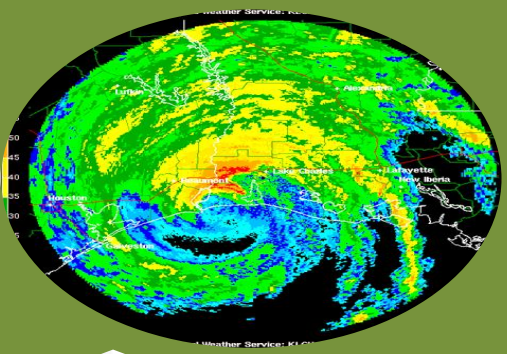
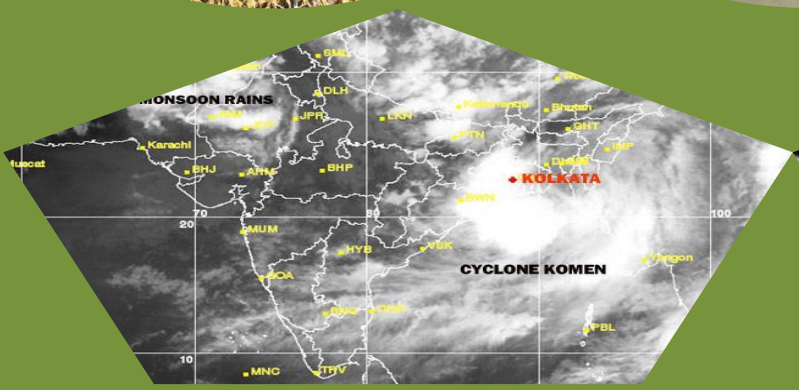
Baseline Survey Report
to

Assess User Satisfaction of Agro-Meteorological Advisories and Products Under the Agro-Meteorological Information Systems Development Project





June 2018

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CHAPTER-1

BACKGROUND OF THE STUDY

1.1 Introduction

The baseline survey report was prepared in accordance with the provision of contract agreement signed between the Project Director (PD) of Agro-Meteorological Information Systems Development Project (AMISDP) and Development Technical Consultants Pvt. Limited (DTCL) on 29 March 2018. Development Technical Consultants Pvt. Ltd. (DTCL) is pleased to the project authority for selecting DTCL for conducting the baseline survey to Assess User Satisfactions of Agro-Meteorological Advisories and Products". This AMISDP is a part of Component-C of Bangladesh Weather and Climate Services Regional Project (BWCSRP) which is implementing in 487 upazilas of 64 districts under 8 divisions of Bangladesh. The baseline survey was conducted in 16 sample upazilas of Rajshahi, Naogaon, Patuakhali, Satkhira, Sunamganj, Netrokona, Khagrachari and Bandarban districts.

The aim of the project is to strengthen the capacity of the Department of Agricultural Extension (DAE) of the Government of Bangladesh (GOB) to deliver reliable weather, water and climate information/advisories or services. The objectives of the project will be achieved in improving access to such services for farmers and communities to cope-up with the weather and climate risks therefore increase agricultural production. The project is implementing by the Department of Agricultural Extension (DAE) of the Ministry of Agriculture (MOA) from July 2016 and will be continued until June 2021.

1.2 Background and Rationale of the Project

Agriculture is the main driving force of the economy of Bangladesh, which is highly dependent on climatic phenomena. Despite technological improvements such as improved crop varieties and irrigation system, weather and climate are still key factors in agricultural productivity. Changes in temperature, erratic behavior of rainfall, increasing frequency and intensity of weather-related extreme events including floods, droughts, cyclone and storm-surge influence changes in cropping patterns and seasons. Salinity intrusion into inland water and soil are other major climate change related threats to agriculture. The impact of climate change on agriculture could result in problems with food security and may threaten the livelihood activities upon which much of the population depends.

The hydro-meteorological information infrastructure over land, atmosphere and ocean, basic public weather services, forecasting, and multi-hazard end-to-end early warning systems of the country is still weak and need to be updated and strengthened. Agriculture sector needs tailored weather and climate data and services which are very essential for proper planning and decision-making to mitigate the adverse effects of climate variability and changes. Provision of these types of services is still limited and needs to be strengthened for the effectiveness of agro-met service delivery.
The food production in Bangladesh is highly vulnerable due to the erratic behavior of climatic phenomena. However, the rate of variation is not same in all the parts of the country. Bangladesh Meteorological Department (BMD) is only the mandated organization to generate early warning related to weather and climate hazards along with weather and climate prediction information and agro-met services. Currently, BMD provides agro climatic advisory bulletin to the Department of Agriculture Extension (DAE) and relevant other organizations (BMD, 2007). The bulletins also give some advice to the farmers against the disastrous impacts, such as probable water stress, pest infestations and diseases, winter fog and cold weather, soil moisture, sunshine hours, solar radiation, temperature, evaporation and humidity, etc. However, BMD issued forecast is not easy to understand for all of the farmers. Moreover, most of the farmers still do not have the facilities to access this information due to lack of required support of the equipment.

Considering the above importance of the sector, the Government of Bangladesh (GoB) with support from the World Bank (WB) is implementing the "Agro-Meteorological Information Systems Development Project (AMISDP)" under the Component-C of "Bangladesh Weather and Climate Services Regional Project (BWCSRP)" to strengthen the capacity of the DAE regarding agro-met service delivery. The project will assist in delivering reliable weather and climate information/advisories or services to the farmers and communities. The objectives of the project will be achieved by strengthening hydro-meteorological information/advisories and forecasting delivery related to weather, climate and flood for multi-hazard disaster risk management of the agricultural sector. Therefore, hydro-meteorological services delivery will be improved to increase agricultural production.

The project is aligned with **Sustainable Development Goals (SDG-2)** (end hunger, achieve food security and improved nutrition and promote sustainable agriculture), SDG-13 (Take urgent action to combat Climate Change and its impact) and SDG-15 (Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reserve land degradation and halt biodiversity loss).

The project fully conforms to **7th Five Year Plan**-4.3.1. Plan Policies and strategies for Crop Sub-Sector: Technology based weather prediction and forecasting.

The project targets 30,000 lead farmers to be direct beneficiaries and 300,000 farmers will be indirect beneficiaries of the project. This project will increase and sustain the present agricultural production through modernized agro-meteorological advisories, early warning and forecasting. It will provide better decision-making process of the farming community. This project will also help farmers to reduce their production loss by effective use of agro-met advisories.[1]

The summary of the project at a glance is given below:

1	**Name of the Project**	**Agro-Meteorological Information Systems Development Project (AMISDP)**	
2	**Administrative Ministry**	Ministry of Agriculture	
3	**Funding Agency**	The World Bank and Government of Bangladesh (GOB)	
4	**Implementing/ Executing Agency**	Department of Agricultural Extension (DAE)	
5	**Location of the Project**	4051 Union Parishads of 487 Upazilas of 64 Districts of 08 Divisions	
6	**Estimated Cost (Lakh Taka)**	Total: 11,918.08	GOB: 1304.38 PA: 10613.70 (World Bank)
7	**Implementation Period**	**Date of Commencement**	**Date of Completion**
		July 2016	June 2021

Source: PAD of BWCSRP

1.3 Component of the project

The brief descriptions of the component and sub-components of the AMISDP had been described as follows:

Component C- Agro-Meteorological Information Systems Development: Component C is implementing by the Department of Agricultural Extension (DAE), with the support of the Agricultural Meteorology Division of the Bangladesh Meteorological Department (BMD). The main sub-components include:

- **Sub-Component C1**: Establishment of the Bangladesh Agro-Meteorological Information System (BAMIS);

[1] Project Appraisal Document (PAD) of BWCSRP)

- **Sub-Component C2**: Training, Capacity Building, Project Management, Monitoring and Evaluation; and
- **Sub-Component C3**: Agricultural Disaster Risk Management through agro-meteorological information dissemination.

The brief description of the sub-components is furnished below:

Sub-Component C.1: Establishment of the Bangladesh Agro-Meteorological Information System (BAMIS)

This sub-component supports the establishment of BAMIS web portal for the provision of data, information, Agro-Meteorological advisories and products such as crop and weather bulletins, drought and heat directories, climate-weather risk maps and services such as short and medium range weather forecasts and seasonal climate outlooks to stakeholders on the web. Specifically, this sub-component will support the following activities:

- Setting up a Comprehensive web-portal for BAMIS at DAE,
- BAMIS infrastructure,
- Development of upazila level agro-met databases,
- Agro-met data analysis and future scenario development,
- Development of advisories and
- Risk mapping of climate vulnerable communities.

This component will provide improved Agro-Meteorological services to farmers across the country to sustain and increase agricultural production in coping with extremes weather and climate. It will support to establish a science-based agro-met information and products to mitigate climate-related agricultural production risks. This will also support to improve the capacity of DAE officials at different levels for effective delivery of climate information and services to the farmers. The following major activities will be performed through the component:

Development of upazila level agro-meteorological databases: In 200 upazilas of the country where Automatic Weather Stations (AWS) (installed under component A) will provide real-time data on all important weather variables. The project is supporting digitalization of historical and current agricultural data on the land holdings, crops/cropping systems cultivated by farmers, average crop yields in different upazilas etc., (currently available as hard copy documents). Under the technical guidance of an International Agro-Meteorological Consultant, DAE, with BMD support, integrating the AWS weather and agricultural data and compiling Agro-Meteorological databases for the 487 upazilas, which will be located in the BAMIS at DAE. These Agro-Meteorological databases will be used to conduct a variety of Agro-Meteorological analyses and to generate information and products for use by the farming communities in different upazilas.

Agro-Meteorological data analysis and future scenario generation: The project is supporting a technical consultancy on conducting Agro-Meteorological data analyses, future scenario generation, including the use of crop models and downscaling the scenarios to block level. Currently, BMD operates 12 Agro-Meteorological stations (out of its 57 weather stations) with long term data for over 40 years for most of the stations. The consultant will assist DAE to develop computations of climatological norms for rainfall, maximum and minimum air temperatures, rainfall probabilities, and combine them with the upazila databases to prepare crop suitability maps for different agro climatic regions in the country. The consultant will guide DAE, with support from BARI, BRRI, BSRI, BJRI and BMD, in developing Agro-Meteorological products for decision support including the selection of optimal planting dates based on expected climate conditions etc. The consultant will also provide assistance in training and capacity building of DAE, BARI, BRRI, BSRI, BJRI and BMD staff on using Agro-Meteorological data, generation of information on soil and crop management practices, and on using a variety of crop models and other tools.

Development of Agro-Meteorological advisories and products for the farming communities: The consultant will help DAE to use the Agro-Meteorological databases and develop Agro-Meteorological advisories and products for use of farmers to make tactical decisions on planting, irrigation, harvesting and processing based on extreme weather events such as heavy rainfall, hail storms etc. It will also support them for implementing crop protection measures on pests and diseases risk reduction.

Risk mapping of climate-vulnerable farming communities: Given the frequent incidence of weather and climate extreme events and the large impact, it is important to identify the vulnerability of farming communities. The component will support the procurement of a consultant in DAE to conduct agricultural disaster risk analysis based on weather and climate information, socio-economic factors such as farmer land holdings and indebtedness, soils information, crops/cropping patterns etc. The analysis will be done at the agro-ecological zone level. Each climate risk can be identified by its natural characteristics, impacts on different geographical areas, time of year it is mostly occurs, and its severity etc., The project will guide the preparation of the climate risk vulnerability maps for all 487 upazilas identifying the areas at risk and vulnerable. Accordingly, DAE and BMD officials will be trained in risk mapping. The component will also explore areas for collaboration with the students from appropriate Universities in this task.

Sub-component C.2 Training, Capacity Building, Project Management and Monitoring and Evaluation:

This Sub-Component aims to strengthen Agro-Meteorological capacity development, project management and monitoring and evaluation of project activities. It includes the following activities:

a. Sub-Component C2.1 Provision of technical training to staff: This will support provision of technical training to professional staff of DAE, BARI, BRRI, BSRI and BJRI: This includes, (a) organization of workshops/ seminars at the BAMIS headquarters in Agro-Meteorological data analysis and development of products and (b) organization of short term training and exposure visits to appropriate institutions and organizations abroad to promote a better understanding of the current methods and approaches in the development of Agro-Meteorological advisories and products. Given the diversity of weather and climate in different agro ecological 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. Hence priority issues will be identified which require detailed technical studies and this component will support the recruitment of a Consultant to organize such technical studies. 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 at the regional, district and upazila levels for officials in the use of BAMIS Portal tools. This project will provide 74 batches of officers, 367 batches of SAAOs and 1000 batches of farmers training. Around 25 National and 70 Regional workshops will also be arranged by the project. Eighty percent budget allocation of the foreign training will cover for foreign training of DAE officials and 20 percent will be allocated for exposure visit. Officials of DAE, Ministry of Agriculture and Planning Commission will be nominated for exposure visit.
The vision for the Agro-Meteorological Information Systems in Bangladesh is an integrated system in which the meteorological community and the agricultural community represented by BMD, DAE, and NARS will work together to produce and disseminate climate and weather information relevant to agriculture thus enhancing climate resiliency and food security in the country. This requires close collaboration between the different agencies responsible for Agro-Meteorological data collection and analysis, agricultural research and extension. Hence a Joint Technical Working Group (JTWG) on Agro-meteorology will be established with the participation of experts from DAE, BARI, BRRI, BSRI, BJRI, BMD and BWDB and support will be provided for the effective functioning of the working group and for the implementation of the decisions taken by the group.

b. Sub-Component C 2.2 Project management, Monitoring and Evaluation: Sub-Component C2.2 will support costs associated with the PIU, operational costs related to DAE operations, additional technical studies, and activities associated with M&E, social outreach and other operational activities.

Sub-Component C.3: Agricultural Disaster Risk Management through Agro-meteorological information dissemination:

This sub-component will support the awareness building and dissemination to farmers of a variety of customized Agro-Meteorological products and tools that will help them to better utilize weather and climate risk in their planning and cope with agricultural disaster risk. The activities include: (1) assessment of farmer's needs for weather and climate services; (2) installation of automatic rain gauges and agro-meteorological display boards at the Union Parishad locations; (3) establishment of kiosks, (4) development of mobile apps; (5) organization of roving seminars and (6) feedback from farmers.

This sub-component supported by the consultant to conduct a baseline survey for a detailed assessment of farmer's needs for weather and climate services. Feedback from farmers will guide quality improvements in Agro-Meteorological products and their dissemination mechanisms. Given the diversity of crops and cropping systems in the 64 districts around the country, the need assessments will contribute to the development and dissemination of need-based advisories and products.

1.4 Outputs of the project

- The project increased the capacity of DAE regarding agro-meteorology. Agro-met advisories will help the farming community to reduce their production loss and better decision making in farming practices.
- Farmers able to use agro-met advisories and send feedback services for user satisfaction.
- Crop simulation model and future scenario generation will help to make future plans and policies in the agriculture sector.
- BAMIS portal facilitated to get hydro-meteorological information of Bangladesh.
- Digitalization of Upazila information will help to utilize GIS and Remote Sensing Technology.

1.5 Objectives of the baseline survey

The main objective of this study is to assess the baseline situation of agro-meteorological (e.g. agro-met) services in Bangladesh to increase agricultural productivity and assist the farmers in coping with changing weather and extreme climatic events. However, the specific objectives of the study are as follows:

- To identify the weather or climate induced hazards effects on agriculture and on their livelihood;
- To identify what type of agro-meteorological services available in Bangladesh and who are the service providers;
- To identify existing agro-meteorological information, ongoing observed parameters and technologies of BMD;
- To assess the farmer's knowledge and perception on agro-met services at the community level;
- To assess the seasonal variation of climatic and weather parameters (e.g. rainfall, temperature etc.) and farmer's perception in relation to crop planning and crop productivity;
- To collect the information regarding agro-met services and products, its functionality, effectiveness and user satisfaction;
- To assess the need/new requirements for agro-met services in order to ensure and

develop effective and user friendly agro-met advisory services for ensuring crop productivity and food security;

- To collect region specific information on land use pattern, demography, hydro-meteorology, agricultural practices, current management practices by farmers and the way of solving problems faced by extreme climatic events;
- To assess whether the existing climate forecast can address the climate variability and recommend necessary arrangements and give recommendations for its improvement;

1.6 Scope of the Work

The scope of works of the survey is to:

- identify the study areas (e.g. District/Upazila/Union) based on the climatic problems and hotspots and expert opinion;
- identify and select tools and methods for conducting agro-meteorological baseline survey;
- identify the weather or climate induced problems on agriculture and on their livelihood through farmers mind/sketch maps and community consultation;
- review of the farmer's knowledge and perception on agro-met services at community level
- observe the seasonal variation of climatic and weather parameters (e.g. rainfall, temperature etc.) and farmer's perception in relation to crop planning and crop productivity
- identify and review the existing documents, advisory tools, products and research work relevant to agro-meteorological services in Bangladesh;
- collect information regarding existing land use pattern, problems regarding climatic events in connection with crop production and the knowledge base, farmers are practicing to solve the challenges;
- find out gaps and weakness of the present agro-met services;
- analysis of agro-climate forecast dissemination network;
- assess institutional capacity regarding dissemination of agro-metrological services to the farmers; and develop survey tools to conduct the households survey. At least 1000 questionnaire survey will be done at household level considering climate induced agricultural constraint.

