and messages. However, about 16.63 percent of the participants consider that they are yet to be involved in the process (Fig.23)

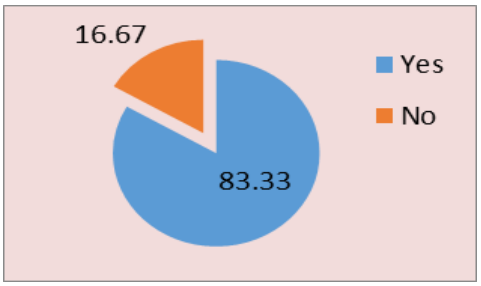


Fig.23. Personal involvement of SAAOs in AMIS

4.6.3 Types of information served with in AMIS at block levels

Though it was mentioned at district level that the content of messages provided by DAE are primarily limited to two broad areas such as forcasting of adverse/extreme weather events as and when arises, and the pre- and post event management of the events (section 3.5.7), the grass root level elaborated the services areas as weather forecast[1], forecast for disease breakout[2], precautionary forecasting before events[3], measures to be taken during[4] and after events[5]. These responses were made by 91.67, 25.00, 8.33, 16.67 and 25.00 percent, participants, respectively. (The superscripts[1,2,3,4,5] illustrate the full meaning in the figure axis).

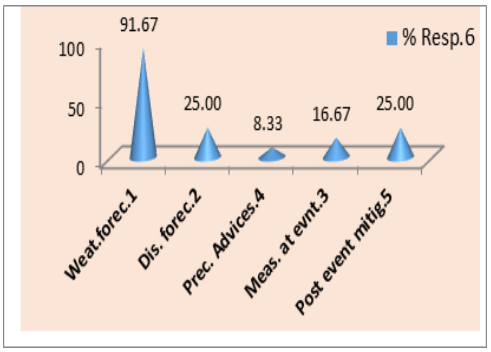


Fig.24.Types of information served with in AMIS at block levels

4.6.4 Media Used for Dissemination of Messages

The block level representatives opined that they used different media to disseminate AMIS messages. These includes personal communications, group meeting, leaflets, mobile calls and social media, being opined by 75.00, 75.00, 75.00, 58.33, and 41.67 percent of the participants, respectively (Fig. 25). The other less mentioned media are public representatives, miking, UP control room for agriculture and Imams of local mosques during weekly prayers represented by 16.67, 16.67, 8.33 and 8.33 percent of representatives. Some of these media is considered very effective as these involves public representatives/local leaders who are well known to farmers and local people.

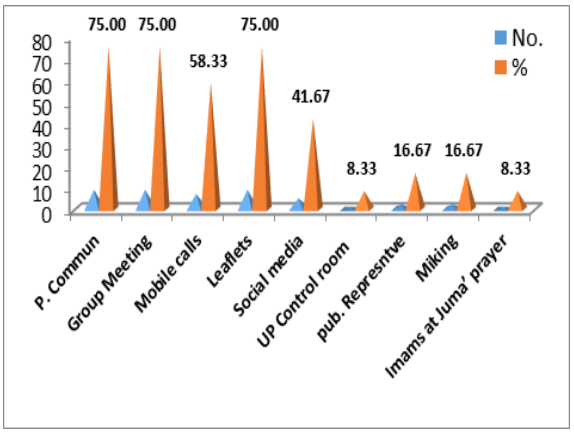


Fig. 25. Media used for dissemination of messages

4.6.5 The Capacity of SAAOs to Deal with AMIS

At the present level of knowledge and skill, without any sorts of training on AMIS, the most of the SAAOs (91.67%) admitted that they are yet to build capacity to efficiently deal agrometeorological advisory services for effective dissemination (Fig.26). Regarding the concept and methods of DAE's agrometeorological services, it was reiterated that so far the SAAOs have not received training on any aspect of agrometeorological advisory services and as to how these services would benefit farmers' crops and production activities. They suggested for bridge the huge capacity gaps of the SAAOs to improve the AMIS to satisfactory level.

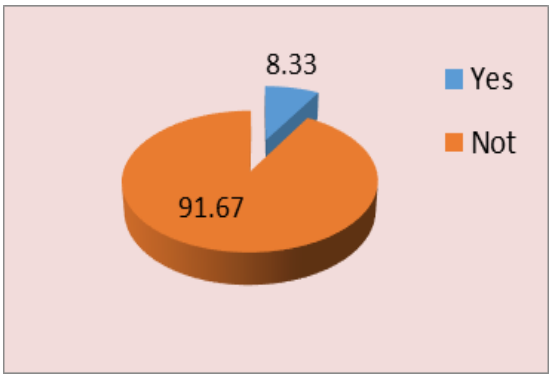


Fig. 26. SAAOs capacity to deal AMIS

4.6.6 Suggested Areas of Training for SAAOs Capacity Building in AMIS

In the context of knowledge and capacity gaps identified, The SAAOs suggested several areas of training needs to improve their capacity to deliver AMIS to the benefits of farmers. They emphasized on the skill to handle different weather equipment and machineries including digital media (83.33%), understand phenomenon of weather extremities (75.00%), management techniques of weather hazards (58.33), techniques to increase farmers' awareness (16..67%), etc. Other areas of suggested training were adverse weather induced outbreaks of insect pests and diseases (8.33%) and preparing AMIS messages at local levels (Fig 27).

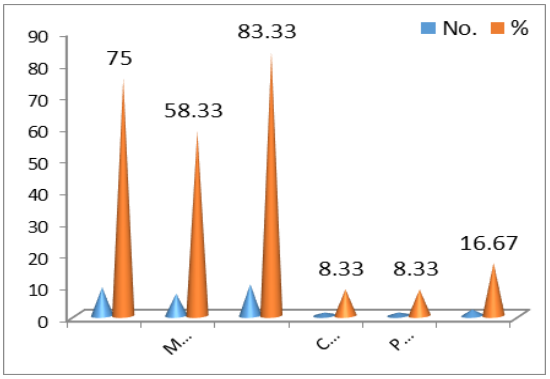


Fig. 27. Suggested Areas of Training for SAAOs Capacity Building to deal AMIS

4.6.7 Farmers Capacity to Deal with AMIS Messages

As in the previous section (3.6.6) the SAAOs suggested developing farmers' capacity to understand and utilize AMIS messages to benefit from the agrometeorological services being rendered by DAE. Most of the SAAOs (91.67%) are in an opinion that target farmers are neither aware nor capable to harvest benefit from AMIS due to their knowledge and skill gaps. Few FGD participants (8.33%), however considers that some knowledgeable and educated farmers' have certain level of capacity to utilize AMIS forecasts and messages (Fig. 28). Since farmers are the ultimate users of agrometeorological forecasts and messages, their capacity (knowledge and skills) must be developed through appropriate training.

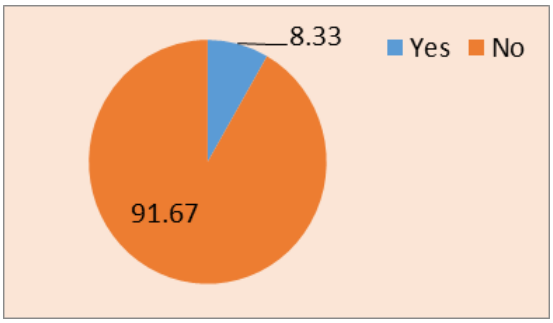


Fig. 28. Farmers' capacity in dealing AMIS

4.6.8 Areas of Training Suggested for Farmers

As the close associates of the farmers, the SAAOs considered them as key persons or community in benefitting from AMISs. Thus they suggested training farmers on some important areas like understanding extreme weather events and their importance, managing crops against weather calamities, and skill on using mobile phones and understanding the messages served under Agrometeorological advisory service systems (Fig. 29).

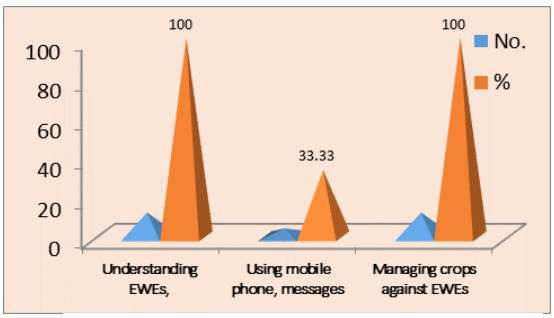


Fig. 29.Suggestd Farmers' Training in AMIS

CHAPTER-V
TRAINING NEED ASSESSMENT

Assessment of the training needs is the ultimate objective of the study. As indicated in the Terms of Reference (TOR), which pinpointed four elements - analysing gaps in a) knowledge and skills; b) assessing capacities; c) assessing training needs and d) recommending areas of training for different levels involved in DAEs' AMIS system. Thus, systematic analyses are being furnished and evidences are being provided in following sections to satisfy the objectives detailed in section 1.1.

5.1 Analysis of Situation and Identification of Training Needs

In addition to extensive review of literature, four separate studies were carried out i.e., Household survey of farmers in selected areas; In-depth interview of District Training Officers; Key Informant Interviews of Deputy Directors and Focused Group Discussion of Sub-Assistant Agriculture Officers of DAE to their opinions and feedback in relation to the said objectives to meet the requirements of the objectives of the study. The findings of the said four studies have been presented above in Chapter IV. The review of relevant literature is presented in Chapter II. On the basis of the study findings, knowledge, skill and capacity gaps at District and Upazila, Block, and Farmer and Intermediary levels were identified (Table 41).

Table 41: Knowledge and skill gaps at District and Upazila, Block Farmer and Intermediaries levels

District and Upazila level	Block level	Farmer and Intermediary level
1. Concepts on weather phenomena and crop-weather relationships as well as weather and climatic stress on agriculture;	1. Lack of ideas on concept of meteorology and agrometeorology	1. Don't know what is Met and Agromet
2. Concepts of benevolent and malevolent weather and its roles and impacts on agricultural production and productivity;	2. Lack of knowledge on weather elements and extreme weather evens	2. Lack knowledge of benevolent and malevolent weather events
3. Inadequate knowledge on EWEs, their impacts on production and productivity, and coping (adaptation and mitigation) with impacts of EWEs;	3. Lack of knowledge on weather impacts on agriculture, specifically on crop agriculture	3. Not aware of using WEs and tackling EWEs
4. Inadequate knowledge and understanding of different types of meteorological forecasts and its implications on agriculture;	4. Lack of understanding of agrometeorological advisory service of DAE	4. Lack access to and skills in dealing AMAS messages
5. Lack of knowledge and skill of sourcing agrometeorological data, data analysis and development of forecast and advisories;	5. Lack of proper understanding of their specific role and implementation of advisory services	5. Not able to use different forms of messages
6. Inadequate knowledge on weather-insect pest and disease relationships;	6. Lack of proper understanding of their specific role and implementation of advisory services	6. The constraints and solutions to efficient use of messages are not clear
7. In adequate knowledge and skills weather and climate risks and risk management in term of policy and interventions;	7. No clear idea and skill about localized AMAS	7. Their role and mechanisms to implement advisories are not known
8. Unfamiliar about meteorological equipment and machineries and their operations;	8. No clear idea and skill about localized AMAS	8. The means of ensured service by lead farmers are not known and fixed
9. Lack on insight on global developments in agrometeorology and agromet services;	9. Not familiar with meteorological instrument and their operation	
10. Inadequate capacity in dissemination of agrometeorological forecasts and use of modern messaging means.	10. Different forms of means of dissemination not known	

5.2 Training Needs at Different levels

Training is regarded as a systematic and planned process to change the knowledge, skills and behavior of personnel to achieve the objectives of the organization they work for. In contrast to education, training is task-oriented because it focuses on the work an individual performs. The acquisition of knowledge and skills is a continuous process throughout one's career and not just a one-time effort. The need for continued training in agrometeorology was demonstrated by a survey on education and training requirements (Olufayo et.al., 1998).

Recent operational developments includes developing extension around the establishment of agrometeorological services that recognizes the importance of paying attention to the enormous need for training of extension personnel at the intermediate level between makers of agrometeorological products and end users. For effectiveness and sustainability of any integrated agro meteorological service, the availability of quality trained technical and professional personnel in agricultural meteorology are critical factors.

Considering the necessity of integrated Agrometeorological and Agricultural Extension services to the benefit of farmers and protect crop agriculture from vagaries of weather, the Government of the People's Republic of Bangladesh is implementing Agro-Meteorological Information Systems Development Project (Component –C of Bangladesh Weather and Climate Services Regional Project) in the Department of Agricultural Extension (DAE). Meanwhile the AMISDP activities has been initiated in all the 64 districts of Bangladesh as an effort to develop District-based and location specific integrated agro-advisory and crop extension services for the farmers.

In the context of the requirements of AAS, capacity development of a huge number personnel both in development and delivery as well recipient ends involved has become essential to develop and sustainably maintain and operate Agrometeorological Advisory Service together with Crop Extension Services. This could be done through proper education and training of concerned personnel in agrometeorology, especially those involved in Agricultural Extension Services in Bangladesh

Based on the extensive review of literature and knowledge, skill and capacity gaps at various levels, Meta Training Modules have been developed against each identified gap for District and Upazila level Extension personnel, Block level Extension personnel and Farmer and Intermediary levels. These Meta Training Modules are presented in Tables 42, 43 and 44, respectively.

Table 42: Training Needs of District and Upazila level Officer and Meta Training Modules

(1st draft)

Knowledge, Skill and Capacity Gaps at District and Upazila Level*	Training Need (Title of Training)	Training Objectives	Subject Matter Focus
1. Inadequate knowledge on weather phenomena and crop-weather relationships as well as weather and climatic stress on agriculture;	1. Weather phenomena and crop-weather relationships in terms of crop growth and development.	- To understand various elements of weather and climate; - To understand the influence of congenial and adverse weather conditions on crop growth and development.	- Introduction to weather and climate; - Introduction to meteorology and agrometeorology; - Important weather events affecting agriculture (crops, livestock and fisheries sector); - Introduction to EWEs and their impacts on agriculture in Bangladesh.
2. Inadequate understanding of benevolent and malevolent weather and its impacts on agricultural production and productivity;	2. Concepts of benevolent and malevolent weather and its role in crops, fisheries and livestock production and productivity.	- To understand climatic variabilities and its impacts on farming systems; - To be familiar with WE, EWEs; - To know the existing practices for adjustment with weather variabilities; - To be familiar with potential means and methods for adjustments; - To understand and learn to utilize windows of benevolent weather in agricultural production.	- The benevolent and malevolent WEs and their impacts in farming activities; - Means and methods of benefiting agricultural production from favorable weather conditions in Bangladesh condition; - Means and methods of coping with adverse weather conditions Bangladesh condition; - Existing mechanism adjusting WEs and EWEs in agriculture and its potential in Bangladesh agriculture.
	3. Weather and climatic stresses on crops, livestock and fisheries agriculture	- To identify and characterize of various climatic stresses affecting agriculture in Bangladesh	- Description of various weather and climatic stresses in agriculture; - Impacts of weather and climatic stresses in crop, fisheries and livestock production and productivity; - Weather and climatic stress management in different sectors in Bangladesh agriculture.
3. Inadequate knowledge on EWEs, their impacts on production and productivity, and coping (adaptation and mitigation) with impacts of EWEs;	4. Important Extreme Weather Events and its implication in Bangladesh agriculture in different seasons	- Identify important EWEs affecting agriculture in Bangladesh in different seasons; - Understand the impacts of EWEs in crop, fisheries and livestock sectors.	- Description of EWEs affecting agriculture in different seasons; - Impacts of EWEs in different seasons in crops, fisheries and livestock sector; - Mechanism of avoidance, adaptation and mitigation to escape EWEs as well as minimize damages due to EWEs.
4. Inadequate knowledge and understanding of different types of meteorological forecasts and its implications on agriculture;	5. Weather forecasting and understanding of different types of meteorological forecasts and its implications on agriculture;	- NOWcast; - Short range forecast: - Medium range weather forecast - Long range forecast	- Definition and characteristics of NOWcast, Short Range, Medium Range and Long Range weather forecast; - Sources and items of data required for different types of weather forecast; - Utilization of different types of weather forecasts in agriculture; - Suitability of different types of weather forecasts in agrometeorological services.

Knowledge, Skill and Capacity Gaps at District and Upazila Level*	Training Need (Title of Training)	Training Objectives	Subject Matter Focus
	6. Translation/ interpretation of different spatial and temporal weather and climate forecast in agriculture (both Theoretical and Hands on)	- To understand different spatial and temporal weather and climate forecast and using the information in developing agrometeorological advisory.	- Spatio-temporal analysis of weather data; - Interpretation techniques of spatial and temporal weather forecasts; - Translating interpreted information in generating advisory messages.
5. Lack of knowledge and practices on modern agrometeorological services	7. Concepts and utility agrometeorological services and its application in agriculture development in Bangladesh	- To develop clear understanding of modern agromet service; - To know the pros and cons of agromet service; - To identify the requirements developing integrated and sustainable agromet service in Bangladesh	- Basic concepts and principles modern agromet services; - Integration of meteorology with agricultural extension services; - Strategies and procedure of developing agrometeorological advisory services; - Aligning weather forecasts to the advantages of farmers through advisory messages; - The requirements for functioning and sustainability of Agromet services in Bangladesh.
	8. Remote sensing (RS) technologies using GIS,GPS, and satellite- based information for AMAS	- To understand the working mechanism weather data recording by means of remote sensing; - To be able to use of RS data for advisories in wider areas.	- The machineries for generating weather information by remote sensing; - Generation of GIS, GPS and Satellite based weather data and archiving those data for further use; - Use of remote-sensing technologies to generate information/ advisories for large areas;
6. Lack of knowledge and skill of sourcing agrometeorological data, data analysis and development of forecast and advisories;	9. Sourcing, collation and analyses of weather data and transforming into user-friendly advisory messages	- To know and establish linkages with the sources of weather data for agromet services; - To understand weather data management for forecasts and advisory messages; -	- Availability of different agrometeorological data from various sources; - Data collection and data management techniques for agrometeorological services; - Collation, analyses and transformation of data in to information; - Process of developing user-friendly forecasts and advisory messages.
7. Inadequate knowledge on weather-insect pest and disease relationships;	10. Developing insect pest and disease calendars for crop, fisheries and livestock components	- To be able to develop insect pest and disease calendars for different farming enterprises - To understand the purpose and utilities insect pest and disease calendars; - To develop skills in developing insect pest and disease calendars of various farming enterprises.	- What are insect- disease calendars and their utilities - How to prepare insect- disease calendars - Predicting possible outbreaks of insect pests and diseases in different farming components, - Hands on practice on preparation of sample calendars
	11. Climate- induced insect and disease outbreak phenomena in various farming components.	- The climate- pests relationship is clarified - The system of monitoring pest surveillance against weather variabilities is anchored	- Climate-induced insect–disease outbreak and control phenomena, - Monitoring insect- diseases' surveillance for AMAS messaging,