1.7 Purpose of Baseline Survey

The baseline survey was conducted to collect benchmark of the project situation so that it can compare with the progress of the project activities especially with Mid-term evaluation and end of project evaluation data with the target of the result-framework data to assess the project impact or changes due to this intervention.

CHAPTER-2

APPROACH AND METHODOLOGY

2.1 Approaches

The consultant's approach was in line with the main objective of the study that seeks to gather information and provide the complete picture of the baseline status of agro meteorological (e.g. agro-met) services in Bangladesh to increase agricultural productivity and assist the farmers in coping with changing the weather and extreme climatic events. More precisely the survey revealed the following answers of the project: (a) weather or climate induced problems on agriculture and on the livelihood of farmers; (b) farmer's knowledge and perception on agro-met services at community level; (c) seasonal variation of climatic and weather parameters (e.g. rainfall, temperature etc.) in relation to crop planning and crop productivity; (d) existing agro-meteorological services in Bangladesh; (e) existing farmers' land use pattern, problems regarding climatic events in connection with crop production to solve the challenges; (f) gaps and weakness of the present agro-met services; (g) agro-climate forecast dissemination network; and (h) institutional capacity regarding dissemination of agro-metrological services to the farmers. A wide range of efforts has been done such as i) inception of assignment with PIU-AMISDP/DAE; i) in house meetings among the consultants at DTCL office to prepare the inception report; iii) sharing of inception activities through workshop with the project officials and other experts of DAE at Head Quarter Level; and iv) field visit and interview of relevant stakeholders aiming to gather objective oriented information; v) baseline report has been made in accordance with the objective and scope of the study.

2.2 Methodology

The methodology for the present baseline survey used system-wide approach, which was both detailed and participatory. This approach involved wide-ranging and sequenced discussion with PD/PMU and DAE professionals and officials related to assess the socio-economic and benchmark situation of the project area. The survey involved use of:

(i) formal and non-formal interviews;
(ii) semi-structured interviews by means of focus group discussions and
(iii) field survey through a structured questionnaire
(iv) collection of secondary information
(v) review available reports and
(vi) series of reconnaissance field visits by consultants to the project area.

The reconnaissance field visits covered the substantial part of the project area. During the field visit, consultants interacted with concerned DAE, BMD and BWDB personnel of the survey area. The detailed description of the common activities of the survey has been presented in the following pages:
In accordance with the TOR, the Inception Phase was covered in 30 days for the baseline survey and was basically aimed at preparing the ground for the survey activities. During this phase, the consultant, through the Team of consultants, was engaged in an open and inclusive process with the client and other stakeholders in order to collect and assimilate all relevant current information that was enabled to make an assessment of the survey environment and of the pertinence of the TOR vis-à-vis the actual situation. Following discussions and feedback, the final approval of the inception report was taken from the PD. During this phase the following tasks were implemented:

2.2.1 Organization of the team of experts

The inception of the services initiated after signing Contract Agreement between the PD/PMU and the consulting firm. Consultants and support staff have been deployed to take

up their individual works as per specific inputs stipulated for them in the TOR. The Team Leader has organized and set the stage for this. The consultant mobilized both staff and logistics together with all arrangements for backup supports and communication. The TL and other specialists (according to staffing schedule), as well as support staff, started functioning according to the given tasks and times allocated to them. The TL met PIU consultants of AMISDP at PD's office after submitting draft inception report for follow-up and seeking comments and suggestions from PIU and DAE. The survey consultancy office was accommodated in the firm premises with all furniture and other utilities and together with security arrangements.

2.2.2 Desk Study: Collection and Review of Data, Reports and Information

Immediately after the commencement of the survey, the team of experts started analyzing relevant documents and existing data on the current development in agriculture in Bangladesh. Some of those documents had already been collected during the phase of preparation of the technical proposal. Those background relevant documents had been analyzed by the team of experts in order to provide an outline of the initial assessment and fact finding and have been included in the draft baseline report.

Further, the role of the DAE and the different bodies was analyzed on the basis of policy papers and laws in order to draft a detailed scheduled on sharing of responsibilities and leading a professional dialogue with these authorities. In addition, detailed review of: (i) existing documents on concept, definition, classification and methodology for assessing the implementation status of the project components and results and outcomes of project support and services; (ii) similar works done in the past in different countries and benefit from the findings; (iii) to be undertaken in designing the proposed survey, implementing it, analyzing the feedback and preparing reports. The review of relevant documents and data collected from secondary sources was done by the senior members of the survey team prior to finalization of methodology and data gathering instruments. The consultants were reviewed all the existing literature and documents prepared for the project, monitoring/ progress reports, DPP, appraisal documents, policy papers, tools and formats for conducting the survey and its consequences based on the outcomes indicators and report. The survey team was collected relevant literature from the DAE offices. The consultants listed the main factors such as household demographics, crops production, consumption, storage, marketing, food security and nutrition status, financial status and training etc. The consultants gathered baseline information which was used for analyzing the impact and implications of the project from its implementation status, achievements and challenges, best practices and lessons learned.

2.2.3 Set up of a working group on the national level

As indicated in the general approach, the creation of a working group is an important element for ensuring the participation of stakeholders in the implementation of the survey, toward the sustainability of the survey results. Therefore, during the inception phase, the consultant in cooperation with the partner created the working group, with the objective of establishing close working relations with the client and relevant stakeholders. A list of possible stakeholders was prepared in order to identify the members of the Working Group (WG), and the team of experts established direct contact with them and explained objectives and the importance of being becoming a member of the WG. The team of experts shared with them information about the survey and requested their feedback. Virtual meetings using ICT technology was organized. In addition, the members of the Working Groups accessed internal portal of the survey, which was part of the DTCL website in order to provide feedback on data collection and diagnostic work. They were involved in the assessment of information and data collection; in the elaboration of the methodology for data and information collection and in the preparation of the survey.

2.2.4 Preparation of Inception Report

At the end of the inception phase, the team of experts has prepared the inception report that was delivered to the client for review and approval. The inception report was an opportunity to validate and confirm the consultant suggested approach and methodology towards the fulfillment of the Terms of Reference. The inception report contains the final version of the Plan of action for the experts, schedule and activities. It was an outline initial assessment and fact finding of the survey team in relation to the objectives of the survey including sample size and framework, and tools and techniques. In addition, it was included in detail: Quality assurance plan, setting up processes for assuring the quality of research; comments on research methodology and outcomes of questionnaires and field-test/piloting process.

2.3 Design of the study

- The consultants designed the survey emphasizing on appropriate survey sample frame and sampling technique that is statistically sound and acceptable to the client.
- The survey design included the specific timeline for every activity aiming to complete the survey timely.
- The design also included proper deployment of manpower and systematic monitoring, supervision and coordination among all activities so that the activities to be completed following a critical path-most efficient and effective time use for desirable accomplishment.
- One most important element of the design was finalization of data collection tools-questionnaires for respondent survey and data collection checklists for FGD & LG.
- Prior to the design of the questionnaires and checklists, the consultants finalized a list of indicators and measurements of all indicators in detail.
- The questionnaires and checklists were the techniques to ask questions to get measurements of different indicators that are relevant to assess the status of different aspects of the farmers and their qualities and quantities.
- The design also included data collection methodologies-secondary data and primary data. The consultants started fieldwork only after approval of the design by the client.

2.4 Sample Design

Two types of analysis were made to gather information about the survey and these are quantitative and qualitative.

(i) Quantitative Analysis

For any type of research work representativeness of collected information must be ensured so that valid and dependable conclusion can be drawn. The present survey was not exclusion. Thus, in order to ensure representativeness of the data and information collected, consultants followed probabilistic sampling strategy, which is delineated below.

The population under the survey universe was constituted of farmers in villages of 16 upazilas in 8 districts of 8 divisions. Thus, it is appropriate to determine a representative sample size of farmer households at first. Since consultant had information on necessary parameters viz. population size and standard deviation, the consultant used the appropriate formula fit for ***Finite Population Correction (FPC) recommended by Daniel (1999)*** for calculating sample size at the district level as given below:

The survey team considered the respondent as the sample unit

$$n = \frac{N \times p \times q \times Z^2}{(N-1) \times e^2 + Z^{2\times} p \times q} \times \text{Design effect}$$

Where,
n = sample size
P = probability of a dichotomous event. Since information regarding project area indicators is absence thus we assume that crop production in the project area has increased around 30%. i.e. p=0.3
q = 1-P=1-0.3=0.7
Z = standardized normal variate which is 1.96 at 5% level of significance with 95% confidence interval
N = population size=30,000 direct beneficiary farmers
e = relative variation (or relative error) which we assumed for this survey is 4%=0.04
Design effect = 2

Using the above information, the sample size is determined as approximately as follows for each district:

$n = (30{,}000 \times 0.3 \times 0.7 \times 1.96^2)/\{(30{,}000-1) \times 0.04^2 + 1.96^2 \times 0.7 \times 0.3\} \times 2$

$n = 24202.08/48.805 \times 2 = 495.8921 \times 2 \sim 991.78 \sim 1000$

As per indication of the TOR, there are about 30,000 target direct beneficiary farmers in 64 districts of 8 divisions. Using a 95% confidence level with 4% margin of error, the consultants obtained a representative sample size of farmer households to be n=1000 for this survey.

However, in order to reach such households consultants adopted multistage random sampling procedure. At the first stage 8 districts were chosen, two districts from each hotspot or climatic problem zone. From these 8 districts, the 16 upazilas were chosen at the second stage from each of which a random sample of 2 unions was selected at the third stage. From each of selected union 2 dispersed villages were chosen randomly at the fourth stage. Thus, the sample of 64 villages from 16 upazilas that means 4 villages in each upazila. At the fifth stage selected a random sample of farmer households by farm holding types. The sample of villages was chosen using Probability Proportionate Size (PPS) identified by the number of the households. However, determined number of households was proportionately allotted to chosen upazilas. Allotted number of households at upazila levels proportionately allotted to the selected villages.

In order to reach the stipulated farmer households (small, marginal and large including women at upazila/village level) a list of farmers was collected from UAO/PMU/PD before the survey. The list of different farmers by type of farm holding was aimed at identifying the targeted population of farmers in the village. ***Focus was on*** **climate change vulnerability consideration, one upazila from eight districts following the climate induced problems**. The study areas (e.g. District/Upazila/ Union) selection was based on the climatic problems and hotspots and expert opinion. Four hotspots considering the climatic and agro-ecological constrains are:

a. **Barind:** Drought, Cold Wave, Thunder Storm and Lightening
b. **Coastal area:** Coastal flood, Salinity Intrusion and Storm Surge due to cyclone
c. **Haor area:** Flash flood
d. **CHT area:** Zhum Cultivation and Forest degradation

From this sampling frame, the allotted number of farmer household was randomly chosen using Simple Random Sampling (SRS) procedure. In case the required number of farmer household was not available in that village, the adjacent village was selected.

Now, for collecting information on some issues like agro-met existing services and service providers, weather and climate induced problems on crop planning and crop production, existing documents, advisory tools, products and research work relevant to agro-meteorological services in Bangladesh as well as existing land use pattern, problems regarding climatic events in connection with crop production and the knowledge base,

farmers practiced to solve the challenges etc. some other respondents were involved in the survey.

Table 2.1: Summary of Basic Statistics of the Farmers in Project Area[2]

Type of Hydro meteorological Extreme ever	Sample Districts	Sample Upazila	Farm Household by type				Total
			Large & Medium 7.5 acre & above	Landless (no agri-land)	Marginal (0.05-2.49 acre)	Small (2.5-7.49 acre)	
Drought Cold wave, Storm	Rajshahi	2	50118	227207	96552	174711	548588
	Naogaon	2	94987	237015	84226	211308	627536
Cyclone, Salt, flood	Patuakhali	2	46041	69726	73060	94278	283105
	Satkhira	2	39616	137679	54580	157840	389715
Flash/ Pre-Monsoon Flood	Sunamganj	2	62121	160540	36761	107838	367260
	Netrokona	2	60688	158775	50595	171368	441426
Forest degradation	Khagrachari	2	41598	240485	95773	189399	567255
	Bandarban	2	20754	17316	6078	18591	62739
Total	**8**	**16**	**415923**	**1248743**	**497625**	**1125333**	**3287624**

Distribution of sample farmer households by districts, upazila and farm holdings

The number of sample farmer was determined by proportional allocation. The allocation was said to be proportional allocation when the total sample size n (1000) is distributed among different districts in proportion to the total number of farmer household of districts. In other words, the allocation is proportion if

$$ni = n\,\frac{Ni}{N} \quad \text{for } i = \mathbf{1, 2} \ldots\ldots 8.$$

Where Ni is the Population (total number of farmer households by farm holdings) in the i th district$n$ is the sample size of i th district and N is the total number of farm holding in respective district. After determination of Sample size in each farm holding, the number of household will be further stratified according to their upazila. After determination of farmer household by upazila, further stratification was made by farm holdings size (large & medium, small, marginal and landless farmers).

Table 2.2: Distribution of Sample Farmers by Farm Holdings

Type of Hydro-meteorological Extreme Event	Sample Districts	Sample Upazila	Proportionate № of Sample farmers by farm-holding								Total	
			Landless (without agri-land)		Marginal (0.01-0.49 acre)		Small (0.50-2.49 acre)		Large & Medium (> 2.5 acres)			
			Propionate	Adjusted	Propionate	Adjusted	Propionate	Adjusted	Propionate	Adjusted	Propionate	Adjusted
Drought Cold wave, Storm	Rajshahi	2	69	70	29	30	53	54	15	16	166	170
	Naogaon	2	72	70	26	26	64	64	29	28	191	188
Cyclone, Salt, Flood	Patuakhali	2	21	20	22	22	29	28	14	14	86	84
	Satkhira	2	42	40	17	18	48	48	12	12	119	118
Flash/ Pre-	Sunamganj	2	49	50	11	12	33	32	19	20	112	114

[2] *Year Book of Bangladesh Agricultural Statistics, BBS-2016, Published in May 2017 (Series 28)*

Monsoon Flood	Netrokona	2	48	46	15	16	52	52	18	18	133	132
Forest Degradation	Khagrachari	2	73	74	29	30	58	58	13	12	173	174
	Bandarban	2	5	10	2	10	6	10	7	10	20	40
Total	**8**	**16**	**379**	**380**	**151**	**164**	**343**	**346**	**127**	**130**	**1000**	**1020**

Table 2.3: Upazila-wise sample distribution

Type of Hydro meteorological Extreme Event	Sample Districts	Sample Upazila	Distribution of Sample Farmers by Landholdings				Total
			Large & Medium	Landless (No agro-land)	Marginal (0.05-2.49 acre)	Small (2.5-7.49 acre)	
Drought Cold wave, Nor'wester, Pest & Disease	Rajshahi	Tanore	8	35	15	27	170
		Godagari	8	35	15	27	
	Naogaon	Sadar	14	35	13	32	188
		Mohadevpur	14	35	13	32	
Cyclone & storm surge, Salinity intrusion, Pest & Disease	Patuakhali	Kalapara	7	10	11	14	84
		Dumki	7	10	11	14	
	Satkhira	Kaliganj	6	20	9	24	118
		Debhata	6	20	9	24	
Flash/ Pre-Monsoon Flood	Sunamganj	Taherpur	10	25	6	16	114
		Sadar	10	25	6	16	
	Netrokona	Mohanganj	9	23	8	26	132
		Kalmakanda	9	23	8	26	
Forest degradation	Khagrachari	Sadar	6	37	15	29	174
		Matiranga	6	37	15	29	
	Bandarban	Sadar	5	5	5	5	40
		Lama	5	5	5	5	
Total	**8**	**16**	**130**	**380**	**164**	**346**	**1020**

The above formula was used as a guide to ensure the representativeness of the sample. However, the consultants along with survey team finalized sample size keeping in mind the time and budget constraint in consultation with the PD/PIU/DAE officials. Adjusted size of the sample was 1020 farmer households, which fits well in the time and budget framework as well as in the formula used.