Knowledge, Skill and Capacity Gaps at District and Upazila Level*	Training Need (Title of Training)	Training Objectives	Subject Matter Focus
		- Messaging system for FS components on pest alert is grasped	- Messaging forecast of disease–pest attack alert to different components of integrated farming
	12. Insect pest and disease modeling and their application in supporting farming systems (crop/ livestock/ fisheries)	- To understand the techniques developing Insect pest-host models and their and utility in agrometeorological services; - To developed skills for developing pest-host models.	- Concepts and principles modeling insect/disease-host; - Utilities and uses insect pest and disease models in integrated agrometeorological services; - Methodology of host=pest/disease modeling; - Hands on practicing on host-pest/disease modeling and developing sample models.
8. In adequate knowledge and skills weather and climate risks and risk management in agriculture	13. Weather and climatic stresses and risks in agriculture and risk management	- To understand weather and climate induced stress on crops, fisheries and livestock; - To learn the techniques and technologies of risk management in agriculture.	- Defining different types of weather and climate induced risks affecting agriculture; - Identification of weather conditions putting various agricultural enterprises in risk of damage; - Identification and application of interventions for risk management in agriculture to minimize damage and detriments.
9. Unfamiliar about meteorological equipment and machineries and their operations;	14. Introduction to meteorology, important weather instruments, their operation and generating different types forecasts.	- To know about different meteorological equipment and instruments for generating weather data; - To know basic information on operation and maintenance of meteorological equipment and instruments; - To know about meteorological equipment and instruments essential for weather forecasting for agricultural advisory services.	- The instruments currently under use BMD and elsewhere for r recording weather data; - Mechanism weather forecasting using generated data; - Scope and challenges to meet weather data requirement for agrometeorological services in Bangladesh context; - Practical operation of available weather devices emphasizing on data recording and storing for information systems
10 Inadequate capacity of dissemination of agro-meteorological forecasts and use of modern messaging means.	15. Methods and means of disseminating forecasts and advisories	- To understand the mechanism and channels of dissemination of forecasts and advisories; - To identify the pros and cons of existing means and mechanisms of dissemination; - To know the challenges for timely dissemination of forecasts and messages; - To identify best suited means and methods of dissemination and its operational requirements.	- Means and methods currently used for disseminating AMAS in Bangladesh; - Processes, strength and weaknesses of existing dissemination mechanisms; - Hurdles and missing links in existing dissemination mechanism; - Challenges in reaching target beneficiaries (farmers and intermediaries) and means to overcome the challenges; - Means and operational requirements of overcoming the challenges in lifting the dissemination process to a satisfactory level.
	16. Models of location/ block-based AMAS: Experiences in field application of different	- Specific localized messaging models are known - Advantages and challenges of pocket based AMASs is clarified	- Location/ block/ mouza based information systems : experience in other countries; - Advantages and challenges of location specific advisory

Knowledge, Skill and Capacity Gaps at District and Upazila Level*	Training Need (Title of Training)	Training Objectives	Subject Matter Focus
	dissemination models	- Needs for localized messaging system is elucidated	services; - Feasibilities and support requirement do develop and adopt location/ block based messaging in Bangladesh.

Table 43: Training Needs of Block level Officers and Meta Training Modules

Knowledge, Skill and Capacity Gaps at District and Upazila Level*	Training Need (Title of Training)	Training Objectives	Subject Matter Focus
1. Lack of ideas on concept of meteorology and agrometeorology	1. Introduction to meteorology and agrometeorology : Purpose and roles agrometeorology in agriculture	- Participants acquire the basic knowledge of meteorology and agrometeorology; - Understand the role of agrometeorology in agriculture	- Concept of Meteorology and agromet; - Purpose and function of meteorology; - Role of agrometeorology in influencing production and productivity in agriculture.
2. Lack of knowledge on the role of weather and extreme weather evens	2. Roles of weather phenomena in crop productivity and impacts of EWEs on crop agriculture in Bangladesh	- To understand the weather and extreme weather effects on farming enterprises; - To minimize knowledge gaps on weather and extreme weather events. -	- Various weather parameters and their role in crop growth and development; - Extreme weather events occurring in different seasons in Bangladesh; - How agriculture is impacted by EWEs; - Using forecasts and agromet advisories to utilize benevolent weather window to the benefits of farmers; - Coping with the impacts of EWEs.
3. Lack of knowledge on weather impacts on crop agriculture and impact management techniques and technologies	3. Impacts of adverse and extreme weather on crop agriculture and impact/stress management	- To be able to understand impacts of weather events and develop plan of action for adaptation and mitigation of impacts to minimize adverse effect on crop agriculture	- Utilization of positive weather conditions to maximize environmental benefits in crop production; - Identification and use of adaptation and mitigation measures to combat adverse/extreme weather events to minimize detriments and losses in agricultural production;
4. Lack of understanding of agrometeorological advisory service of DAE	5. Role and functions of Block level extension personnel in DAE's agrometeorological services	- To understand the expected roles and functions of Block level extension personnel in DAE's agrometeorological services. -	- Present functions of SAAOs in dealing with AMAS; - Strengths and weaknesses of present services at Block level - Actions required from SAAOs for desired level and quality of services; - Supports needed to improve the efficiency of AMAS by SAAOs at Block level.
5. Lack of proper understanding of their specific role and implementation of advisory services	6. Concept and elements of location specific (Block-based) AMA services and its advantages and bottlenecks	- To understand the function of Block level forecast and advisory; - To know and clarify the role of SAAOs in providing location specific AMAS; - To minimize knowledge gaps for supporting Block-based AMAS.	- Generation of AMAS messages for Block-specific needs and demands; - Benefits of Block-based AMAS - Existing capacity and future needs for functioning Block-based AMAS

Knowledge, Skill and Capacity Gaps at District and Upazila Level*	Training Need (Title of Training)	Training Objectives	Subject Matter Focus
6. No clear idea and skill about localized AMAS	7. Operating common weather instruments, computer programs, android phones and collection, recording and reporting of data.	- Skill developed identifying and operating AMAS related equipment and instrument; - Ability developed for operating computerized weather programs and android apps; - Skill developed for using digital and analog weather equipment, data recording and reporting	- Basic ideas on AMAS system based machineries - Operating block/ UP/ UZ level weather equipment in use; - Operation of computer and android phone program/ apps for collecting information and dissemination of AMAS forecast and messages; - Data recording and reporting by digitalized and analog instruments.
7. Not familiar with AMAS messaging system	8. Messaging system in DAE's agrometeorological in different forms /media and improving efficiency of dissemination and utilization	- To be familiar with AMAS messaging system of DAE; - To develop skill on uses of different AMAS messaging devices and mechanisms in use; - To understand and clarify the pros and cons of present dissemination mechanism and future expectations; - To know the required facilities for effective dissemination system(s).	- Acquaintance with and understanding the AMAS messaging system of DAE; - Uses of different forms of AMAS messages for farming components (Practical demonstration) - Dissemination system in present use and future requirements for an efficient systems; - Forms and media of demonstration of forecasts and messages.

Table 44: Training Needs of Farmers and Intermediaries and Meta Training Modules

Gaps in knowledge and capacities*	Training Need (Title of Training)	Training Objectives	Subject Matter Focus
1. Lack knowledge of weather and extreme weather events	1. Positive and negative weather events and their best management concepts	- To know beneficial weather condition and utilizing them to maximize benefits from farming; - To know adverse/harmful weather condition and the means of adaptation and mitigation To know the role of affected community to avert losses due to EWEs.	Weather events those are beneficial for farming and how these can be used in benefitting farmers? Harmful or extreme weather events and how they affect farming components (crop, livestock, and fisheries) Coping with harmful weather and minimize losses; The role of farming community to avert losses due to EWEs
2. Not aware of using WEs and tackling EWEs	2. Awareness building training/ campaigns on AMAS of DAE/AMSIDP	- To make farmers aware of AMAS services and benefits of using AMAS messages and advisories; - To enhance farmers' knowledge in using AMAS messages and advisories. .	- Introduction of DAE/AMIDP's agrometeorological advisory services; - Media and means of receiving forecasts and advisories by farmers; - Identification of trained intermediary at community level; - Means and media of dissemination of DAE's AMAS and arrangements to provide access to farmers; - Exploring expectations of farmers and identify links of AMAS with it.
3. Lack access to and skills in dealing AMAS messages	3. AMAS messaging system by DAE, its contents, advantages and	- To introduce to the farmer the purpose and contents of AMAS provided by DAE/AMISDP;	- The content of AMAS messages by DAE (Theory and practical) - The level of understanding by common farmers to the supplied

Gaps in knowledge and capacities*	Training Need (Title of Training)	Training Objectives	Subject Matter Focus
	weaknesses (Theory and practical)	- To capture the level of understanding of different forms of messages by target farmers and intermediaries; - To understand the strengths and weaknesses of target farmers to understand forecasts and advisory messages.	messages in different forms - The strengths and weaknesses of current messaging by DAE in the context of farmer uptake capacity.
4. Not able to use different forms of messages	4. Different forms and media of messaging employed by DAE/AMISDP	- To demonstrate to the farmers currently used forms and media of messaging; - Farmers should reasonably able to understand use different forms of messaging	- Practical on different messaging media: practice on understanding the messages; - Helping common farmers by trained intermediary farmers to ensure understanding and following advices provided by target farmers.
5. The constraints and solutions to efficient use of messages are not clear	5. Constraints in understanding AMAS messaging in different forms and media and the practical solutions to ease their uses	- To identify farmers' constraints in understanding different forms of messages and possible solutions	- Common constraints in understanding and using AMAS messages by farmers. - Identification of means of improving farmers' understanding of messages; - Possible steps and activities to improve farmers' understanding and uses of AMAS messages - Surveillance to ensure satisfactory level of use of AMAS messages
6. The means of ensured service by lead farmers are not known and fixed	6. Monitoring mechanism of lead farmers role and holding up the ensured use by common farmers	- The Monitoring mechanism is fixed	- The mechanisms to monitor Lead farmers/LSPs role - Roles of specific officials DAE regular setup and the AMISDP in monitoring field applications of AMAS services - The process to follow for supervising / evaluating the field monitoring staff for AMASs

CHAPTER-VI
CONCLUSION AND WAY FORWARD

Agro-Meteorological Information Systems Development Project (AMISDP), Department of Agricultural Extension, Government of the People's Republic Bangladesh is a new initiative to develop and institutionalize the system of providing agrometeorological forecasts and advisory services to the farmers and other stakeholders alongside crop extension services. Success of this initiative lies in the establishment and proper functioning of the agrometeorological units along with infrastructure and development of capable human resources to operationalize the system for intended outcome.

Given the diversity of weather and climate in Bangladesh and the range of crops and cropping systems farmers operate, there are a number of critical weather, climate and agricultural issues on which advanced information is needed to develop effective strategies to maintain agricultural productivity. In this endeavor, AMISDP has established the BAMIS portal at the DAE headquarters in agrometeorological data analysis and development of service products. It is intended that DAE's extensive network will be used in the use of BAMIS porta at the regional, district and upazila levels. This will necessitate capacity development of DAE officials at various levels as well as intended farmer beneficiaries through extensive training programs.

Accordingly, AMISDP has a program to provide agrometeorological technical training to DAE officials at different levels as well as to farmers to utilize weather forecasts and advisories in their on-farm applications. The present Training Need Assessment (TNA) study was, therefore, undertaken to assess the training needs of DAE personnel at different levels to be able to provide need based timely forecasts and agrometeorological advisories to the target farmers and other stakeholders.

The said TNA study has assessed the knowledge and skills and capacity gaps at different levels of DAE personnel as well as target farmer beneficiaries (Table 41). Based on the analyses of gaps in different areas, the major areas of training needs have been identified along with the proposed training activities at different levels (Tables 42, 43 and 44). It is expected that imparting training to concerned personnel at different levels in the delivery end and farmer intermediaries and farmers at the recipient end using appropriate training modules would greatly improve DAE's capacity for Agrometeorological Advisory Service delivery in one hand and farmers' capacity building to better understand the agrometeorological forecasts and advisory messages and utilize them to their benefits on the other.

Way Forward: Enabling DAE for Efficient Agromet Advisory Services

Implementing Efficient Agromet Advisory Services (EAMAS) requires changes in the behavior and approach of beneficiary farmers and the implementing staff. The DAE can play a crucial role in changing to Climate-smart Agriculture and help build resilient agromet systems if a conducive environment for their effective functioning is created. Promoting EAMAS involves a number of moves for DAE. Compared to its conventional role of promoting the dissemination of new information and knowledge among farmers, providing assistance in the framework of EAMAS is more knowledge intensive, hence needs to provide long-term tailored support to farmers to adopt EAMAS practices. Without an enabling framework that enhances collaboration among different stakeholders in the public, private and civil society sectors, and that achieves policy coherence across different sectors, DAE will not be able to optimize its potential contributions to EAMAS. The following actions are vital in achieving the best outputs:

Capacity Development for EAMAS: In addition to knowledge about climate change and technologies to promote EAMAS, DAE has to deepen and broaden its' knowledge and soft-skills related to communication, facilitation, co-learning and dealing with diverse groups, and also learn to lead much broader intermediation at different levels so as to facilitate changes (Sulaiman, 2017). The

development and promotion of new training modules on EAMAS appropriate to different levels of DAE staff, and strengthening training of trainers on EAMAS, needs priority attention and could be supported by a number of actors including donors, governments, NGOs and research institutes within the framework of specific programs.

Strengthening Research on EAMAS: DAE need more research support to select locally relevant practices (both technological and institutional) adapted to a new and more variable climates, and also to provide policy relevant advice to decision-makers on investment policy options and program performance. Adequate resources and personnel need to be allocated to conduct decentralized adaptive research, as well as policy relevant socio-economic investigations to generate mechanisms, technologies and practices for promoting EAMAS. Creation of special research funding (e.g. climate research funds supporting collaborative research on EAMAS) should also be considered. Besides national research institutes and universities, the National Agricultural Technology Program (NATP) Phase-II and Krishi Gobeshona Foundation (KGF) can actively consider this. Regional and global dialogue, exchange and learning on research results and good practices on EAMAS would be beneficial to DAE if the research works are not possible or effective in country.

Establish co-ordination systems to support EAMAS at different levels (i.e. regional, national and international): DAE needs to network with a wide range of stakeholders to plan and coordinate EAMAS interventions, platforms enabling regular and effective multi-stakeholder interactions have to be constituted and strengthened. Mechanisms such as departmental/ inter-ministerial working groups, coordination committees, stakeholder platforms, and policy working groups, need to be constituted and facilitated in order to have significant sharing, dialogue, reflection and learning among all EAMAS stakeholders including DAE. This dialogue will also be necessary in developing policies, programs and DAEs interventions to support EAMAS.

Enhanced investments in DAE for supporting EAMAS: EAMAS needs to be driven by investments in the agricultural sector in general, and in supporting DAE in particular. DAE need additional financial resources to recruit more and better qualified/trained staff at the field level in order to support farmers in transitioning to EAMAS. Investments are also needed to build staff capacity on CSA at all levels. Moreover, DAE personnel, especially at the senior level, needs capacities to raise additional funds by developing viable proposals from different sources, including accessing different climate funds.

Separate Set-up for Agromet Responsibilities*:* As the DAE is the biggest extension agency in the agricultural system in Bangladesh, its staff are generally pre-occupied with various projects and regular departmental activities. To achieve the best of EAMAS a set of staff need to be build up/ engaged to handle agromet activities, specially at District and Upazila levels. The Agri-Engineers, currently posted in districts and Upazilas may be an option.

Integrating Climate Smart Agricultural Advisory Service (CSAAS): The multinational project on climate-smart agricultural advisory service implemented in South and South East Asia may be mainstreamed in DAE after fine-tuning, to harness the power of information and communication technology (ICT) for the out scaling of Climate-Smart Agriculture (CSA) technologies and climate-informed advisory services for all crops and farming systems in the country. This has also been suggested by Sulaiman (2017).

Institutional Commitment to Promote EAMAS and Strengthening DAE: Finally, a high level of institutional commitment to promote EAMAS and strengthen pluralistic extension activities will be needed to enhance the contribution of DAE to EAMAS. A national platform or forum of agricultural service providers can play a major role in shaping the enabling environment for DAE, so that their voice is heard in the design and implementation of national climate adaptation and mitigation plans, as well as in access to climate funds.

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ANNEXES

Annex-1. Terms of Reference (ToR) for Technical Consultancy on agrometeorological Training Needs Assessment

Government of the people's Republic Bangladesh
Agro-Meteorological Information Systems Development Project (AMISDP)
Component –C of Bangladesh Weather and Climate Services Regional Project (BWCSRP)
Department of Agricultural Extension (DAE)
Khamarbari, Farmgate, Dhaka-1215

Package No: DAE/SD-01
Package Name: Technical Consultancy on Agro-meteorological Training Need Assessment

1. Background

Increased frequency of climate extremes is another face of climate change confronted by humans, resulting in catastrophic losses in agriculture. While climate extremes take place on many scales, impacts are experienced locally and mitigation tools are a function of local conditions. To address this, agrometeorological advisories along with early warning systems must be place and location based, incorporating the climate, crop and land attributes at the appropriate scale.

The agrometeorological weather forecast is one of the most important items focused in the form of an agrometeorological bulletin. In this context, short- and long-term forecasts bear particular importance in bulletin, and users use these forecasts in their operational applications. All the countries in the region have agrometeorological databanks, including long term daily climatic data, phenological observations for different cultivated plants, and soils data. Climate data quality controls based on standards are regularly accomplished. In most countries of the region, news and information are broadcasted through the mass media in critical situations, particularly to farmers.

Agrometeorological technical training will be provided to DAE officials at different level as well as to farmers to utilize weather forecasts in their on-farm applications. This includes, i) organization of workshops/seminars on the BAMIS portal at the DAE headquarters in agrometeorological data analysis and development of products and ii) organization of short-term training and exposure visits to appropriate institutes and organizations abroad to promote a better understanding of the current methods and approaches in the development of agrometeorological advisories and products. Given the diversity of weather and climate in different agroecological regions in the country and the range of crops and cropping systems which farmers cultivate, there are a number of critical weather, climate and agriculture issues on which advanced information will be needed to develop effective strategies to maintain agricultural productivity. As DAE has a good network of offices in the 64 districts providing information to farmers, this network will be used for the organization of workshops for ~~at~~ the regional, district and upazila levels officials in the use of BAMIS portal. This project will provide training for 74 batches of officers, 367 batches of Sub-Assistant Agricultural Officers (SAAO's) and 1000 batches of farmers and each batch consist by 30 persons. About five National and 70 regional workshops will also be arranged by the project.

In this context, training plays an important role in the advancement of human performance in a given situation. Training is a process of acquisition of new skills, attitude and knowledge in the context of preparing for entry into a vocation or improving ones productivity in an organization or enterprise. Effective training requires a clear picture of how the trainees will need to use the information received during the training to replace the local practices which they have adopted before in their situation. Officials and farmers training workshops are directed towards improving their job efficiency at the farming level. Training needs assessment process helps determine the priority of changes in

knowledge, skill, attitude and behavior that will provide the greatest impact on achieving organizational or individual goals. The possible methods or techniques for individual analysis include performance appraisal, interviews, questionnaires, tests, analysis of behavior, informal talks, checklist, counseling, critical incidents, recording, surveys, and observations. Training is a circular process that begins with needs identification and after a number of steps ends with evaluation of the training activity. Thus, there is a need for agrometeorological training assessment for DAE officials at different levels as well as farmers in Bangladesh.

2. Objectives:

The main objectives of agrometeorological training needs assessments are given below:

- To determine the gap in capacities of DAE officials at different levels as well as farmers to improve their knowledge on weather and climate as well as agrometeorological services.
- To assess the gap between what is required of an official to perform competently and what he actual knows.
- To determine if a training need exists and if it does, what training is required to fill the gap.
- To determine the different levels of training which is required for various target groups.

3. Scope of the work

The proposed consultancy will be accomplished through several tasks, but it is not limited. Those tasks will be furnished through set of activities, which are given below:

- To identify agrometeorological training needs assessment for officials of DAE as well as farmers on weather and climate and agrometeorological services.
- To determine agrometeorological training needs assessment organizational context.
- To perform agrometeorological training needs assessment gap analysis for officials as well as farmers.
- To identify agrometeorological training needs assessment of farmers as the end users for agrometeorological services.
- To determine design of agrometeorological training needs assessment analysis for officials of DAE as well as farmers.
- To establish the method of selection criteria.
- To assess the advantages and disadvantages of different methods.
- To collect datafrom DAE officials as well as farmers for agrometeorological training needs assessment.
- To conduct interviews by questionnaires and surveys.
- To conduct qualitative and quantitative analysis for agrometeorological training needs assessment.
- To collect feedbackon agrometeorological training needs assessment from officials of DAE as well as farmers.