(ii) Qualitative Analysis

In this analysis the most appropriate methods were used are as follows:

a) Focus Group Discussion (FGD)
b) Regional Level Data Validation Workshop

a. Focus Group Discussion (FGD)

For the qualitative analysis, total 16 Focus Group Discussions (FGDs) were conducted considering one for each of the upazila. The participants for each FGD were 10 to 12 respondents. The FGD meetings were conducted with concerned stakeholders such as farmers of different types including women at district/ upazila and field level. The FGD was conducted to collect the information using pre-designed guidelines (**Appendix-2)** encompassing issues about the efficiency and effectiveness of project activities such as:

- Weather or climate such as rainfall, temperature, cyclone, storm, drought, cold-wave and heatwave, salinity, Zhum cultivation, flood & forest degradation induced problems on agriculture
- Farmer's knowledge and perception on agro-met services at the community level
- Seasonal variation of climatic and weather parameters (e.g. rainfall, temperature etc.) and farmer's perception in relation to crop planning and crop productivity

- Existing land use pattern, problems regarding climatic events in connection with crop production and the knowledge base, farmers are practicing to solve the challenges
- Needs or new requirements of agro-met services in order to ensure and develop effective and user friendly agro-met advisory services for ensuring crop productivity and food security

b. Regional Level Data Validation Meeting

Five (5) regional level data validation meeting was conducted in Tanore upazila under Rajshahi district; Sadar and Mohadevpur upazila under Naogaon district; Sadar upazila of Satkhira district and Sadar upazila of Patuakhali district. The regional level meetings were conducted to validate the collected information using questionnaire by enumerators of the respective sampled upazilas with participation of upazila level officers and target respondents.

c. Upazila Level Agriculture Information

The upazila level basic agricultural information such as rainfall, temperature, land use pattern, demography, hydro- meteorology, agricultural practices, current management practices etc. was collected from 16 UAOs using pre-designed semi-structured questionnaire (**Appendix-3**) encompassing issues about the indicators such as:

- Past two-year statistics of weather or climate such as rainfall, temperature, cyclone, storm, drought, cold and heat wave, salinity, Zhum cultivation, flood & forest degradation induced problems on agriculture
- Crop production status of small and marginal farmers and their common problems
- Agro-met services and products, its functionality, effectiveness and user satisfaction
- Land use pattern, demography, hydro-meteorology, agricultural practices, and current management practices
- Whether existing climate forecast can address the climate variability?
- Recommendations to address weather and climate problems

2.4.1 Summary of the data and information collection is presented below:

Table 2.4: Number and Types of Respondents

Activity	Participants/ Respondents	No. of Respondents	Respondents Category
A. Quantitative Survey			
A1. *Direct Interviews with Questionnaire*	Direct beneficiary farmers	1,020	Small, marginal and landless farmers of the respective upazila
	Total	**1,020**	
A. Qualitative Survey			
B1. FGD	Farmers	16	Small, marginal and landless farmers of the respective upazila
B2. Regional Level data validation workshop	All categories people	04	Farmers, DAE, researcher, academician, local elites, Meteorological official etc.
B3. District /Upazila Level Agricultural Information	Upazilla Agricultural Officer	16	UAO, AEO, SAAO etc.

2.5. Development and Finalization of Questionnaire

The baseline survey questionnaire was prepared based on the objectives and scope of work and the needs and indicators for the survey as indicated in the TOR. The questionnaires were thoroughly reviewed by the experts at different stages including Inception Report Presentation Workshop. Additions and modifications were made during meetings/workshops with experts and PMU/DAE authorities. After the final approval of the PD/AMISDP the questionnaires were discussed in training session with enumerators and were judged about their understanding and field-testing were also conducted. The questionnaire was finalized incorporating comments and suggestions of client and field-testing and translated into Bangla for data collection.

2.6 Recruitment and Training of Field Staff

Total 18 enumerators having bachelor/master's degree in agriculture were recruited through an interview board headed by the Team Leader. A three (03) day training course was organized for the data collection team. The first day was devoted to theory, followed by one day of practical training in the field for pre-testing and sharing field experiences with each other and experts. The third day was for reviewing the field experience. Apart from the foundation lectures on how to fill-in the questionnaire, group discussions, role playing in the classroom, and question and answer sessions were arranged. The experts and the senior key personnel of the firm provided the training.

2.7 Data Collection

The trained survey enumerators and supervisors were placed to collect data in each of the survey locations. The survey supervisors were placed for supervising the data collection and they were also responsible for monitoring, data checking and field verification of collected data. All the field staff reached the survey area with the required number of questionnaires, guidelines, checklists, and daily progress reports, manual of data collection, and other documents and articles necessary for field activities. The work of enumerators was constantly monitored and supervised by the supervisors. The supervisors checked all completed questionnaires in the field and re-interviewed some of the respondents to be sure about the quality of data. It was done rigorously so as to avoid return visit any particular site, to avoid consuming much time. The supervisors were responsible for conducting focus group discussions and regional data validation meeting. The consultant made random visits at the survey area to ensure quality control of data collection and also to encourage the beneficiaries/respondents` and supervisors.

The filled-up questionnaires were checked and verified properly by the Field Supervisors and was sent to the DTCL office every weekend right from the second week of the start of the survey. In addition to data collection, the consultant conducted visit in the project area to evaluate the project activities and knowledge of the DAE officials.

2.8 Quality Assurance Measures of Data

The highest possible care was taken in ensuring a high quality of collected data and information. A system of Total Quality Management (TQM) was instituted which comprised of all systematic arrangements and activities directed towards safeguarding, maintenance and promotion of quality throughout the study period. To ensure the appropriate quality of the collected data/information, quality control was maintained in various steps in this study with quantitative and qualitative research endeavors. Quality was ensured in all the indicators, triangulation, analysis and reporting.

A sound quality control system was developed to adequately monitor the quality of data collection. For this purpose, experts, supervisors and quality enumerators were deployed. They moved constantly around the sample spots; and ensure quality data through: (i) field checking, and (ii) data monitoring. Field checking was undertaken in both **'presence' and 'absence'** of the field teams. **'Checking in presence'** was done through verification of the

work of a field team in a sample area during the time of the questionnaire survey and qualitative studies. **'Checking in absence'** was done through verification of the work of a field team in a sample area after the team leaves the site, having completed its assigned work in the area. During their field checking, the experts performed re-interviews, and checked data accuracy. 'Field checking in presence' was conducted for all field enumerators/facilitators, while 'field checking in absence' was done at randomly selected sites.

2.9 Data Management, Processing and Analysis

The filled-in questionnaires were considered as the sources of raw data. For effective analysis and quality output generation, the following activities were undertaken on the collected data:

- Filing the filled-in questionnaires and checklists;
- Editing and coding the questionnaires and checklists for entry into the computer; and
- Quality control and coding of open-ended responses.

The filled-in questionnaires and checklists were collected, filed and batched according to different strata and task programs to enable easy operation for processing steps (editing, coding, entry etc.). The edited and coded questionnaires were dispatched to computer operators for data entry/punching to the software installed (SPSS and MC Access) for this purpose. The entire work was undertaken under the supervision and guidance of the team leader and computer programmer.

All possible in-built conditional, logical and range checking procedures was incorporated in the data entry program to detect mistakes done by the entry operator during the data entry.

Frequency tables were prepared for all the variables and necessary cross tables consistent with the survey objectives were prepared.

Analysis Plan

For making a sensible analysis of collected data following statistical tools was adopted

- Descriptive summary statistics
- Graphical representation
- Confidence Intervals for crucial variables
- Analyze weather & climate induced problems on agricultural production
- Inter-regional difference analysis
- Differential analysis by small, marginal and landless, farm holdings, by gender.

The specific analysis included:

- Socio-demographic profile including the family composition by age & sex, education, occupation
- Landownership status
- Land use scenarios such as area, cropping pattern and intensity, cropping plan on climate changes and its knowledge
- Cyclone, cold and heat wave, storm, flood, temperature, rainfall, salinity, zhum cultivation, flood, lightening related common problems on agricultural production.
- Crop production, productivity, and diversity etc.

CHAPTER- 3

FARMER'S BASIC INFORMATION

This chapter describes about the farmers demographic information such as family, ownership of land, land use pattern and production and productivity etc. The objective of the study was to identify land use pattern, demography, hydro-meteorology, agricultural practices, current management practices etc. of farmers. As per the objectives, findings of the study have been presented herewith mainly based on the primary and secondary data.

3.1 General information of the farmer

Gender, marital status, education level, major source of income and number of family members were determined by analyzing questionnaires as follows:

3.1.1 Gender and marital status of respondents

Out of 1020 farmers, around all (98.9%) of them were male and 1.1% farmers (11) were female participated in the survey. In terms of marital status, 96.5% of the farmers (984) were married, 2.4% farmers (25) were unmarried, 0.9% farmers (9) were widow and 0.2% farmers (2) were divorce.

Table 3.1 Marital status of the respondents

Marital status	Response of famer's	
	№	%
Married	984	96.5
Unmarried	25	2.5
Divorce	2	0.2
Widow	9	0.9
Total	**1020**	**100**

3.1.2 Education level of respondents

Out of 1020 farmers, 27.5% of them (281) had no formal education, 25.1% farmers (256) had secondary school education, 20.4% farmers (208) had primary school education. On the other hand, 13.6% farmers (139) could read and write only, 10.4% farmers (106) had college level education, 2.3% farmers (23) had university level education and 0.7% farmers (7) had technical education.

Table 3.2: Education level of respondents

Education Level	Number of respondents	% response
No formal education	281	27.5
Can read and write	139	13.6
Primary school	208	20.4
Secondary school	256	25.1
Technical education	7	0.7
College	106	10.4
University	23	2.3
Total	**1020**	**100.0**

3.1.3 Major sources of income

All (100%) farmers stated that their major source of income came from the agricultural activities/farmland while 17% farmers reported that in addition of agricultural farmland income, they had an additional source of income from the non-agricultural activities/non-farmland.

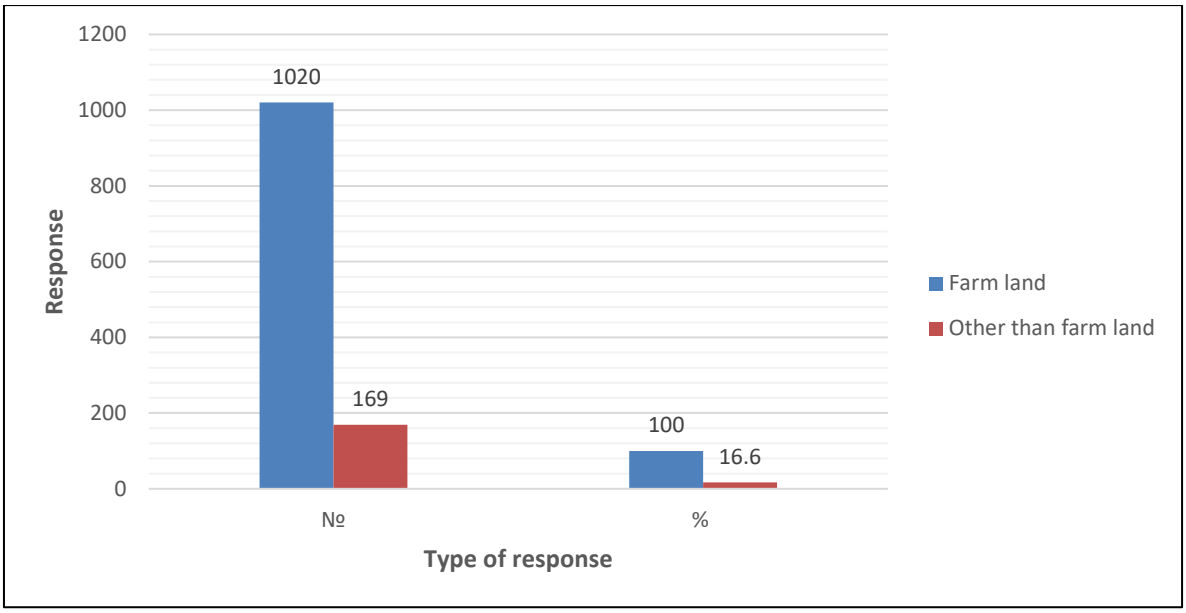


Figure 3.1. Major source of farmers' income

3.1.4 Members of the family and engaged with agriculture

Number of members in the family: The average number of the family members participated in the survey was 5.36, where the minimum members were 2 and maximum family members were 17.
Number of family members engaged in agriculture: The average family members engaged in agriculture was 1.56, where the minimum members engaged in agriculture were 1 and maximum family members were 9.

Table 3.3. Number of members in the family and engaged with agriculture

Family parameters	Member range (no./family)			Standard deviation
	Minimum	Maximum	Average	
Member in the family (no.)	2	17	5.36	2.429
Family members engaged in agriculture (no.)	1	9	1.56	0.953

3.1.5 Owner of the lands

Total land of the household: The average total land area of the household was 242.17 decimal/household, whereas the minimum area of total land of the household was 5 decimals and the maximum area of the total land of the household was 960 decimals.

Own land: The average own land of the household was 200.34 decimal/household, whereas the minimum own land of the household was 2 decimals and the maximum own land of the household was 960 decimals.

Lease/mortgage land: The average lease/mortgage land of the household was 49.12 decimal/household, whereas the minimum lease/mortgage land of the household was 4 decimals and the maximum lease/mortgage land of the household was 90 decimals.

Total cultivable land of the household: The average total cultivable land of the household was 239.89 decimal/household, whereas the minimum total cultivable land of the household was 4 decimals and the maximum total cultivable land of the household was 980 decimals.

Own cultivable land: The average own cultivable land of the household was 218.16 decimal/household, whereas the minimum own cultivable land of the household was 4 decimals and the maximum cultivable own land of the household was 980 decimals.

Lease/mortgage cultivable land: The average lease/mortgage cultivable land of the household was 41.24 decimal/household, whereas the minimum lease/mortgage cultivable land of the household was 3 decimals and the maximum lease/mortgage cultivable land of the household was 90 decimals.

Table 3.4. Land area under the household

Land pattern	Area of land (decimal/family)			Standard deviation
	Minimum	Maximum	Average	
Total land of the household	5	960	242.17	207.110
Own land	2	960	200.34	225.482
Lease /mortgage land	4	90	49.12	36.371
Total cultivable land of the household	4	980	239.89	217.198
Own cultivable land	4	980	218.16	199.024
Leased/mortgage cultivable land	3	90	41.24	34.679

3.1.6 Soil type of the land under the household

Out of 1020 farmers participated in the survey, the soil type of the land of 47.1% (480) farmers was loamy which was considered ideal soil for agricultural crop production. Whereas 31.8% farmers (324) had sandy-loam soil land. On the other hand, 8.7% (89) farmers had clay soil land, 7.3% farmers had clay-loam soil land and only 5.2% farmers had sandy soil land.

Table 3.5: Soil type of the land under the household

Soil type	Number of respondents	% response
Sandy and Salty	53	5.2
Loamy	480	47.1
Clay	89	8.7
Sandy-loam and Saline	324	31.8
Clay-loam	74	7.3
Total	1020	100.0

3.1.7 Land type of the farmers

Land type data indicates that out of 1020 farmers, 34% of them (344) had high land, 35% farmers (355) had medium high lands. Therefore, 69% of respondents had high and medium high lands and they could practice year-round crop production. On the other hand, 24.1% farmers (246) had low land, 6.8% farmers had marshland and only 0.6% farmers (6) had pond. Therefore, 31% farmers had low and marshland and pond, which were not suitable for year-round crop production.

Table 3.6: Land type of the farmers

Land type	Number of respondents	% response
High	344	33.7
Low	246	24.1
Medium high	355	34.8
Marsh land	69	6.8
Pond	6	0.6
Total	**1020**	**100.0**

3.1.8 Utilization of irrigation on land

Out of 1020, about 90.6% farmers (924) participated in the survey utilized irrigation on their agricultural land for crop production. On the other hand, other 9.4% (96) farmers reported that they did not use irrigation on their land for crop production.