4. Brief Method

Proper tools and methods are very essential for assessing agrometeorological training needs assessment on weather and climate information as well as agrometeorological services. However, both qualitative and quantitative methods will be used to collect data for this study.

Under qualitative method, consulting firm will conduct focus groups discussion (FGD), Key Informant Information (KII), Large gathering (LG) or any other methods and individual interviews on agrometeorological services and training of DAE officials at different levels as well as farmers in 28 upazilas of 14 regional offices (list of upazilas name enclosed below). Training needs assessment will be carried out on how they receive and use agrometeorological advisories, the perceived gaps, and suggestions for improvement. The assessment will uncover the key role of diverse communications approaches. In villages where many disseminations channels will be used to disseminate agrometeorological services, such as SMS and voice messaging, meetings and trainings by agricultural extension officers, farmers clubs, and roving seminar in villages, awareness and use of agrometeorological advisories and training on it.

Under quantitative method, the consulting firm will collect data from randomly selected large, medium, small and landless farmers on their needs for different agrometeorological services and how they can receive and use agrometeorological services and benefit from the program. The consulting firm also will find out the training need assessment on Kiosk, Analog Display Board, Handheld Automatic Rain Gauge (ARG), Tablet, Web base portal software, Apps etc for DAE officials as well as farmers from different upazilas.

5. Project Outcome:

The outcome of the project will be enhanced ability on how to use weather and climate information as well as agrometeorological advisories for strategic use of climate information and for coping with climate variability and extreme weather and climate events for sustainable agricultural development.

6. Output and Deliverable:

The output of agrometeorological training needs assessment will be to help the farmers to alleviate the adverse impacts of extreme weather events and maximize benefits of benevolent weather conditions. Following are the expected deliverables from the proposed study:

i. Inception report on Agrometeorological Training Needs Assessment.
ii. Draft final report on Agrometeorological Training Needs Assessment.
iii. Final report on Agrometeorological Training Needs Assessment.

7. Duration of services and reporting:

Total study period will be about three months. The tentative reporting schedule for the consultant's assignment is given below:

Reports	**Planned Time**
Inception Report: 05 copies	At the end of 2nd week of contract signing
Draft Final Report (with workshop): 05 copies	At the end of the 2nd month of contract signing
Final Report: 10 copies	At the end of the project duration.

8. Qualification of the consulting farms

The consulting firm will be selected based on the adequacy of the relevant professionals and length of experience. Therefore, the expected firm should have at least five years experiences in the field of agricultural research including market research. The firm must have similar experiences at least five similar projects.

Other criteria that must be fulfilled by firm are:

The firm/company must be capable of providing enough manpower, financial resources and equipment to perform the entire scope of work mentioned herein.

In case of a Joint Venture, the role and responsibility of each partner should be clearly furnished.

The prospective bidder must submit the audited turnover at least 10 Lac taka at the time of bidding.

9. Key personnel and Qualifications

It is expected that three 03 man-months of key professional staff may be required for the study as shown in the Table 1 below. The qualifications and responsibilities are shown in Table 2.

Table 1: Key professionals and estimated duration

SL	Name and Position	Number of professionals	Person Months
1.	Team Leader/Sr. Agro-meteorologist/Environmentalist	01	03
2.	Agriculture Expert	02	04
3.	Agro-economist	01	02
4.	Data Analyst/Jr. Programmer	02	02
5.	Field Coordinator	01	02
6.	Data Collector	14	28
	Total	21	40

Table 2: Composition of the proposed study team and qualification

Sl. No.	Position	Educational Qualification	Area of Expertise
1.	Team Leader/Sr. Agro-meteorologist/ Environmentalist	Master's degree in agricultural meteorology/ agronomy or engineering discipline, such as irrigation water management, or water resources and Bachelor degree in agriculture /agricultural engineering or related subject or Environmental Science.	Total years of experience required will be 10 with at least 7 years experiences in conducting and preparing climate related agricultural assessment study. Working experience with BADC, BARC, BRRI or DAE will be given preference. He/she should have the capability to analyze the existing agricultural practices including cropping pattern, agricultural input use and crop production, agro-met services and early warning
2.	Agriculture Expert	B.Sc. in Agriculture and M.Sc. in any Agriculture discipline.	Minimum five years of experience in conducting and preparing climate related agricultural assessment study. Working experience with BADC, BARC, BRRI or DAE will be preferred. Experience in agricultural related baseline survey.
3.	Agro-economist	B.Sc. in Agriculture Economics and M.Sc. in any discipline.	Minimum five years of experience in conducting and preparing baseline survey and report writing.
4.	Data Analyst/Jr. Programmer	B.Sc. in Computer Science or Statistics	Minimum 2 years of experience in data processing, analyzing and

Sl. No.	Position	Educational Qualification	Area of Expertise
			automated report generation
5.	Field Coordinator	B.Sc. in any discipline.	Minimum five years of experience in conducting and coordinating the agricultural related field survey.
6.	Data Collector	Diploma in Agriculture or Diploma in any discipline.	Minimum 2-3 years of experience in conducting and preparing climate change and agricultural assessment study.

10. Technical Evaluation Criteria

The consulting firm shall be selected for assessing the "Technical Consultancy on Agrometeorological training needs assessment" on the basis of consultant qualification selection under IBRD Loans & IDA credits & Grants by World Bank Borrowers, January 2011 & on the basis of Consulting firms' qualification, experiences and capability to carry out the assignment.

Sl.No.	Evaluation Criteria		Full Marks
1.	**Establishment of the firm**		**5**
1.1	Years of Establishment (at least 5 years)	2	
1.2	Audited turnover at least 10 Lac Taka up to bidding time.	3	
2.	**General Experience of the Firm**		**10**
2.1	General Experience of Firm	4	
2.2	Specific Experience of the Firm	6	
3.	**Description of Approach, Methodology and Work Plan for Performing the Assignment.**		**40**
3.1	Work Plan		11
3.1.1	The main activities of the assignment, their content and duration, phasing and interrelations.	7	
3.1.2	Clarity of progress reporting plan and delivery dates of the reports.	4	
3.2	Technical Approach and Methodology		15
3.2.1	Understanding of the objectives of the assignment and approach to the services.	15	
3.3	Organization and staffing.		14
3.3.1	Structure and composition of project team.	6	
3.3.2	Description of individual roles.	8	
4.	**Qualifications and competence of the Consulting firm's personnel proposed to the assignment**		**45**
4.1	Team Leader		15
4.1.1	Education	4	
4.1.2	Specific Experience	6	
4.1.4	Experience as Project Team Leader	5	
4.2	Agriculture Expert		10
4.2.1	Education	4	
4.2.2	Specific Experience	6	
4.5	Agro-economist		10
4.5.1	Education	4	

Sl.No.	Evaluation Criteria		Full Marks
4.5.2	Specific Experience	6	
4.6	Data Analyst/Jr. Programmer		10
4.6.1	Education	4	
4.6.2	Specific Experience	6	

11. Payment Schedule

Deliverables	Timing (from Contract signing)	Payment %
Inception Report	After acceptance of Inception Report i.e. after the second week	10 %
Draft Final Report	After acceptance of draft final report	60%
Final Report	After acceptance of final report	30%

Note:

1. The Consulting Firm will be responsible for all taxes and duties including income tax applicable as per GoB rules and regulations

ANNEX-1

Table: Names of 28 upazilas in 14 Regions

Sl No.	Region	District	Upazila
1.	Dhaka	Kishoregonj	Mithamoin
2.		Tangail	Dhanbari
3.	Comilla	Comilla	Muradnagar
4.		Brahmanbaria	Bijoynagar
5.	Sylhet	Sunamganj	Tahirpur
6.		Sylhet	Jointapur
7.	Mymensingh	Sherpur	Nokhla
8.		Mymensingh	Fulpur
9.	Jessore	Jessore	Ovoinagar
10.		Magura	salika
11.	Bagura	Bagura	Dhunot
12.		Joypurhat	Akkelpur
13.	Rajshahi	Rajshahi	Durgapur
14.		Naogaon	Nojipur
15.	Khulna	Satkhira	Shemnagr
16.		Bagerhat	Mongla
17.	Barishal	Borguna	Bamna
18.		Potuakhali	Golachipa,
19.	Rangpur	Rangpur	Mithpukur
20.		Kurigram	Bhurungamari
21.	Faridpur	Shariatpur	Naria
22.		Faridpur	Charbhadrason
23.	Chattogram	Coxbazar	Kutubdia
24.		Noakhali	Kabirhat
25.	Rangamati	Bandarban	Lama
26.		Rangamati	Kaptai
27.	Dinajpur	Dinajpur	Birol
28.		Thakurgaon	Baliadangi

Annex-2. KII Checklist for Policy Level Personnel of DAE

Agro-meteorological Training Needs Assessment

1. Do you think agrometeorological advisory services are the essential component of agricultural extension (Yes/No).

   If yes, please briefly point out how?

   i.

   ii.

   iii.

2. Is there a well-defined agrometeorological advisory services policy of your department (Yes/No);

   If yes, please mention the salient features as to how this policy serves the farmers' needs

   i.

   ii.

   iii.

3. Who are the major stakeholders/target groups of DAE's agrometeorological advisory services?

   i.
   ii.
   iii.

4. Please mention the current agro-meteorological advisory services provided to the farmers by your department:

   i.

   ii.

   iii.

5. Please mention the major sources of the technical information given in current agro-meteorological advisory services:

   i.

   ii.

   iii.

6. What are the major technical contents of DAE's agrometeorological advisory messages/forecasts for different target groups/stakeholders?

   i.

   ii.

   iii.

7. Please mention major categories of agro-meteorological advisory messages/forecasts provided to the farmers by your department:
   i.
   ii.
   iii.

8. Are departmental personnel properly trained in preparing and handling various agrometeorological advisory messages/forecasts?
   i.

9. Is there a need to impart agro-meteorological training to departmental personnel at different levels (Policy, District, Upazila and Block levels):
   i.
   ii.
   iii.

10. Who bears responsibility of developing the contents of different types of agro-meteorological advisory messages/recommendations?

11. Are you satisfied with the current level of agro-meteorological advisory services of DAE? Y/N. Please point out logics in favour of your statement.
    i.
    ii.
    iii.

12. Your suggestions to bridge the gaps between supply and demand of agro-meteorological advisory services, if any:
    i.
    ii.
    iii.

Thank you for the time and effort given.

Particulars of Interviewer

Name of Enumerator:	
Mobile Number:	
Date Interviewed:	
Signature of the Enumerator:	Date:
Name of Coordinator:	Date:

Annex-3. KII Checklist for District Level Personnel of DAE
Agro-meteorological Training Needs Assessment

1. Hopefully you are aware about agro-metrological advisory services provided by DAE to the farmers? (Yes/No)

2. If yes, please mention the existing sources of agro-metrological information/forecasts you disseminate:
   i.
   ii.
   iii.

3. Please mention the major extreme weather events affecting crop yield and productivity in your area:

4. Please mention the name of crops affected by extreme weather events in different seasons your area:
   i. Rabi:
   ii. Kharif-I:
   iii. Kharif-II:

5. Please name the Extreme Weather Events causing crop damage in different seasons:
   i. Rabi:
   ii. Kharif-I:
   iii. Kharif-II:

Weather Event Code: 1. Drought; 2. Cold Wave; 3. Prolong Fogy Days; 4. Prolong Warm Period in Winer; 5. Prolong Rainless Days; 6. Hail Storm; 7. North Wester; 8. Heat Wave; 9. Flood; 10. Soil/River Bank Erosion; 11. Prolong Cloudy Period; 12. Sudden Heavy Rain; 13. Prolong rainy days; 14. Soil Salinity; 15. Cyclone; 16. Storm Surge; 17. Land Slide; 17. Other 1; 17. Other 2: ; 18. Other 3.

4. What are the major contents of current agro-meteorological advisory messages/ forecasts given to the farmers/Target groups?
   i.
   ii.
   iii.

5. What is your opinion regarding the adequacy and quality of agro-meteorological advisory services provided by DAE and other organizations to the farmers:

6. Is it adequate? (Yes/No). Please provide reason in favour of your statement
   i.
   ii.
   iii.
7. Is the quality satisfactory? (Yes/No). Please provide reason in favour of your statement
   i.
   ii.
   iii.

8. Do you think there are gaps between needs (demand) and qualitative and quantitative aspects of agrometeorological service delivery in the present scenario of the District, Upazila and Block levels? (Yes/No)
9. If yes, then what are your suggestions to improve the services? (e.g., including all relevant parameters in the messages, publication of bulletins/leaflets, developing Mobile Apps and SMS services, etc.).
   i.
   ii.
   iii.

10. What are the major channels/means used to send agro-meteorological advisory messages/forecasts to the farmers/Target groups?
    i.
    ii.
    iii.

11. What is the level of competency of Upazila/Block level officers regarding development and delivery of agro meteorological advisory messages:

12. Please mention the major types of agro-meteorological training given to the departmental personnel (District, Upazila and Block levels):

    District:

    Upazila:

    Block:

13. Please mention the training needs at different levels (District, Upazila and Block) to improve the capacity to develop deliver different types of agro-meteorological advisory messages:
    District:

    Upazila:

    Block:

Thank you for the time and effort given.

Particulars of Interviewer

Name of Enumerator:	
Mobile Number:	
Date Interviewed:	
Signature of the Enumerator:	Date:
Name of Coordinator:	Date:

Annex-4. In-depth Interview Schedule for District Training Officers

Agro-meteorological Training Needs Assessment

1. Hopefully, you are aware that DAE is given the responsibility to provide agro-meteorological advisory services to the farmers and related stakeholders? (Yes/No).
2. If yes, please mention the services currently being provided by DAE:

   i.

   ii.

   iii.
3. Do you use the weather information (rainfall, temperature, relative humidity, wind speed and evapotranspiration, forecast of extreme weather events, etc.in developing agro-meteorological advisory messages? (Yes/No)
4. Please mention the sources of meteorological messages you are currently using:

   i.

   ii.

   iii.
5. Do you think that the meteorological data you have access to, is adequate to meet the needs of satisfactory agro-meteorological advisory service delivery for the district (given that there are a large number of extreme weather events affecting agriculture in different ways)? (Yes/No).
6. If no, please suggest as to how the data gap could be minimized/ what are the data need to be included?:

   i.

   ii.

   iii.
7. The following Table shows a number of crops that may be affected by extreme weather events. Could you give an idea of the extent and nature of crop damage in the district?

Crop Type	Crop Name	Extent, Nature and Time of Crop Damage by Weather Calamities			
		% Damage	Nature of Damage	Time /Month of Damage	Specific Observation/ Remarks of Respondents
Cereal Crops	Boro Rice				
	Aus Rice				
	T. Aman Rice				
	B. Aman Rice				
	Wheat				
	Maize				
Oilseed crops	Mustard				
	Sesame				
	Groundnut				
Pulse Crops	Chickpea				
	Lentil				

Crop Type	Crop Name	Extent, Nature and Time of Crop Damage by Weather Calamities			
		% Damage	Nature of Damage	Time /Month of Damage	Specific Observation/ Remarks of Respondents
	Grass pea				
	Mungbean				
Spices Crops	Onion				
	Garlic				
	Chili				
Vegetable crops	Cabbage				
	Cauliflower				
	Sweet gourd				
	Ash gourd				
	Bitter gourd				
	Bottle gourd				
	Potato				
	Tomato				
	Brinjal				
	Country bean				
Fruit (Field)	Watermelon				
	Mask melon				
Fruit (Tree)	Mango				
	Litchi				
	Banana				
	Papaya				
	Jujube				
	Guava				
	Other Fruits				
Others					
Weather Event Code: 1. Drought; 2. Cold Wave; 3. Prolong Fogy Days; 4. Prolong Warm Period in Winer; 5. Prolong Rainless Days; 6. Hail Storm; 7. North Wester; 8. Heat Wave; 9. Flood; 10. Soil/River Bank Erosion; 11. Prolong Cloudy Period; 12. Sudden Heavy Rain; 13. Prolong rainy days; 14. Soil Salinity; 15. Cyclone; 16. Storm Surge; 17. Land Slide; 17. Other 1; 17. Other 2: ; 18. Other 3.					

8. Who develops the contents of the farmers' advisory (messages) for different extreme weather events for the district(Y/N)

9. Do you think collaboration and linkages among DAE, BMD, SPARRSO, BWDB and Universities would be helpful in developing appropriate contents of agro-metrological advisory messages/forecasts and delivery mechanisms;

   If yes, in what way?

10. Do you consider whether DAE officials of the district down to the rank of SAAOs have adequate knowledge and skills on effects/impacts of different extreme weather events on various crops in different seasons? (Yes/No)

11. Are the officials of the district down to SAAOs have the appropriate training (knowledge and skills) to cater the needs of agro-meteorological advisory services? (Yes/No)
12. If no, please mention the details of the training required (e.g., subject matter content, sourcing and processing of agro –meteorological information, development of advisory messages, means of information dissemination, effect of various extreme weather events on crops and crop performance, etc.):

    i.

    ii.

    iii.
13. How the UAOs, AEOs and SAAOs disseminate the agro-meteorological information to the farmers in time? Please mention the media and methods?

    i. Media:

    ii. Methods:
14. Can the Upazila level officers i.e. UAO, AEOs, SAAOs disseminate agro-meteorological information to the farmers in time? (Yes/No)

If no, please mention the reasons:

    i.

    ii.

    iii.

15. What type of farmer friendly information dissemination mechanism would be focused (e.g., text message, SMS, voice mail, leaflets, loud speaker, etc.in future?

    i.

    ii.

    iii.

16. Are farmers capable enough to use the information contained in the agro-meteorological services? (Y/N)

    If no, how farmers' capacity to interpret and use the information they get in bulletin, media news or otherwise may be improved?

    i.

    ii.

    iii.

17. If it is training, what type of training to be given to farmers (content & duration)?
    i.
    ii.
    iii.

18. Do you think including crop-based agro-meteorological information would help minimize crop damage and improve productivity? (Yes/No)

19. What are your recommendations for improvement of the current agro-meteorological services in terms of quality and outreach?

    i.

    ii.

    iii.

    iv.

    v.

Thank you for the time and effort given.

Particulars of Interviewer

Name of Enumerator:	
Mobile Number:	
Date Interviewed:	
Signature of the Enumerator:	Date:
Name of Coordinator:	Date:

Annex-5. FGD Checklist for SAAOs
Agro-meteorological Training Needs Assessment

1. Are you aware about of the agro-meteorological advisory services provided by DAE? (Yes/No)

   If Yes, do you personally provide agro-meteorological advisory messages to the farmers? (Yes/No)

2. What are major types of advisory messages disseminated to the farmers?
   i.
   ii.
   iii.

3. Which are the major means/channels of dissemination/delivery of agro-meteorological advisory messages used at SAAO level?
   i.
   ii.
   iii.

4. Do you consider that SAAOs are adequately knowledgeable/trained and skilled on effects/impacts of different extreme weather events/calamities on various crops in different seasons? (Yes/No)

5. Do you consider that SAAOs have training needs to develop/improve the capacity to develop and deliver agro-meteorological advisory messages? (Yes/No)

   If yes, please mention the titles and subject matter content of training needed;
   i.
   ii.
   iii.

6. How you deliver the agro-meteorological advisory messages?
   i.
   ii.
   iii.

7. Do you think that farmers have proper knowledge and skills to understand and use agro-meteorological advisory messages? (Yes/No))

   If No, what specific training they need;
   i.
   ii.
   iii.

Thank you for the time and effort given.