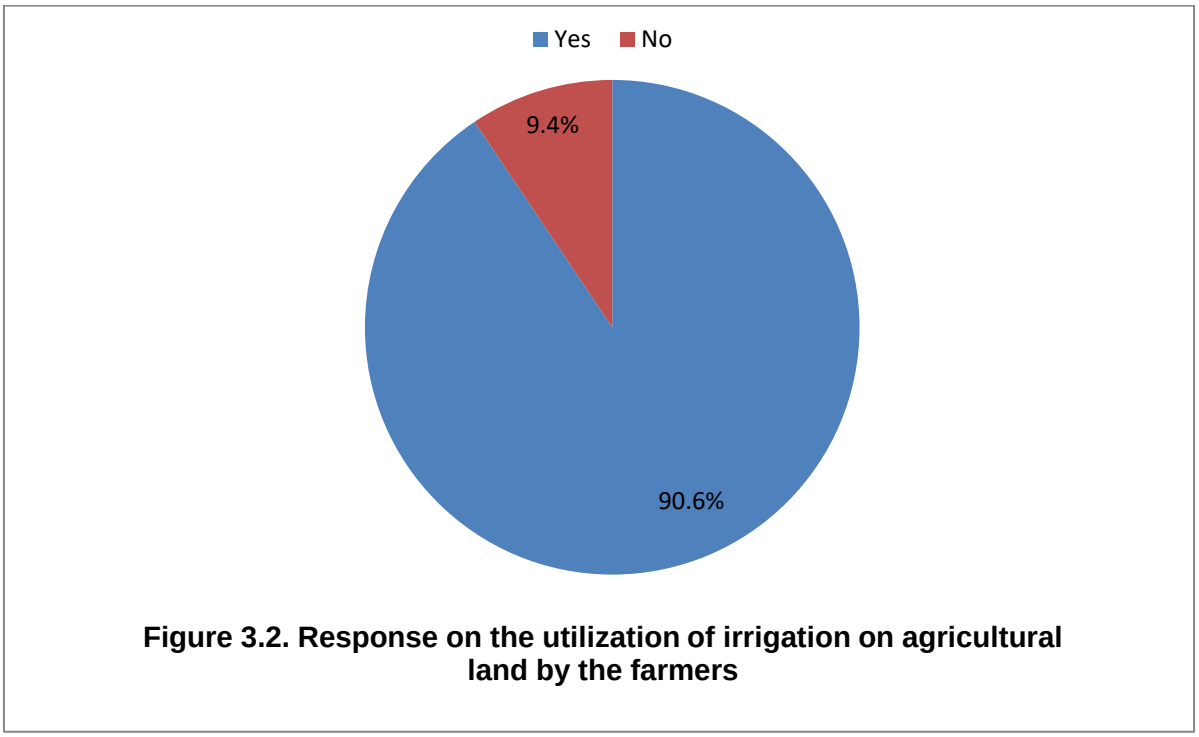


Figure 3.2. Response on the utilization of irrigation on agricultural land by the farmers

Per hectare average production in irrigated agricultural land is 7.0 MT and per hectare average income is Taka 182,000 in the project sample area.

CHAPTER-4

WEATHER AND CLIMATE INDUCED PROBLEMS

This chapter describes overall weather and climate induced problems faced by the farmers for crop production, their losses and overall impact of the farmer's livelihood etc. The objective of the study was to identify what type of agro-meteorological services available in Bangladesh and who are the service providers and existing agro-meteorological (if any) information, ongoing observed parameters and technologies of BMD. In addition, assess the farmer's knowledge and perception on meteorological or agro-met services at community level and the seasonal variation of climatic and weather parameters (e.g. rainfall, temperature etc.) and farmer's perception in relation to crop planning and crop productivity. The study also assesses the effectiveness of existing forecast information and future requirements. As per the objectives, findings of the study have been presented herewith mainly based on the primary and secondary data.

4.1 Upazila-wise past two years' weather and climate information

The intensity of weather and climate induced problems in 16 upazilas of the 8 sampled districts under four hydro meteorological Extreme Region/hotspots areas are varied from one location to another. However, the major temperature variation, annual rainfall, cyclone, sudden flood, drought, and storm related information have been furnished below:

Minimum Temperature: The lowest 4.9^{0}C temperature recorded in Sadar and Mohadebpur upazila under Naogaon district which was followed by Sadar upazilas under Rajshahi (5.8^{0}C), Khagrachari (5.1^{0}C), Netrokona (6.2^{0}C), and Satkhira (7.5^{0}C). However, the highest temperature recorded in Bandarban (11.5 ^{0}C) followed by Patuakhali (9.5^{0}C) and Sunamganj (8.8^{0}C).

Maximum Temperature: Similar trend of temperature variation had also recorded in case of maximum temperature. The highest 35^{0}C temperature recorded in Tanore and Godagari upazila under Rajshahi district which was followed by Satkhira (34^{0}C), Naogaon and Sunamganj (33^{0}C), Patuakhali (32^{0}C). However, the lowest temperature recorded in Bandarban and Khagrachari (26^{0}C) while average temperature was ranged between 22^{0}C-30^{0}C.

Annual rainfall: The lowest 1075 and 1112 mm rainfall recorded in Tanore and Godagari of Rajshahi district which was followed by Sadar and Matiranga upazilas under Khagrachari (1224 and 1550 mm), Naogaon (1552 mm), Satkhira (1711 mm) while highest 2800 mm recorded in Taherpur of Sunamganj, which was followed by Kalapara of Pataukhali (2690mm) Kalmakanda of Netrokona (2460 mm), Bandarban (2300 mm) etc.

Cyclone: Highest 4- and 3-times cyclone recorded in Kalapara and Dumki of Patukhali while 2 times in Kaliganj upazila of Satkhira, Matiranga upazila of Khagrachari and 1 time in Tanore, Sunanganj Sadar and lama upazila of Bandarban etc. There was no record about cyclone in the other upazilas in past two years.

Flash Flood: All upazilas of the sample areas were affected due to flash flood**.** Highest 3 times flash cyclone recorded in Kalapara and Dumki of Patukhali while 2 times in Kaliganj upazila of Satkhira, Matiranga upazila of Khagrachari and 1 time in Tanore, Sunanganj Sadar and Lama upazila of Bandarban etc. There was no record about cyclone in the other upazilas in past two years.

Drought: The Tanore upazila of Rajshahi district was recorded drought in the past two years while mild drought recorded in Patuakhali and Khagrachari districts in rabi season. There was no record of drought in other districts in the past two years.

Storm: Highest 12 times storms observed in Sunamganj Sadar, which was followed Tanore of Rajshahi and Taherpur of Sunamganj (9), Kalapara of Patuakhali (8), Kaliganj of Satkhira (5). However, the lowest (1) number of storm recorded in Naogaon, Debhata of Satkhira, Matiranga of Khagrachari, which was followed by Netrokona (2). Almost all upazila storms were recorded except Bandarban and Khagrachari Sadar, Mohanganj of Netrokona.

Table 4.1: Upazila-wise-past two years weather and climate information

District	Upazila	Minimum	Maximum	Average Temp.(⁰C)	Annual Rainfall (mm)	Cyclone	Flash flood	Drought	Storm
Rajshahi	Tanore	5.8 ⁰C	35 ⁰C	28⁰C	1112	1	1	Present	9
	Godagari	5.8⁰C	35⁰C	28 ⁰C	**1075**	-	1	Absent	2
Naogaon	Sadar	4.9 ⁰C	33⁰C	22 ⁰C	1552	-	1	-	2
	Mohadebpur	4.9 ⁰C	33⁰C	20⁰C	1811	-	1		1
Patuakhali	Kalapara	9.5 ⁰C	32⁰C	25⁰C	2609	4 times	2 times	Mild Drought in Rabi Season	8
	Dumki	9.5 ⁰C	32⁰C	27⁰C	2490	3 times	2 times	Mild Drought in Rabi Season	4
Satkhira	Kaliganj	7.5 ⁰C	34⁰C	29⁰C	1800	2 times	3 times		5
	Debhata	7.5⁰C	34⁰C	25⁰C	1711		2 times		1
Sunamganj	Taherpur	8.8⁰C	33⁰C	27⁰C	2800	-	1 time	-	9
	Sadar	8.8⁰C	33⁰C	28⁰C	2200	1	1 time	-	12
Netrokona	Mohanganj	6.2⁰C	32⁰C	30⁰C	1800		1 time		-
	Kalmakanda	6.2⁰C	32⁰C	26⁰C	2460	-	1 time		2
Khagrachari	Sadar	6.1⁰C	32⁰C	30⁰C	1550	-	2 times	Kharif -2 Season	-
	Matiranga	6.1⁰C	26⁰C	26⁰C	1224	2	2	Mild Drought	1
Bandarban	Sadar	11.5⁰C	26⁰C	22⁰C	2300	-	1	-	-
	Lama	11.5⁰C	26⁰C	25⁰C	2200	1	3	-	-

Source: UAO-DAE 2017-18

4.2 Weather and climate induced problems in Kharif-1 (Aus) for crop production

Basically, the intensity of weather and climate induced problems on crop production are varied from one location to another. However, the major and minor problems in Kharif-1 (Aus) season (16 March to 15 July of the year) for crop production have been illustrated as follows:

Major problems in Kharif-1 season: Out of 1020 respondents, the majority (62.64%) farmers stated that insect pests attack in crop fields were the major problems in Kharif-1 (Aus) season for crop production which was followed by disease (51.7%) and weed infestation (27.3%). In case of climate related problems, the highest (20.9%) farmers indicated that salinity was the major problems for Kharif-1 season for crop production which was followed by drought (15.5%), Nor'wester (10.49%), flash flood (10.3%), heat wave (8.6%), flood (7%), cold wave (5.8%) and lightening (5%). However, the lowest (0.2%) percent farmers stated that they had a major problem of landslide which was followed by

flood inundate (1.6%), cyclone (2%), storm surge (2.3%), and forest degradation (3.6%) under multiple responses.

Minor problems in Kharif-1 season: Out of 1020 respondents, 10 to 25% farmers reported that the attack of insect and mite pests, diseases on crops, rats in crop field, weed infestation were the minor problems for crop production in Kharif-1 season. In case of climate related problems, 10% to 14% farmers of the survey area reported that the flood, flash flood, storm surge were the minor problems. On the other hand, 4% to 5% farmers reported that the drought, thunderstorm, cyclone, forest degradation, etc. were the minor problems.

Table 4.2: Weather and climate induced problems in Kharif-1 (Aus) season

Problems	Major problem		Minor problem	
	Number of respondents	% response	Number of respondents	% response
Climate related problems				
Drought	158	15.5	45	4.4
Cold-wave	59	5.8	15	1.5
Heatwave	88	8.6	23	2.3
Nor 'wester	107	10.49	47	4.6
Lightening	51	5.0	17	1.7
Coastal flood	50	4.9	19	1.9
Flood	71	7.0	15	1.5
Flash Flood	105	10.3	103	10.1
Flood Inundate	16	1.6	35	3.4
Salinity	213	20.9	142	13.9
Storm surge	23	2.3	120	11.8
Cyclone	20	2.0	54	5.3
Landslide	2	0.2	21	2.1
Forest degradation	37	3.6	43	4.2
Pest related problems				
Attack of insect pests	639	62.64	259	25.4
Attack of diseases	527	51.7	154	15.1
Weed infestation	278	27.3	106	10.4
Multiple Responses	**2444**		**1218**	

4.3 Weather and climate induced problems in Kharif-2 (Aman) for crop production

Basically, the intensity of weather and climate induced problems on crop production are varied from one location to another. However, the major and minor problems in Kharif-2 (Aman) season (16 July to 15 October of the year) for crop production have been illustrated as follows:

Major problems in Kharif-2 season: Out of 1020 respondents, the majority (51.17%) farmers stated that insect pests attack in crop fields were the major problems in Kharif-2 (Aman) season for crop production which was followed by disease (32.84%) and weed infestation (18.7%). In case of climate related problems, the highest (14.5%) farmers indicated that flood was the major problems for Kharif-2 season for crop production which was followed by flood inundate (10.7%), salinity (9.7%), flash flood (8.1%), storm surge (6.9%) and nor'wester (4.7%). However, the lowest (0.4%) percent farmers stated that they had a major problem of forest degradation which was followed by landslide (1.1%), lightening (2.1%), cold wave (3.4%), cyclone (3.6% and drought (4%).

Minor problems in Kharif-2 season: In terms of weather and climate related problems, out of 1020 respondents, drought, cold wave, heat wave, lightening, cyclone, forest degradation, etc. were the minor problems in Kharif-2 season for crop production.

Table 4.3: Weather and Climate induced problems in Kharif-2 (Aman) season

Problem	Major problem		Minor problem	
	Number of respondents	% response	Number of respondents	% response
Climate related problems				
Drought	41	4.0	24	2.4
Cold-wave	35	3.4	11	1.1
Heatwave	41	4.0	11	1.1
Nor'wester	48	4.7	17	1.7
Lightening	21	2.1	15	1.5
Coastal flood	75	7.4	21	2.1
Flood	148	14.5	27	2.6
Flash Flood	83	8.1	35	3.4
Flood Inundate	109	10.7	19	1.9
Salinity	99	9.7	84	8.2
Storm surge	70	6.9	23	2.3
Cyclone	37	3.6	19	1.9
Landslide	11	1.1	3	0.3
Forest degradation	4	0.4	3	0.3
Pest related problems				
Attack of insect pests	422	51.17	168	16.5
Attack of diseases	335	32.84	268	26.3
Weed infestation	191	18.7	194	2.4
Multiple responses	**1770**		**942**	

4.4 Weather and climate induced problems in Rabi (Boro) for crop production

Basically, the intensity of weather and climate induced problems on crop production are varied from one location to another. However, the major and minor problems in Rabi (Boro) season (16 October to 15 March of the year) for crop production have been illustrated as follows:

Major problems in Rabi (Boro) season: The major problem of crop production in Rabi (Boro) season was the drought as reported by the 28.1% respondents, followed by attack of insect pest (27.25%), cold wave (22.1%), attack of disease (16.4%), weed infestation (7.1%), salinity (6.3%) and flash flood (4.7%). However, none of the response reported in the category of flood, heat wave, flood inundate, and landslide while 1.2% farmers indicated that the forest degradation was the major problem which was followed by nor'wester (0.8%), storm surge (0.5%), cyclone (0.4%), lightening (0.2%), and coastal flood (0.1%).

Minor problems in Rabi (Boro) season: In terms of weather and climate related problems, out of 1020 respondents, heat wave, all kinds of floods, storms and cyclone etc. were the minor problems in Rabi (Boro) season for crop production.

Table 4.4: Weather and climate induced problems in Rabi (Boro) season

Problem	Major problem		Minor problem	
	Number of respondents	% response	Number of respondents	% response
Drought	287	28.1	9	0.9
Cold-wave	225	22.1	5	0.5
Heatwave	0	0.0	35	3.4
Nor 'wester	8	0.8	36	3.5
Lightening	2	0.2	56	5.5
Coastal flood	1	0.1	45	4.4
Flood	0	0.0	51	5.0

Flash Flood	48	4.7	42	4.1
Flood Inundate	0	0.0	40	3.9
Salinity	64	6.3	39	3.8
Storm surge	5	0.5	2	0.2
Cyclone	4	0.4	12	1.2
Landslide	0	0.0	2	0.2
Forest degradation	12	1.2	2	0.2
Attack of insect pests	278	27.25	283	27.7
Attack of diseases	167	16.4	183	17.9
Weed infestation	72	7.1	129	12.6
Multiple Responses	**1231**		**1083**	

From above findings, it was revealed that attack of insect pests was the single most major problem in Kharif-1, Kharif-2 and Boro seasons for crop production in the survey area which was followed by diseases. Other major problems were flash flood/ flood especially in Aman and Boro seasons. The salinity problems in Rabi and Kharif-1 season were occurred in coastal areas.

4.5 Weather and climate induced problems in hotspots area of Drought, Cold wave, Nor 'wester, Pest & Disease

District-wise response of farmers under hydro meteorological extreme event/hotspots area of drought, cold wave, nor 'wester, pest & disease regarding weather and climate induced problems had been furnished below:

Rajshahi: Highest 65.29% farmers indicated that they had a pest infestation problem while 53.53% farmers opined that they had a diseases infestation problem in the crop field. This was followed by drought (32.94%), cold-wave (24.71%), heat wave (27.06%), storm (13.53%), and cyclone (11.76%). The lowest 5.29% farmers opined that they had a problem of lightening which was followed by nor 'wester (9.41%). None of the farmers reported about the problems of floods, landslide, forest degradation and salinity problems in Rajshahi district.

Naogaon: Similar to the Rajshahi, the highest 67.86% farmers indicated that they had a pest infestation problem while 56.38% farmers opined that they had a diseases infestation problem in their crop field. This was followed by drought (37.77%), cold-wave (32.98%), heatwave (27.13%), cyclone (11.70%), and nor 'wester (11.17%). The lowest 6.91% farmers opined that they had a problem of lightening which was followed by storm surge (9.57%).