Particulars of Interviewer

Name of Enumerator:	
Mobile Number:	
Date Interviewed:	
Signature of the Enumerator:	Date:
Name of Coordinator:	Date:

Annex-6. Household Survey Questionnaire

কৃষি সম্প্রসারণ অধিদপ্তর
কৃষি আবহাওয়া তথ্য উন্নতকরণ প্রকল্প
কৃষি-আবহায়া সংক্রান্ত প্রশিক্ষণ চাহিদা মূল্যায়ন

খানা জরীপ প্রশ্নমালা

১. উত্তরদাতার বিবরণ

১.১	উত্তরদাতার নাম	:		১.২	বয়স	:	
১.৩	মোবাইল নম্বর	:		১.৪	গ্রাম	:	
১.৫	ইউনিয়ন	:		১.৬	উপজেলা	:	
১.৭	কৃষক শ্রেণী	:					
কৃষক শ্রেণী কোডঃ ভূমিহীন (জমির পরিমান ৫ শতাংশের নিচে)=1; প্রান্তিক (৫-৪৯ শতাংশ)=2; ক্ষুদ্র (৫০-২৪৯ শতাংশ)=3; মধ্যম (২৫০-৭৪৯ শতাংশ)=4; বড় (৭৫০ শতাংশ বা তার অধিক)=5							

২. উত্তরদাতার খানার জনমিতিক বৈশিষ্ট্য (কোড ব্যবহার করুন)

খানা সদস্য	খানা প্রধানের সাথে সম্পর্ক	বয়স (পূর্ন বৎসর)	লিঙ্গ (পুরুষ=1, মহিলা=2)	শিক্ষা	পেশা	গড় মাসিক আয় (টাকা)
১.						
২.						
৩.						
৪.						
৫.						
৬.						
৭.						
৮.						
৯.						
১০.						
সম্পর্ক কোড: খানা প্রধান=1, স্বামী=2, স্ত্রী=3, ছেলে=4, মেয়ে=5, পিতা=6, মাতা=7, ভাই=8, বোন=9, অন্যান্য=10						
শিক্ষা কোড: ৫ বছরের নিচে=1, নিরক্ষর=2, পড়তে ও লিখতে পারে=3, প্রাথমিক=4, এস.এস.সি এর নিচে=5, এস.এস.সি=6, এইচ.এস.সি এর নিচে=7, এইচ.এস.সি=8, গ্রাজুয়েট এর নিচে=9, গ্রাজুয়েট=10, মাস্টার্স ও এর উপরে=11						
পেশা কোড: নির্ভরশীল=1, ছাত্র=2, কৃষি=3, কৃষি শ্রমিক=4, অকৃষি শ্রমিক=5, গৃহস্থলীর কাজ=6, চাকুরি=7, পরিবহন=8, ব্যবসা=9, কুটির শিল্প=10, বেকার=11, অন্যান্য=12						

নোট: শুধুমাত্র মহিলাদের ক্ষেত্রে গৃহস্থলীর কাজ ব্যতীত অন্যকোন পেশায় জড়িত থাকলে তা উল্লেখ করুন

৩. জমির মালিকানা ও ব্যবহার

কোড	মালিকানার	জমির ব্যবহার (শতাংশ)

	ধরণ	বসত ভিটা	কৃষি জমি	ফল বাগান	কাঠ বাগান	পুকুর	মাছের ঘের	স্থায়ী পতিত	অন্যান্য
1.	নিজস্ব								
2.	ইজারা-নেয়া								
3.	ইজারা-দেয়া								
4.	বর্গা-নেয়া								
5.	বর্গা-দেয়া								
6.	ভাড়া-নেয়া								
7.	ভাড়া-দেয়া								
মোট									

৪. বিভিন্ন মৌসুমে আবহাওয়ার চরম অবস্থা ও ক্ষতিগ্রস্থ প্রধান প্রধান ফসল

ফসলের মৌসুম		আবহাওয়ার চরম অবস্থা	ক্ষতিগ্রস্থ প্রধান প্রধান ফসলের নাম (কোড)
১.	**রবি: ১৬** অক্টোবর-১৫ মার্চ (কার্তিক-ফাল্গুন)		
২.	**খরিফ-১: ১৬** মার্চ-১৫ জুলাই (চৈত্র-আষাঢ়)		
৩.	**খরিফ-২: ১৬** জুলাই-১৫ অক্টোবর (শ্রাবণ-আশ্বিন)		

আবহাওয়ার চরম অবস্থা কোড: ক্ষরা=1, শৈত্য প্রবাহ=2, দীর্ঘ মেয়াদী কুয়াচ্ছন্নতা=3, শীত কালে দীর্ঘ উষ্ণ সময়=4, দীর্ঘ মেয়াদী বৃষ্টি হীনতা=5, শিলা বৃষ্টি=6, কালবৈশাখী ঝড়=7, বজ্রঝড়=8, ঘুর্নিঝড় (সাইক্লোন)=9, নিম্ন চাপ=10, তাপ প্রবাহ=11, বন্যা=12, মাটি ক্ষয়/নদীর পাড় ভাঙ্গন=13, দীর্ঘ মেয়াদী মেঘাচ্ছন্নতা=14, হঠাৎ ভারী বর্ষন=15, দীর্ঘ মেয়াদী বৃষ্টিপাত=16, মাটির লবনাক্ততা=17, লবনাক্ত পানির অনুপ্রবেশ=18, জলচ্ছ্বাস=19, ভূমি ধ্বস=20, অন্যান্য-১ (উল্লেখ করুন).....=21, অন্যান্য-২ (উল্লেখ করুন)=22

ফসল কোড: ***দানাদার ফসল:*** বোরো=1, আউশ=2, রোপা আমন=3, বোনা আমন=4, গম=5, ভূট্টা=6; ***তৈলবীজ ফসল:*** সরিষা=7, তিল=8, চীনাবাদাম=9, সূর্যমুখী=10; ***ডাল ফসল:*** ছোলা=11, মসুর=12, খেসারী=13, মুগডাল=14, অড়হর=15, ফেলন=16, মটর=17, মাসকলাই=18; ***মসলা ফসল:*** পেঁয়াজ=19, রসুন=20, মরিচ=21, ধনিয়া=22, আদা=23, হলুদ=24; ***শাকসব্জি:*** বাধাকপি=25, ফুলকপি=26, মিষ্টি কুমড়া=27, চাল কুমড়া=28, করলা=29, লাউ=30, টমেটো=31, বেগুন=32, সীম=33, পানি কচু=34, ডাঁটা=35, লালশাক= 36, পুঁইশাক=37, গীমা কলমি=38, পটল=39, ঢেঁড়শ =40, ঝিংগা=41, চিচিঙ্গা=42, গাজর=43, মূলা=44, ওলকপি=45, ব্রকলি=46, শসা=46, ক্ষীরা=47, কাঁকরোল=48;
কন্দাল ফসল: আলু=49, মিষ্টি আলু=50, মুখীকচু=51; ***ফল জাতীয় মাঠ ফসল:*** তরমুজ=52, বাংগী=53, আনারস=54 ; ***ফলদ গাছ:*** আম=55, কাঠাল=৫৬, লিচু=57, পেয়ারা=58, বরই=59, পেঁপে=60, কলা=61, জাম=62; ***আঁশ জাতীয় ফসল:*** পাট (দেশী)=63, পাট তোষা)=64, তুলা=65; ***নেশা জাতীয় ফসল:*** পান=66, তামাক=67, ***চিনি জাতীয় ফসল:*** আখ=68, অন্যান্য-২ (উল্লেখ করুন)=69

৫. আবহাওয়ার গুরুত্বপূর্ণ চরম অবস্থায় ক্ষতিগ্রস্থ ফসলের নাম উল্লেখ করুন (১০টি পর্যন্ত)

ফসলের নাম (কোড)	ফসলের জন্য ক্ষতিকর আবহাওয়ার চরম অবস্থা (৪টি কোড)	ফলনের ক্ষতি (%)	ক্ষতির প্রকৃতি (কোড)	মোকাবিলার কৌশল (অনুগ্রহ পূর্বক উল্লেখ করুন)

ফসলের নাম (কোড)	ফসলের জন্য ক্ষতিকর আবহাওয়ার চরম অবস্থা (৪টি কোড)		ফলনের ক্ষতি (%)	ক্ষতির প্রকৃতি (কোড)	মোকাবিলার কৌশল (অনুগ্রহ পূর্বক উল্লেখ করুন)
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ফসলের নাম (কোড)	ফসলের জন্য ক্ষতিকর আবহাওয়ার চরম অবস্থা (৪টি কোড)		ফলনের ক্ষতি (%)	ক্ষতির প্রকৃতি (কোড)	মোকাবিলার কৌশল (অনুগ্রহ পূর্বক উল্লেখ করুন)
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	২				
	৩				
	৪				

আবহাওয়ার চরম অবস্থা কোডঃ

ক্ষরা=1, শৈত্য প্রবাহ=2, দীর্ঘ মেয়াদী কুয়াচ্ছন্নতা=3, শীত কালে দীর্ঘ উষ্ণ সময়=4, দীর্ঘ মেয়াদী বৃষ্টি হীনতা=5, শিলা বৃষ্টি=6, কালবৈশাখী ঝড়=7, বজ্রঝড়=8, ঘুর্নিঝড় (সাইক্লোন)=9, নিম্ন চাপ=10, তাপ প্রবাহ=11, বন্যা=12, মাটি ক্ষয়/নদীর পাড় ভাঙ্গন=13, দীর্ঘ মেয়াদী মেঘাচ্ছন্নতা=14, হঠাৎ ভারী বর্ষন=15, দীর্ঘ মেয়াদী বৃষ্টিপাত=16, মাটির লবনাক্ততা=17, লবনাক্ত পানির অনুপ্রবেশ=18, জলচ্ছ্বাস=19, ভূমি ধ্বস=20,
অন্যান্য-১ (উল্লেখ করুন).....=21, অন্যান্য-২ (উল্লেখ করুন)=22

ক্ষতির প্রকৃতি কোডঃ

চারা না গজানো=1, ফসলের দৈহিক ক্ষতি=2, ফসল ভেঙ্গে পড়া/হেলে পড়া/ উপড়ে পড়া=3,
সম্পূর্ণরূপে ফসল ক্ষতিগ্রস্থ হওয়া=4, রোগের প্রাদুর্ভাব=5, পোকামাকড়ের প্রাদুর্ভাব=6, আগাছার প্রাদূর্ভাব=7,
ফসল ঝড়ে পড়া=8, ফল পড়ে যাওয়া=9, উৎপাদিত ফসলের গুনগত মান হ্রাস=10, অন্যান্য=11 (উল্লেখ করুন .....)