Table 4.5: Weather and climate induced problems in hotspots area of Drought, Cold-wave, nor 'wester, Pest & Disease

Type of problems	Rajshahi farmer's response		Naogaon farmer's response	
	Number (N=170)	% response	Number (N=188)	% response
Drought	56	32.94	71	37.77
Cold-wave	42	24.71	62	32.98
Heatwave	46	27.06	51	27.13
nor 'wester	16	9.41	21	11.17
Lightening	9	5.29	13	6.91
Coastal flood	-		-	
Flood	-		-	
Flash Flood	-		-	
Flood Inundate	-		-	
Salinity	-		-	
Storm surge	23	13.53	18	9.57
Cyclone	20	11.76	22	11.70

Landslide	-		-	
Forest degradation	-		-	
Pest infestation	111	65.29	126	67.02
Disease infestation	91	53.53	106	56.38
Multiple responses	**414**		**490**	

4.6 Weather and climate induced problems in hotspots area of cyclone & storm surge, salinity intrusion, pest & disease

District-wise response of farmers under hydro meteorological extreme event/hotspots area of cyclone & storm surge, salinity intrusion, pest & disease regarding weather and climate induced problems had been furnished below:

Patuakhali: Highest 66.67% farmers indicated that they had a pest infestation problems and salinity while 60.71% farmers opined that they had a diseases infestation problem in the crop field. This was followed by salinity (42.86%), storm-surge (32.14%), cyclone and coastal flood (30.95%), flash flood (28.57%), flood (25%), and flood inundate (21.43%). However, the lowest 10.71% farmers opined that they had a problem of forest degradation which was followed by heatwave (17.86%), nor' wester (15.48%) and lightening (9.52%).

Satkhira: Similar to the Patuakhali, the highest 58.47% farmers indicated that they had a pest infestation problems and salinity while 51.69% farmers opined that they had a diseases infestation problem in their crop field. This was followed by salinity problems (39.83%), flood (33.05%), coastal flood (30.51%), flash flood (27.97%), cyclone (22.88%) and flood inundate (22.03%). Conversely, the lowest 9.32% farmers opined that they had a problem of forest degradation which was followed by storm-surge (19.49%), nor 'wester (13.56%), and heat wave (12.71%).

Table 4.6: Weather and climate induced problems in hotspots area of cyclone & storm surge, salinity intrusion, pest & disease

Type of problems	Patuakhali farmer's response		Satkhira farmer's response	
	Number (N=84)	% response	Number (N=118)	% response
Drought	0	0.00	0	0.00
Cold-wave	0	0.00	0	0.00
Heatwave	15	17.86	15	12.71
Nor 'wester	13	15.48	16	13.56
Lightening	8	9.52	10	8.47
Coastal flood	26	30.95	36	30.51
Flood	21	25.00	39	33.05
Flash Flood	24	28.57	33	27.97
Flood Inundate	18	21.43	26	22.03
Salinity	36	42.86	47	39.83
Storm surge	27	32.14	23	19.49
Cyclone	26	30.95	27	22.88
Landslide	0	0.00	0	0.00
Forest degradation	9	10.71	11	9.32
Pest infestation	56	66.67	69	58.47
Disease infestation	51	60.71	61	51.69
Multiple responses	**330**		**413**	

4.7 Weather and climate induced problems in hotspots area of flash/ pre-monsoon flood

District-wise response of farmers under hydro meteorological extreme event/hotspots area of flash/pre-monsoon flood regarding weather and climate induced problems had been furnished below:

Sunamganj: Around 59.65% farmers indicated that they had a pest infestation problem in the crop field which was followed by flood (53.51%), disease infestation (49.12%), flash flood (44.74%), flood inundate (42.98%), and cyclone (34.21%). However, the lowest (9.65% farmers informed that they had lightening problems which were followed by cold-wave (13.16%), nor 'wester (14.04%), and storm surge (20.18%).

Netrokona: More than fifty percent **(**56.06%) farmers indicated that they had a pest infestation problem which was followed by disease infestation (46.97%), flash flood (29.55%), flood (26.52%), and flood inundate (23.48%). However, the lowest 8.33% farmers opined that they had a problem of lightening which was followed by nor'wester and cyclone (12.12%) and storm-surge (15.91%).

Table 4.7: Weather and climate induced problems in hotspots area of Flash/ Pre-Monsoon Flood

Type of problems	Sunamganj farmer's response		Netrokona farmer's response	
	Number (N=114)	% response	Number (N=132)	% response
Drought	0	0.00	0	0.00
Cold-wave	15	13.16	11	8.33
Heatwave	0	0.00	0	0.00
Nor 'wester	16	14.04	16	12.12
Lightening	11	9.65	11	8.33
Coastal flood	0	0.00	0	0.00
Flood	61	53.51	35	26.52
Flash Flood	51	44.74	39	29.55
Flood Inundate	49	42.98	31	23.48
Salinity	0	0.00	0	0.00
Storm surge	23	20.18	21	15.91
Cyclone	39	34.21	16	12.12
Landslide	0	0.00	0	0.00
Forest degradation	0	0.00	0	0.00
Pest infestation	68	59.65	74	56.06
Disease infestation	56	49.12	62	46.97
Multiple responses	**389**		**316**	

4.8 Weather and climate induced problems in hotspots area of forest degradation

District-wise response of farmers under hydro-meteorological extreme event/hotspot area of forest degradation regarding weather and climate induced problems had been furnished below:

Khagrachari: Less than fifty percent **(**43.68%) farmers indicated that they had a pest infestation problem while 40.80% farmers opined that they had a forest degradation problem. This was followed by flood (39.08%) and disease infestation (36.21%).

Bandarban: Similar trend of result had also found in Bandarban**.** Highest 72.50% farmers indicated that they had a pest infestation problem while 67.50% farmers opined that they had

a forest degradation problem. This was followed by flash flood (disease infestation flash flood (62.50%), and disease infestation (57.50) %.

Table 4.8: Weather and climate induced problems in hotspots area of forest degradation

Type of problems	Khagrachari farmer's response		Bandarban farmer's response	
	Number (N=174)	% response	Number (N=40)	% response
Drought	0	0.00	1	2.50
Cold-wave	11	6.32	1	2.50
Heatwave	0	0.00	0	0.00
Nor 'wester	6	3.45	2	5.00
Lightening	6	3.45	0	0.00
Coastal flood	0	0.00	0	0.00
Flood	68	39.08	19	47.50
Flash Flood	46	26.44	25	62.50
Flood Inundate	48	27.59	14	35.00
Salinity	0	0.00	0	0.00
Storm surge	21	12.07	7	17.50
Cyclone	11	6.32	2	5.00
Landslide	39	22.41	15	37.50
Forest degradation	71	40.80	27	67.50
Pest infestation	76	43.68	29	72.50
Disease infestation	63	36.21	23	57.50
Multiple responses	**466**		**165**	

4.9 Extent of crop damages due to the weather and climatic problems

Out of 1020 respondents, about 48.1% (491) farmers reported that the extent of crop damages due to weather and climatic problems was moderate which is followed by severe crop damage as reported by about 35.6% farmers (363) during survey. On the other hand, about 16.3% (166) farmers reported that the extent of crop damage was negligible due to weather and climatic problems.

From these findings, it was revealed that the extent of crop damage due to weather and climatic problems was moderate to severe as reported by about 84% farmers. Therefore, early forecast of weather and climate services for the farmers will be very effective to protect their crops from the damages.

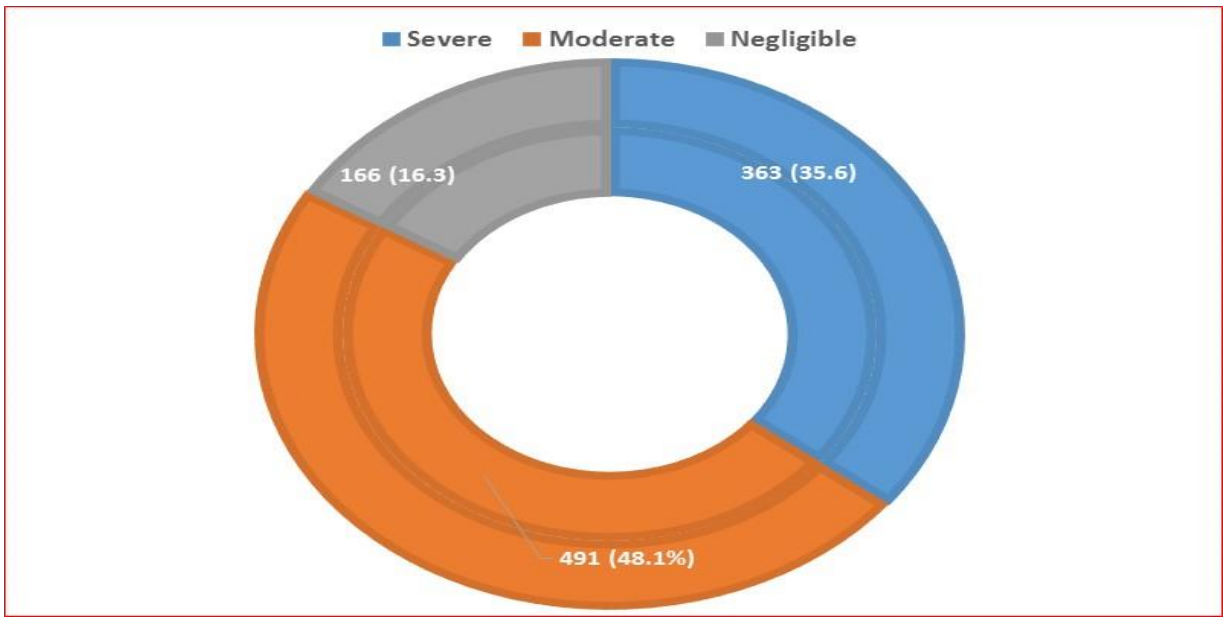


Figure 4.1: Extent of crop damages due to weather and climate related problems

4.10 Frequency of weather and climate related problems

Out of 1020 respondents, about 95% farmers (967) reported that they faced weather and climatic problems at least 1 to 4 times during crop production; of which 48.4% farmers faced problems at 3-4 times and 46.4% farmers faced problems at 1-2 times. On the other hand, about 5% (50) farmers faced such type of problems at 5-6 times during crop production.

Considering the frequency of weather and climatic problems faced by the farmers during crop production, early forecasting of agro-meteorological information will be the most effective way to take actions to combat crop damage due to weather and climatic problems.

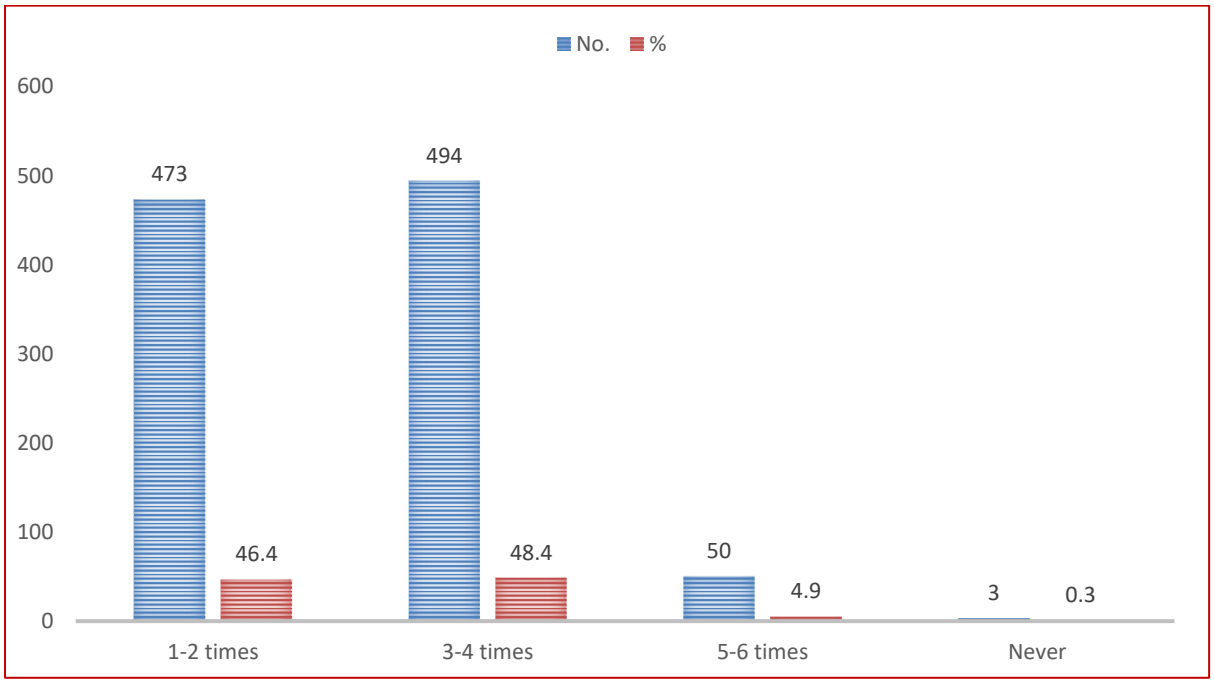


Figure 4.2: Frequency of weather and climatic problems faced during crop production

4.11 Problems faced during 2016 and 2017

Table below indicated the past two years (2016 and 2017) weather and climate induced problems faced by the farmers. Majority (70.1%) farmers reported that insect attack was the major problems for producing crops followed by attack of disease (60.9%), flash flood (36.2%), weed infestation on crop field (34.1%), drought (22.4%) cold-wave (21.8%) and nor ‘wester/thunderstorm (10.39%). However, the lowest ((0.6%) farmers indicated forest degradation were the major problems followed by landslide (1.2%), coastal flood (1.9%), storm surge (3.9%), lightening (7.05%), cyclone (8.4%), flood (9.3%), flood inundate (9.4%), and heatwave (9.5%).

To overcome from the huge damage of crops, it is strongly recommended immediate availability of agro-meteorological service to the farmers for reducing the crops damage from the climate and weather induced problems.

Table 4.9: Problems faced during 2016 and 2017

Problems faced in past 2 years (2016 and 2017)	Number	%
Drought	219	22.4
Cold-wave	213	21.8
Heatwave	93	9.5
Thunder storm	106	10.39
Lightening	32	7.05

Coastal flood	19	1.9
Flood	91	9.3
Flash Flood	353	36.2
Flood Inundate	92	9.4
Salinity	191	19.6
Storm surge	38	3.9
Cyclone	82	8.4
Landslide	12	1.2
Forest degradation	6	0.6
Attack of insect	684	70.1
Attack of diseases	594	60.9
Weed infestation	333	34.1
Others	21	2.2
Multiple Responses	**3219**	

4.12 Average production loss

According to the figure 4.3, the extent of problems faced by the farmers were insect attack, disease attack, flash flood, weed infestation on crop field, drought, cold-wave and thunderstorm. The highest (39.9%) farmers reported that they had a loss of 20-39 kg per acre (100 decimal) land which is followed by above 100 kg in per acre (100 decimal) land. The lowest (6.5%) farmers opined that they had a loss of 80-100 kg in per acre land which is followed by 60-79 kg (8.8%), 41-59 kg (12.1%) and above 100 kg (32.7%).

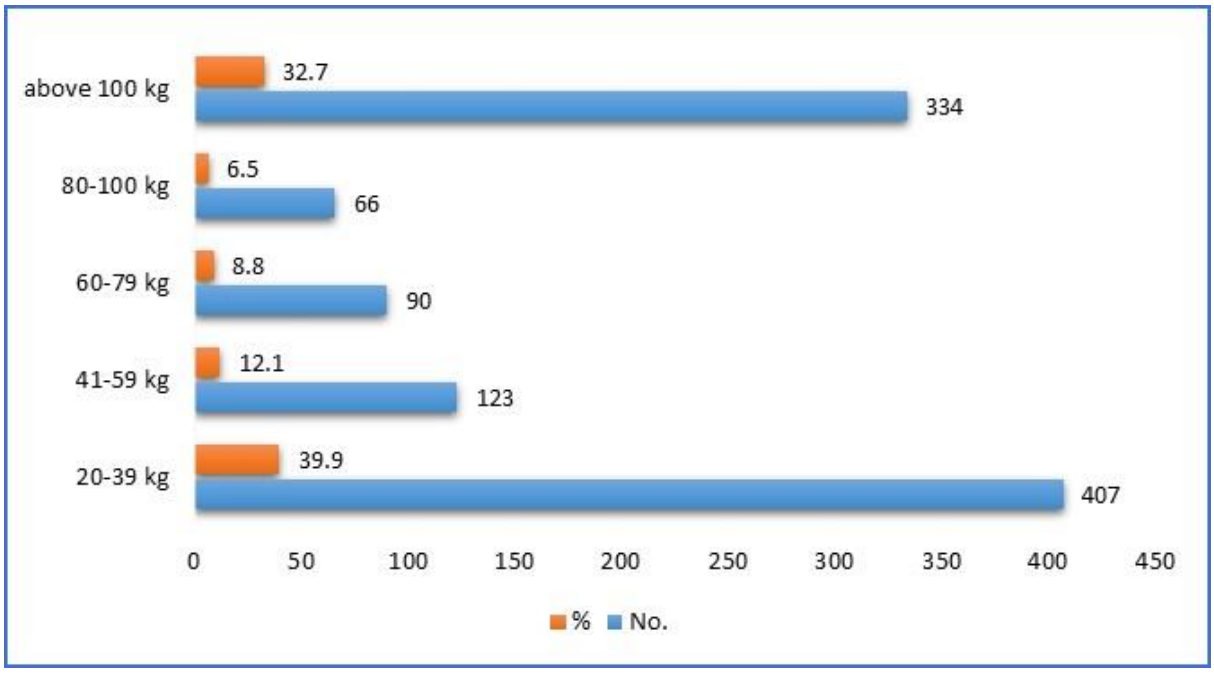


Figure 4.3: Average production loss due to problems

CHAPTER-5

AGRO-METEOROLOGICAL RELATED INFORMATION

This chapter describes overall weather and climate related information available for farmers. The objective of the study was to identify existing agro-meteorological information, ongoing observed parameters and technologies of BMD and to assess the farmer's knowledge and perception on agro-met services (if available) at community level. As per the objectives, findings of the study have been presented herewith mainly based on the primary and secondary data.