৬. ফসল উৎপাদন ও সংশ্লিষ্ট কার্যক্রমে আবহাওয়ার চরম অবস্থা/দুর্যোগের প্রভাব সম্পর্কে বলুন

ফসল উৎপাদন কার্যক্রমের পর্যায়		আবহাওয়ার চরম অবস্থা/দুর্যোগ (কোড)	ক্ষতির প্রকৃতি (উল্লেখ করুন)	ফসলের নাম (কোড)
১.	জমি তৈরী			
২.	বীজ বপন			
৩.	চারা তৈরী			
৪.	চারা রোপন			
৫.	সার প্রয়োগ			
৬.	আগাছা দমন			
৭.	বিভিন্ন স্প্রে ব্যবহার			
৮.	ফসল কর্তন			
৯.	মাড়াই ও ঝাড়াই			
১০.	শুকানো			
১১.	সংরক্ষণ			
১২.	বাজারজাতকরণ			
১৩.				
১৪.				

আবহাওয়ার চরম অবস্থা কোডঃ

ক্ষরা=1, শৈত্য প্রবাহ=2, দীর্ঘ মেয়াদী কুয়াচ্ছন্নতা=3, শীত কালে দীর্ঘ উষ্ণ সময়=4, দীর্ঘ মেয়াদী বৃষ্টি হীনতা=5, শিলা বৃষ্টি=6, কালবৈশাখী ঝড়=7, বজ্রঝড়=8, ঘুর্নিঝড় (সাইক্লোন)=9, নিম্ন চাপ=10, তাপ প্রবাহ=11, বন্যা=12, মাটি ক্ষয়/নদীর পাড় ভাঙ্গন=13, দীর্ঘ মেয়াদী মেঘাচ্ছন্নতা=14, হঠাৎ ভারী বর্ষন=15, দীর্ঘ মেয়াদী বৃষ্টিপাত=16, মাটির লবনাক্ততা=17, লবনাক্ত পানির অনুপ্রবেশ=18, জলচ্ছ্বাস=19, ভূমি ধ্বস=20, অন্যান্য-১ (উল্লেখ করুন).....=21, অন্যান্য-২ (উল্লেখ করুন)=22

ফসল কোড

দানাদার ফসলঃ বোরো=1, আউশ=2, রোপা আমন=3, বোনা আমন=4, গম=5, ভূট্টা=6; ***তৈলবীজ ফসলঃ*** সরিষা=7, তিল=8, চীনাবাদাম=9, সূর্যমুখী=10; ***ডাল ফসলঃ*** ছোলা=11, মসুর=12, খেসারী=13, মুগডাল=14, অড়হর=15, ফেলন=16, মটর=17, মাসকলাই=18; ***মসলা ফসলঃ*** পেঁয়াজ=19, রসুন=20, মরিচ=21, ধনিয়া=22, আদা=23, হলুদ=24; ***শাকসব্জিঃ*** বাধাকপি=25, ফুলকপি=26, মিষ্টি কুমড়া=27, চাল কুমড়া=28, করলা=29, লাউ=30, টমেটো=31, বেগুন=32, সীম=33, পানি কচু=34, ডাঁটা=35, লালশাক= 36, পুঁইশাক=37, গীমা কলমি=38, পটল=39, ঢেঁড়শ =40, ঝিংগা=41, চিচিঙ্গা=42, গাজর=43, মূলা=44, ওলকপি=45, ব্রকলি=46, শসা=46, ক্ষীরা=47, কাঁকরোল=48;

কন্দাল ফসলঃ আলু=49, মিষ্টি আলু=50, মুখীকচু=51; ***ফল জাতীয় মাঠ ফসলঃ*** তরমুজ=52, বাংগী=53, আনারস=54 ; ***ফলদ গাছঃ*** আম=55, কাঠাল=৫৬, লিচু=57, পেয়ারা=58, বরই=59, পেঁপে=60, কলা=61, জাম=62;

আঁশ জাতীয় ফসলঃ পাট (দেশী)=63, পাট তোষা)=64, তুলা=65; ***নেশা জাতীয় ফসলঃ*** পান=66, তামাক=67, ***চিনি জাতীয় ফসলঃ*** আখ=68, অন্যান্য-২ (উল্লেখ করুন)=69

৭. কৃষি আবহাওয়া পূর্বাভাস ও পরামর্শ বার্তা গ্রহণ সম্পর্কিত অবস্থা বর্ননা করুন

ক্র.ন.	পূর্বাভাস/সতর্কতা প্রদানকৃত আবহাওয়ার অবস্থা	আবহাওয়ার পূর্বাভাস সম্পর্কে ধারণা আছে কি না?		পরামর্শ প্রাপ্তি		বার্তার প্রয়োগযোগ্যতা		বার্তার উৎস (কোড)	বার্তা গ্রহণের মাধ্যম (কোড)
		হ্যাঁ=1	না=2	হ্যাঁ=1	না=2	উপকারী=1	উপকারী নয়=2		
১.	ক্ষরা								
২.	শৈত্য প্রবাহ								
৩.	দীর্ঘ মেয়াদী কুয়াচ্ছন্নতা								
৪.	শীত কালে দীর্ঘ উষ্ণ সময়								
৫.	দীর্ঘ মেয়াদী বৃষ্টি হীনতা								
৬.	শিলা বৃষ্টি								
৭.	কালবৈশাখী ঝড়								
৮.	বজ্রঝড়								
৯.	ঘুর্নিঝড় (সাইক্লোন)								
১০.	নিম্ন চাপ								
১১.	তাপ প্রবাহ								
১২.	আগাম বন্যা								
১৩.	পরে বন্যা								
১৪.	মাটি ক্ষয়/নদীর পাড় ভাঙ্গন								
১৫.	দীর্ঘ মেয়াদী মেঘাচ্ছন্নতা								
১৬.	হঠাৎ ভারী বর্ষন								
১৭.	দীর্ঘ মেয়াদী বৃষ্টিপাত								
১৮.	মাটির লবনাক্ততা								
১৯.	লবনাক্ত পানির অনুপ্রবেশ								
২০.	জলচ্ছ্বাস								
২১.	ভূমি ধ্বস								

বার্তার উৎস কোড:
কৃষি সম্প্রসারণ অধিদপ্তর=1, আবহাওয়া অধিদপ্তর=2, প্রশাসন (ডিসি/ইউএনও)=3, অন্যান্য=4

বার্তা গ্রহণের মাধ্যম কোড:
টেলিভিশন=1, রেডিও=2, মোবাইল ফোন=3, প্রতিবেশী=4, সংবাদ পত্র=5, এনজিও কর্মী=6,
কৃষি অফিসের কর্মকর্তা/কর্মচারী=7, অন্যান্য=8

৮. নিম্নোক্ত বিষয় সম্পর্কে আপনার বিশেষ মন্তব্য/পরামর্শ দিন

৮.১ কৃষি পরামর্শ বার্তা/পূর্বাভাস কিভাবে ও কি পরিসরে ফসল উৎপাদনে আপনার উপকারে আসছে?

৮.২ ফসল উৎপাদনে কৃষি পরামর্শ সেবার সুবিধা পেতে আপনার কি ধরণের জ্ঞান ও দক্ষতার প্রয়োজন রয়েছে বলে আপনি মনে করেন?

৯. কৃষি-আবহাওয়া সংক্রান্ত পরামর্শমূলক বিভিন্ন পরামর্শ বার্তা/ পূর্বাভাস বুঝতে পাড়া ও তা ব্যবহারে জন্য বিশেষ কোন প্রশিক্ষণের প্রয়োজন আছে বলে কি আপনি মনে করেন ?

হ্যাঁ [1] না [2]

৯.১ উত্তর হ্যাঁ হলে, আপনার জন্য উপকারী প্রশিক্ষণের বিষয়বস্তু ও ধরণ সম্পর্কে বলুন :

প্রশিক্ষণের বিষয়বস্তু (কোড)	প্রশিক্ষণের ধরণ (কোড)

প্রশিক্ষণের বিষয়বস্তু কোড:
আবহাওয়ার চরম অবস্থা/দূর্যোগ সম্পর্কিত=1, দূর্যোগ ব্যবস্থাপনা সম্পর্কিত করিগরি জ্ঞান=2,
বার্তার বিষয়বস্তু ও ব্যবহার সম্পর্কিত জ্ঞান=3, অন্যান্য=4

প্রশিক্ষণের ধরণ কোড:
শ্রেণী কক্ষে লেকচার=1, হাতে কলমে প্রশিক্ষণ=2, অংশগ্রহণমূলক ব্যবহারিক প্রশিক্ষণ=3,
অংশগ্রহণমূলক ব্যবহারিক প্রশিক্ষণের সাথে চরম অবস্থা ব্যবস্থাপনা ম্যানুয়েল বিষয়ে প্রশিক্ষণ=4, অন্যান্য=5

মূল্যবান সময় প্রদান ও প্রচেষ্টার জন্য আপনাকে ধন্যবাদ

সাক্ষাৎকার গ্রহণকারীর বিবরণ				
সাক্ষাৎকার গ্রহণকারীর নাম	:			
মোবাইল নম্বর	:			
সাক্ষাৎকার গ্রহণের তারিখ	:			
সাক্ষাৎকার গ্রহণকারীর স্বাক্ষর	:		তারিখ: /	/২০১৯ ইং
কো-অর্ডিনেটর	:		তারিখ: /	/২০১৯ ইং