5.1 Source of Agro-Meteorological Information

There was no agro-meteorological service for farmers in the country. Farmers were getting forecast information on meteorological matters such as rain, storm, cyclone, heat wave, cold wave, thunderstorm etc. through different sources. Majority (42.74%) farmers reported that they did not get any meteorological information while second highest (37.15%) farmers received meteorological information from the TV which was followed by DAE (30.39%), community people (30%) and radio (25.6%). However, the lowest (0.2%) farmers indicated that they received information from the other sources like DAE *IPM club/extension battayan club* which was followed by local level *micing* (8%), and mobile SMS (9.4%). Aside this around 2.15% farmers indicated that they received meteorological information from the social media.

Table 5.1: Meteorological related information in the project area

Source of getting information of weather, climate, rainfall and flood etc.	Multiple responses	
	Number	%
Radio	260	25.6
TV	379	37.15
Social media	22	2.15
Mobile SMS	95	9.4
Local level *miking*	81	8.0
Community people	305	30.0
None	436	42.74
DAE	310	30.39
Multiple responses	**1680**	

5.2 Perception about the Govt. organization providing weather & climate related information

Asking the question on knowledge about the name of government organizations that provided temperature, rainfall, cyclone, storm, heat wave, and cold wave information, the majority (56%) farmer reported that they didn't have any knowledge about the organization that provided this information. The second highest (25%) farmer indicated that they were getting this information from the Department of Agricultural Extension (DAE) field level officials and extension batayan/IPM club etc. Conversely, 19% farmers indicated that they are getting weather and climate related information from Bangladesh Meteorological Department (BMD) through radio, TV or local level *miking*. However, none of them reported about BWDB.

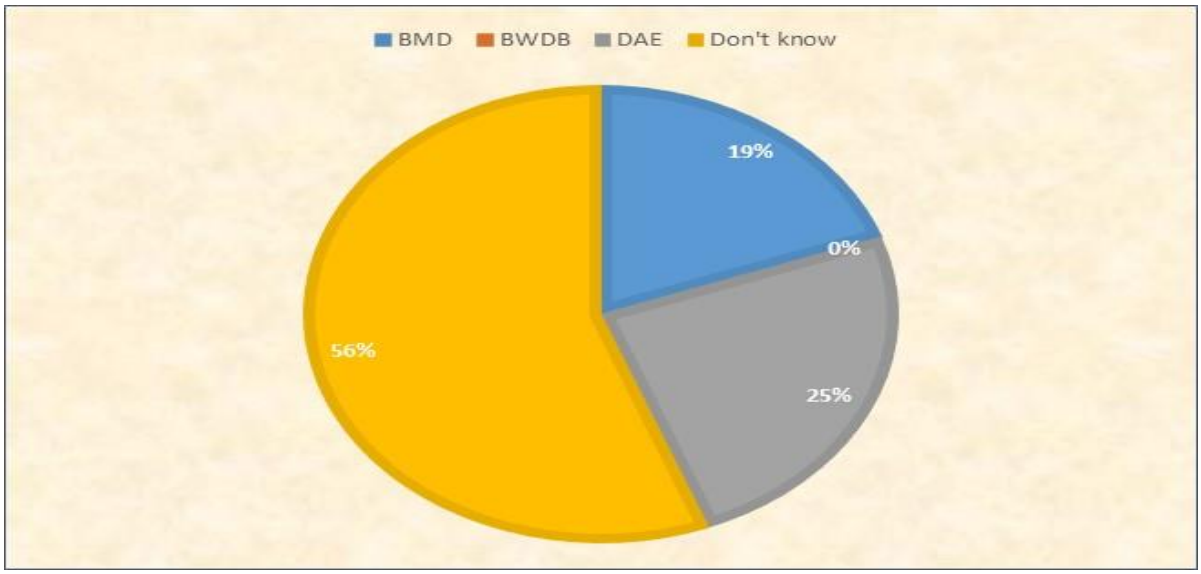


Figure 5.1: Knowledge about the organization providing weather & climate information

5.3 Perception about the govt. organization providing flood related information

Asking the question on knowledge about the organizations providing flood, flash flood, and coastal flood related information, the majority (58.73%) farmer reported that they didn't have any knowledge about the organization who was providing flood related information while 25.10% farmers indicated that they were getting these flood related information from the Department of Agricultural Extension (DAE) field level officials and extension batayan/IPM club etc. The lowest (1.37%) farmer indicated that they were getting this information from the Bangladesh Meteorological Department (BMD) local level officials which were followed by Bangladesh Water Development Board (14.80%). The above findings clearly indicated that farmers didn't have a clear idea about the government agency who was providing flood related information.

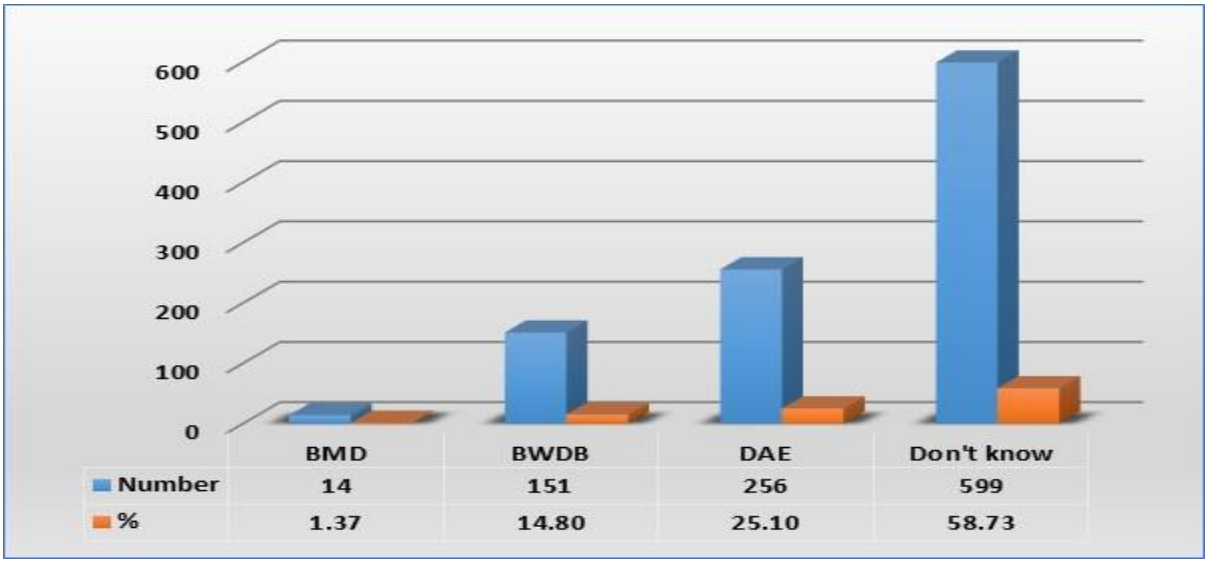


Figure 5.2: Knowledge about the organization providing flood information

5.4 Timing of information to save crops and properties from the damages

Most (86.6%) of the farmers indicated that they were not getting enough time after receiving information to save crops from the damage. Even they were not quite enough sure what to do after getting this information as it was only information of weather not any services or advise which was required for farmers to save crop from the damages. However, only 13.4%

farmers opined that they were getting enough time after getting information to save crop from the damages.

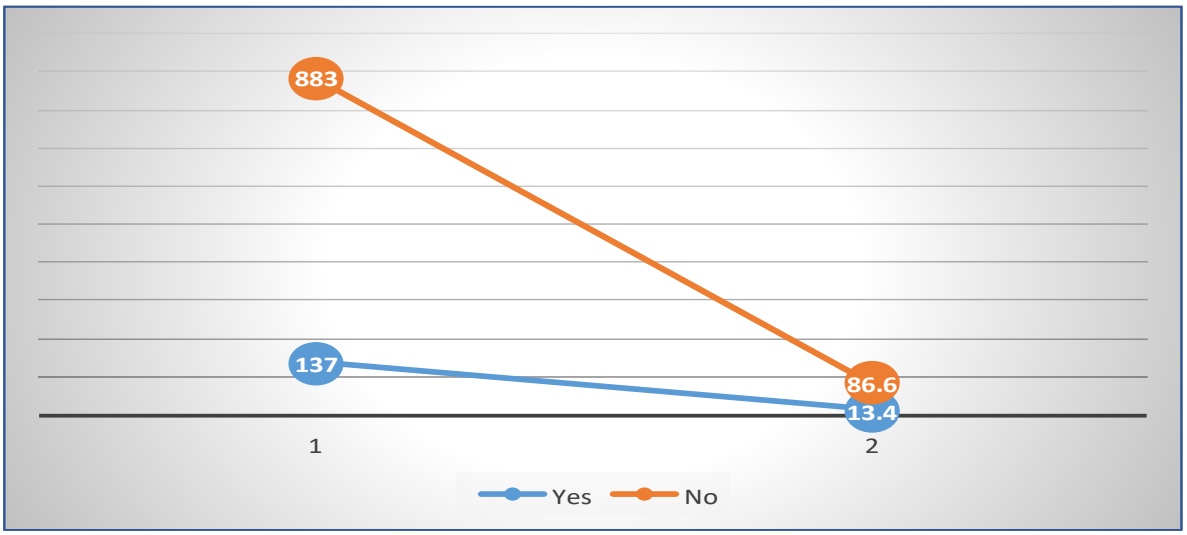


Figure 5.3: Timing of information to save crops and properties from the damages

5.5 Minimum advance forecast time

Majority (54.6%) farmers reported that they need at least 7 days' advance forecast information of weather and climate with advisories or services to save their crops from the damage which is followed by 15 days (29.3%). However, the lowest (1.5%) farmers reported that they need at more than 15 days' advance forecast information of weather and climate with advisories or services to save their crops from the damage which is followed by 3 days (14.6%).

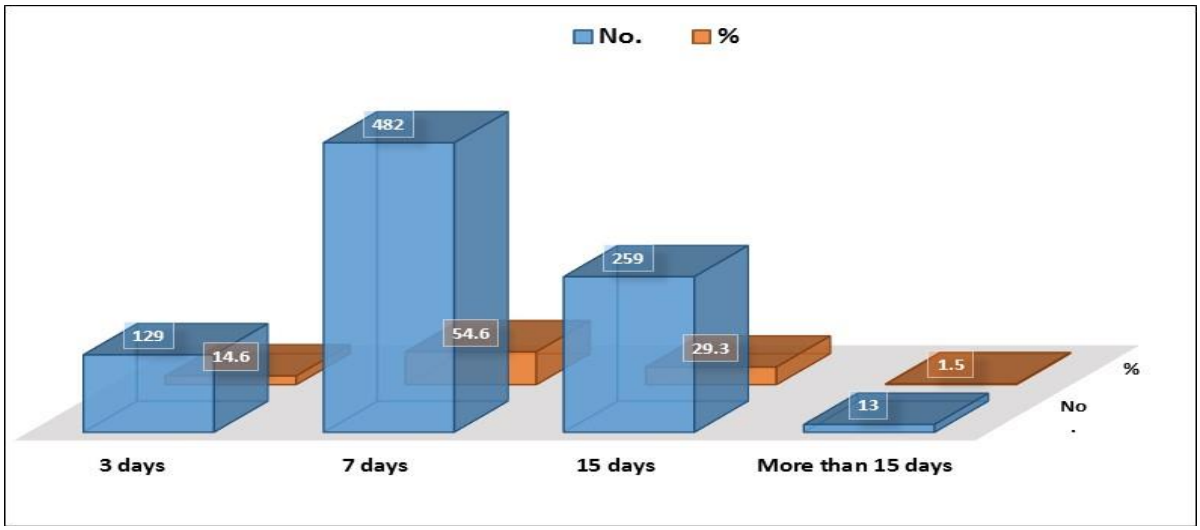


Figure 5.4: Minimum advance forecast time required to save crop from the damages

5.6 Knowledge about Role of BMD

Majority (80.78%) farmers opined that they had no knowledge about the roles of BMD whether it provided any services or advisories for protecting farmers' crops from the hazards like drought, high temperature, cold & heat wave, storms, cyclone and related calamities. Though only 19.22% farmers indicated that they had a little bit knowledge about the roles of BMD which was only provided meteorological information like temperature, rainfall and cyclone information but not any agro-met services or advisories for protecting farmers from

the hazards like drought, high temperature, cold & heat wave, storms, cyclone and related calamities

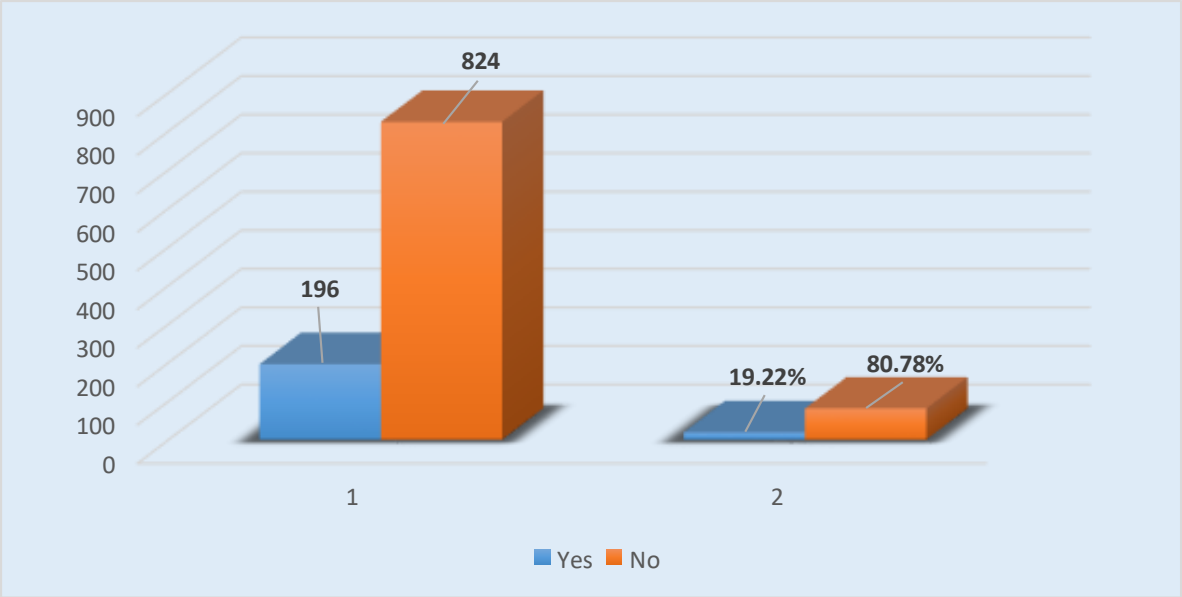


Figure 5.4: Perception about Roles of BMD

5.7 Knowledge about Role of BWDB

Majority (91.27%) farmers opined that they had no knowledge about roles of BWDB whether they provided any flood related services or advisories for protecting farmer crops from hazards like floods related calamities. However, only (8.72%) farmers indicated that they had knowledge about roles of BWDB which only provided flood related forecasting information but not any agro-met services or advisories for protecting farmers' crops from the hazards like floods related calamities.

Table 5.2: Perception about Roles of BWDB

Response type	Response of farmers	
	№	%
Yes	89	8.72
No	931	91.27
Total	**1020**	**100.0**

5.8 Knowledge about the Role of DAE on agro-met services

Majority (79.61%) farmers opined that they had no knowledge about the roles of DAE whether it provided any agro-met services or advisories for protecting farmers' crops from the hazards related to weather, climate and flood like natural calamities. However, only 20.39% farmers indicated that they had knowledge about the role of DAE which was only provided rainfall and flood information to the farmers as received from the Field Service Wing of DAE via Ministry of Agriculture through BMD but not any agro-met services or advisories for protecting farmer crops from the hazards related to weather, climate and flood like natural calamities.

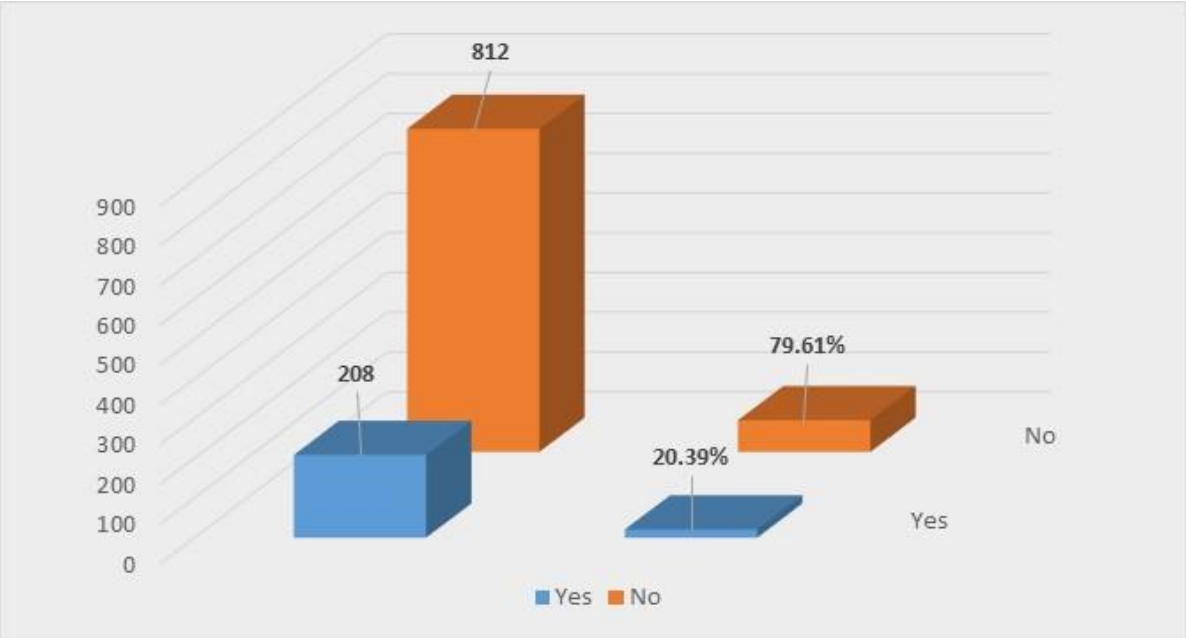


Figure 5.5: Perception about Role of DAE on Agro-met Services

5.9 Coordination among BMD, BWDB and DAE

Majority (89.80%) farmers opined that they had no knowledge about the coordination of BMD, BWDB and DAE to disseminate hydro-meteorological related information to the farmer communities. Though only 10.19% farmers indicated that they had a very little knowledge about the coordination of BMD, BWDB and DAE to disseminate hydro-meteorological related information due to field officials of DAE.

Table 5.3: Coordination among BMD, BWDB and DAE to disseminate hydro-meteorological information

Type of response	Response of farmers	
	№	%
Yes	104	10.19
No	916	89.80
Total	**1020**	**100.0**

5.10 Channel of meteorological information delivery

All farmers reported that there were not received any agro-meteorological services which were required to protect their crops from the damages. The highest (66.08%) farmers indicated that they had not received any meteorological information or services from any channel or sources. However, second highest (26.37%) farmers reported that received general meteorological information from the TV which was followed by Radio (26.18%). Conversely, the lowest (3%) farmers stated that they received this meteorological information from mobile SMS of DAE field level officials such as SAAOs, *extension batayan club* or IPM club etc. which was followed by analogue board (1.76%).

Table 5.4: Channel of meteorological information delivery

Media type	Response (Number)	Response (%)
Analogue board	18	1.76
Radio	267	26.18
TV	269	26.37
Mobile SMS	30	3.0
Others (None)	674	66.08
Multiple Responses	**1258**	

5.11 Satisfaction of the information provided by BMD, BWDB and DAE

Asking question about their satisfaction of information provided by the BMD, BWDB and DAE related to weather and climate information, almost all (90.99%) farmers reported that they were not satisfied enough of present information provided by BMD, BWDB and DAE as it was only an information not any services or advisories so farmers were unable to take any measures to protect their crop from the damages. However, only (9.01%) farmers expressed their satisfaction with the information provided by the BMD, DAE and BWDB.

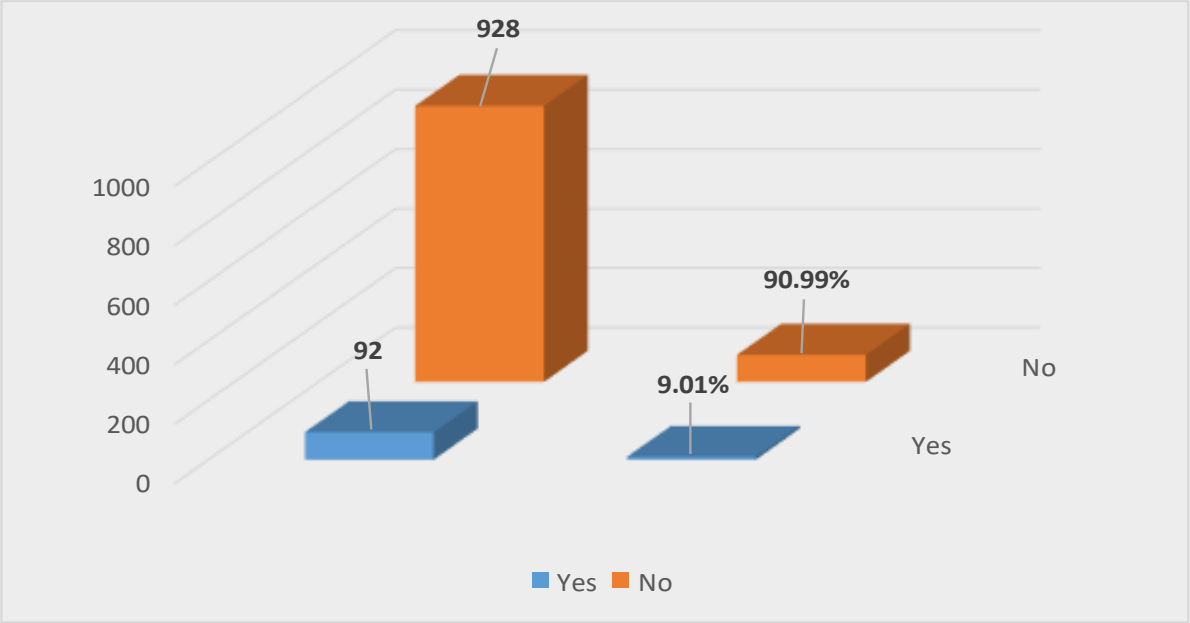


Figure 5.6: Satisfaction of the information provided by BMD, BWDB and DAE

5.12 Source of getting information

If they were not satisfying about the information provided by the BMD, BWDB and DAE then it was asked them, how they would like to get this information. The highest (51.50%) farmers opined that they would like to get this information from mobile SMS which was followed by Union Parishad Office (38.1%), and Upazila Agricultural Office (35.88%). The lowest (3.23%) farmers indicated that they would like to get this information from electronic & social media which was followed by Community people/farmers club etc. (32.6%).

Table 5.5: Source of getting hydro-meteorological information

Source of getting information	Number	%
Upazila Agriculture Office	333	35.88%
Union Parishad Office	388	38.1
Community people	269	32.6
Electronic & Social Media	30	3.23
Mobile SMS	478	51.50
Multiple responses	**1498**	

5.13 Information on seasonal variation data of weather and climate

Asking question to the farmers whether they are getting information on seasonal variation of temperature, rainfall and other weather and climate data, all (91.66%) farmers strongly reported that they had not received any seasonal variation of temperature, rainfall and other weather and climate data which was very important for their crop planning considering weather and climate while 8.34% farmers indicated that they had no knowledge about this.

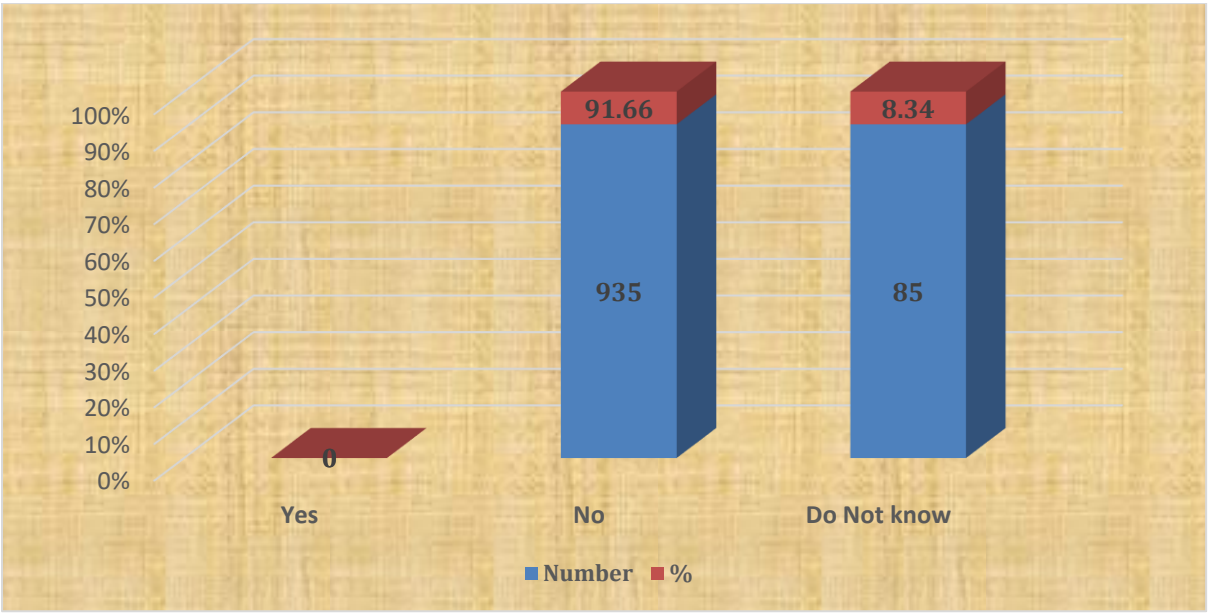


Figure 5.7: Information on seasonal variation data of weather and climate

5.14 Benefit of meteorological information

Majority (61.8%) farmers opined that meteorological information could be very useful for insect pests and disease management strategy of crops followed by crop production planning (58%), harvest and processing plan of crops (43.7%) and crop management plan (40.2%). However, the lowest (0.6%) farmers indicated that it could be useful for others category like storage and marketing purposes followed by irrigation planning (28.8%).

Table 5.6: Benefit of meteorological information

Type of benefit	Number	%
Crop Production Planning	498	58.0
Irrigation Planning	247	28.8
Crop Management	345	40.2
Harvest and processing	375	43.7
Insect pests and disease management of crops	530	61.8
Others	5	0.6
Multiple responses	**2000**	

5.15 Necessity of agro-meteorological advisories and services

Almost all (95.10%) farmers opined that they need agro-meteorological products, advisories and services to protect their crops from the damage while only 4.90% farmers reported they had no requirement of agro-meteorological products, advisories and services to protect their crops from the damage. It was due to their lack of knowledge on agro-met services and advisories.

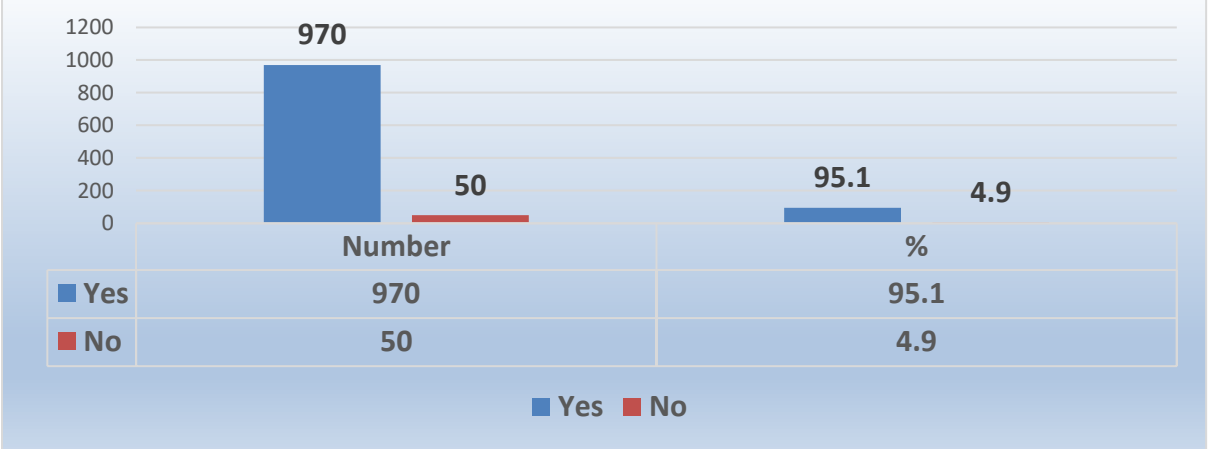


Figure 5.8: Necessity of agro-meteorological services

5.16 Adoption of new technology and techniques

Almost all (99.01%) farmers reported that they were not adopted any new technology, cropping pattern and crop production schedule to avoid weather and climate induced problems as they were not currently getting any agro-meteorological products, advisories and services while only 0.99% farmers reported they were adopted new technology, cropping pattern and crop production schedule to avoid weather and climate induced problems conspiring previous year weather and climate records.

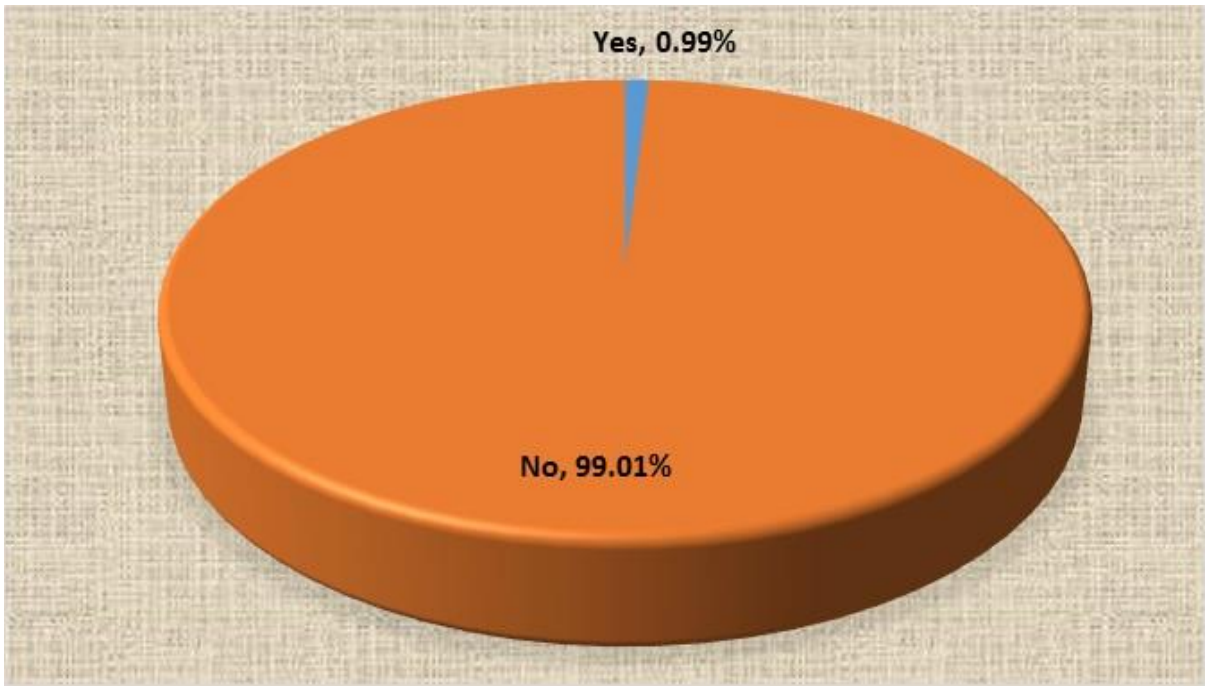


Figure 5.9: Adoption of new technology and techniques

5.17 Type of techniques to be adopted

Majority (78.6%) farmers reported that they could adopt new technology like insect pest tolerant crop varieties to avoid weather and climate induced problems which was followed by disease tolerant crop varieties (78%) and drought tolerant crop varieties (48.1%). However, the lowest (1%) percent farmers reported they could adopt any new technology like others such as crop management or planning or changing of cropping pattern which was followed by heat tolerant crop varieties (11.2%), salt tolerant crop varieties (12.1), and cold tolerant crop varieties (28%) to avoid weather and climate induced problems.

Table 5.7: Type of techniques to be adopted

Adoption type	Number	%
Drought tolerant crop varieties	326	48.1
Salt tolerant crop varieties	82	12.1
Disease tolerant crop varieties	529	78.0
Insect pest tolerant crop varieties	533	78.6
Heat tolerant crop varieties	76	11.2
Cold tolerant crop varieties	190	28.0
Others	7	1.0
Multiple responses	**1743**	

5.18 Knowledge on existing weather forecast to protect crop production

Around three fourth percent (74.71%) farmers out of 1020 respondents indicated that the existing weather forecast was not enough to protect crop production from the damage due to natural calamities while 24.51% farmers opined that they had no idea about this. However, only 0.78% farmers reported that they had knowledge of existing weather forecast to protect crop production from the damages.

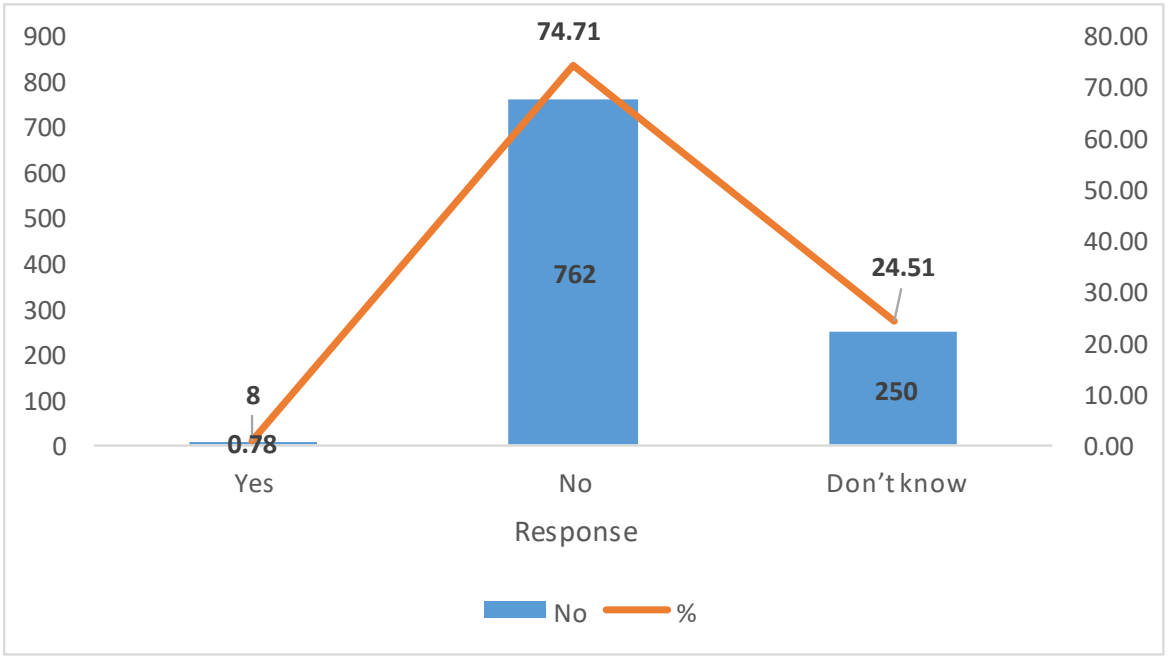


Figure 5.10: Knowledge of existing weather forecast to protect crop production

5.19 Accessibility of meteorological information to the farmers

More than fifty percent (54.9%) farmers indicated that they had not any access of meteorological information or available for them followed by sometimes (36.4%). However, the lowest (2.2%) farmers reported that meteorological information was highly accessible or available for farmers followed by when I look for it (6.6%).

Table 5.8: Accessibility of meteorological information to the farmers

Frequency of information	Number	%
Not at all	560	54.9
Sometimes	371	36.4
When I look for it	67	6.6
Highly accessible	22	2.2
Total	**1020**	**100.0**

5.20 Effectiveness of Meteorological forecast

Almost all (91.37%) farmers reported that current meteorological information or forecast was not effective as it was just a general information not agro-met services thus farmers were unable to take any measures to protect their crops from the damages. If they received agro-meteorological information with advisories that helpful for them to protect their crops from the damages. Currently, they had not no knowledge about the measures to be taken upon received weather and climate information to protect crop from the damages. The second highest (6.86%) farmers indicated that it was less effective to protect their crop from the disaster. However, the lowest (0.69%) percent farmers reported that current meteorological information specially rainfall, temperature and flood were very effective to protect crop from the damages or risks of weather and climate while 1.08% farmers stated that it was effective to protect crop from the damages.

Table 5.9: Effectiveness of Meteorological forecast

Degree of effectiveness	Number	%
Very effective	7	0.69
Effective	11	1.08
Less Effective	70	6.86
Not Effective	932	91.37
Total	**1020**	**100.0**

5.21 Traditional methods used for applying weather forecasts

Due to lack of agro-met services, farmers were mostly used traditional method to protect their crops from the weather and climate induced problems. Majority (56.2%) farmers reported that they were currently planned their crop production based on past two years' weather while 54.1% farmers informed that they were followed last year weather for crop planning. However, the lowest (7%) percent farmers reported that they were followed others such as weather and climate forecast of government agencies while 38.9% farmers depend on prediction or suggestions of older person of the family.

Table 5.12: Methods used for applying weather forecasts

Weather forecasts method	Number	Percentage (%)
last year weather	545	54.1
past 2 years weather	566	56.2
prediction of older person of family	392	38.9
Others (weather forecast)	71	7.0
Multiple Responses	**1574**	

5.22 Perception of traditional weather forecasts

Farmers are mostly using traditional method to protect their crops from weather and climate induced problems. While asking about the perception of traditional weather forecast, the majority (80.78%) farmers informed that this forecast was not reliable at all but they need to depend on it as there was no agro-meteorological products or services. Around (17.94%) farmers reported that traditional weather forecasts were sometimes reliable while 1.07% farmer opined that it was always reliable.

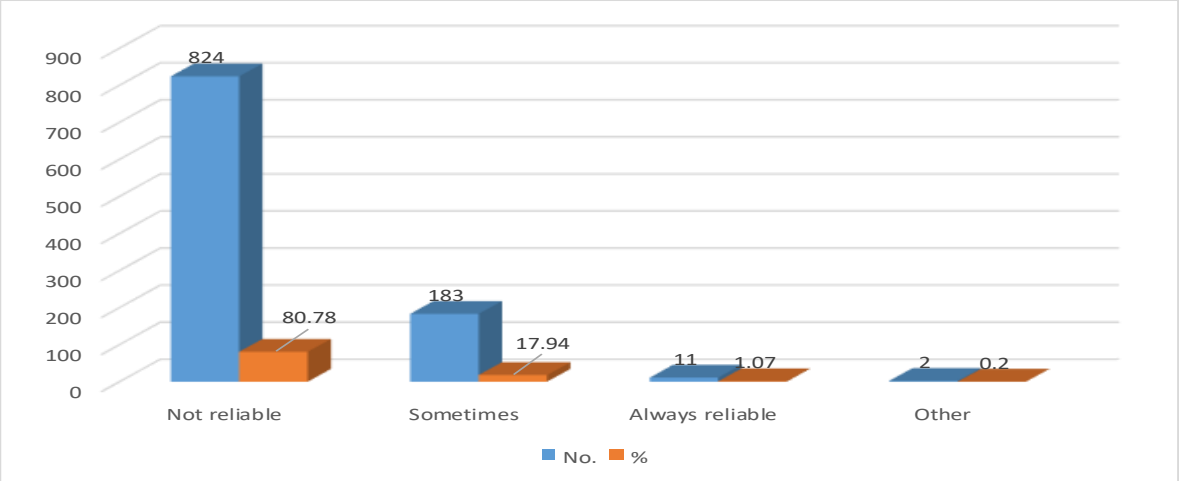


Figure 5.11: Perception of traditional weather forecasts

5.23 Type of crops to be grown based on forecast

Almost all (92.84) farmers indicated that they didn't wait for weather forecast for deciding what type of crops will be grown as there was no crop and location-based agro-meteorological forecast/services or other reliable forecasts which could depend for crop planning. Only 7.15% farmers informed that they decided their crop production plan based on general weather forecast.

Table 5.10: Decision on type of crops to be grown based on forecast

Type of response	Farmer response	
	Number	%
Yes	73	7.15
No	947	92.84
Total	**1020**	**100.0**

5.24 Decisions making time for planting crops

Majority (68%) farmers opined that they used to follow usual season for making decision for planting of crop which was followed by use traditional forecast (10.6%) and follow neighbors (8.85). However, the lowest (3.4%) farmers informed that they used to make a decision for planting crops after receiving forecast of weather and climate which was followed by wait for rains (9.1%).

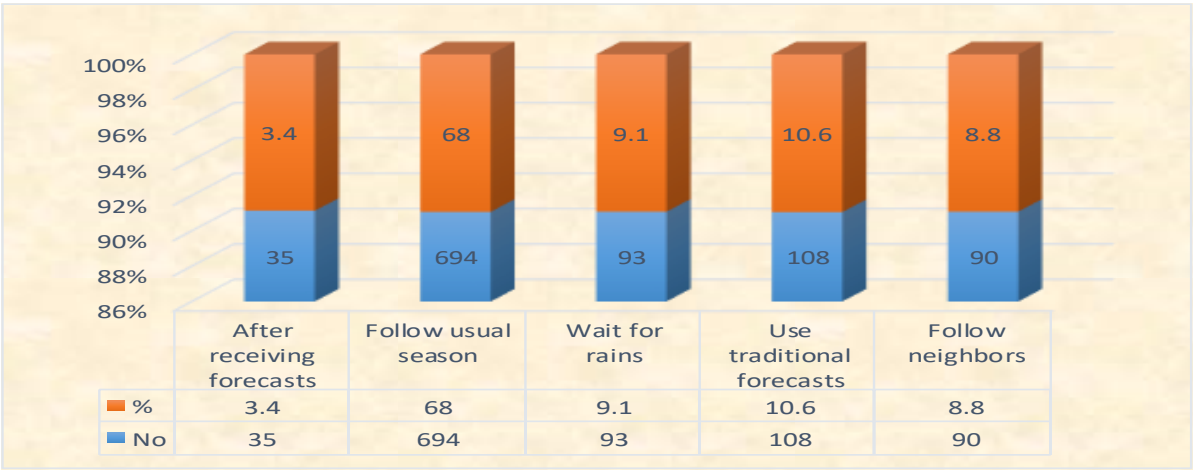


Figure 5.12: Decision making time for planting crops

CHAPTER-6

User Satisfaction Index using Baseline Survey

This section describes overall weather forecast and climate related information available for farmers. The objective of the study is to identify existing agro-meteorological information, ongoing observed parameters and technologies of Bangladesh Meteorological Department (BMD) and to assess the farmer's knowledge and satisfaction on weather forecast and or agromet advisory services at community level. It is envisaged to develop Bangladesh agricultural meteorological information system services to help farmers mitigate climate related production risks, the project provides support for the establishment of early warning systems, upgrading the existing hydro-meteorological system, and enhancing human capacity. User's Satisfaction Index provides the information regarding the understanding of the user's or customer's on goods or services. This is basically the outcome-oriented approach regards satisfaction as an attribute extracted from a product or service after its consumption whether the objectives of systems or the organizational unit utilizing the systems are achieved or not. Thus, this section focuses the knowledge and use of weather forecast, present status of the user's satisfaction level of the district

6.1 Knowledge or experience of the farmers on weather forecast

Regarding the knowledge or experience of the farmers on weather forecast, majority 86.86% of the farmers are found to have lack of knowledge on it. Insignificant proportion of the farmers had knowledge on weather forecast accounting for only 13.14% of the total farmers. However, highest 88.83% of the farmers are found to have lack of knowledge on it in Naogaogn district and the lowest (85%) farmers had the knowledge on it in the Bandarban district which is presented in the following table.

Table-6.1: Districts-wise knowledge or experience farmer's on weather forecast

Type of Hydro-meteorological Extreme Event	District	Total Respondents	Farmer's Response			
			Do have knowledge		Do not have knowledge	
		N=1020	*Number*	%	*Number*	%
Drought Cold wave, Storm	Rajshahi	170	22	12.94	148	87.06
	Naogaon	188	21	11.17	167	88.83
Cyclone, Salt, Flood	Patuakhali	84	13	15.48	71	84.52
	Satkhira	118	18	15.25	100	84.75
Flash/ Pre-Monsoon Flood	Sunamganj	114	15	13.16	99	86.84
	Netrokona	132	18	13.64	114	86.36
Forest Degradation	Khagrachari	174	24	13.79	150	86.21
	Bandarban	40	6	15.00	34	85.00
	Total	**1020**	**134**	**13.14**	**886**	**86.86**

6.2 Practice of using different weather forecast by farmers

As has been already mentioned in the above that overwhelming majority of the farmers did not have knowledge on weather forecast, however those insignificant proportion of the respondents having knowledge on it are using different components of weather forecast during the last 12 months such as rain, temperature, cloud cover, direction and speed of wind etc. Among those respondents having knowledge on weather forecast, maximum proportion of farmers were the users of forecast of rainfall and cyclone accounting for 97.76%, this is followed by the users of the temperature forecast, which accounted for 95.52% of the total knowledgeable respondents. In case of wind and flood/flash flood, the proportions of users are found to be only 76.87% in each and 61.19% in cold-wave of the total knowledgeable respondents. Similarly, the users of forecast of other weather components are found to be

comparatively very low viz. users of forecast of landslide stood at 8.21%, this is followed by the salinity (14.18%), Lightening (20.15%), Nor 'wester (38.81%), heatwave (46.27%), and drought (58.21%) only of the total knowledgeable respondents of 134.

Table-6.2: Use of different weather forecasts in last 12 months by weather components

Weather Components	Farmer's Response N=134 (13.14%) of the total respondents)	
	Number of responses	% of response
Rainfall	131	97.76
Temperature	128	95.52
Wind (direction, speed)	103	76.87
Drought	78	58.21
Cold-wave	82	61.19
Heatwave	62	46.27
Nor 'wester	52	38.81
Lightening	27	20.15
Flood/Flash Flood	103	76.87
Salinity	19	14.18
Storm surge	71	52.99
Cyclone	131	97.76
Landslide	11	8.21
Multiple Responses	**998**	

6.3 Weather related knowledge prior to agro-activities

It is often advisable to the farmers to acquire weather related knowledge prior to agro-activities in order to safeguard the seeds to be used or crops to be cultivated or harvested in the farm. In this regard, the farmers should have adequate knowledge about the weather and its forecast and implement their knowledge by checking weather forecast regularly in time. An enquiry into the acquirement of weather-related knowledge prior to agro-activities revealed that insignificantly very less proportion of the farmers are found to have acquired weather related conditions (knowledge) prior to agro-activities. For instance, out of total 134 farmers having knowledge about the weather forecast, only 26.87% of them are found to have acquired knowledge prior to agro-activities under less often category. This is followed by acquiring knowledge once every three months, which accounted for 20.90% and 14.18% in once in a month and once a fortnight. However, the lowest 6.72% farmers are found to have acquired weather related knowledge prior to agro-activities under daily basis. This is followed by the 2-3 days a week (7.46% and once ia week (9.70%).

Table-6.3: Attainment of weather-related knowledge prior to agro-activities by weather forecasts

Weather Forecast Schedule	Farmer's Response N=134 of the total respondents)	
	Number of responses	% of response
Daily basis	9	6.72
2-3 days a week	10	7.46
Once a week	13	9.70
Once a fortnight	19	14.18
Once in a month	19	14.18
Once every 2-3 months	28	20.90
Less often	36	26.87
Total	**134**	**100%**

6.4 User's Satisfaction Level on the accuracy of weather-related information

The methodology for calculation of the user satisfaction index is given below. The user's satisfaction index is a simple and straightforward approach that is used widely in planning and evaluation studies such as human development index and rating index (Sullivan, 2002; Sullivan et. al. 2003). Specifically, this satisfaction scale was developed on the basis of summated rating scale, which is most commonly known as Likert scale, was based on the assumption that each attribute on the scale has equal 'attitudinal value' or 'importance' or 'weight' in terms of reflecting an attitude towards the issue in question. Summated scales consisted of numbers of related statements that express either a favourable or unfavourable attitude towards an issue of interest. These statements or attributes usually consisted of a mixture of favourable and unfavourable statements.

5-point Likert rating scale has been used to provide comparison and analysis by using the satisfaction rating classified as (i) Highly favourable (ii) Favourable (iii) Neutral (undecided) (iv) Not favourable and (v) Not favourable at all.

4-point Likert rating scale has been used to provide comparison and analysis by using the satisfaction rating classified as (i) Highly favourable (ii) Favourable (iii) Not favourable and (iv) Not favourable at all.

The responses indicating the least favourable to strongly favourableness degree had given the appropriate score; and the User's Satisfaction Index for different key attributes was calculated by using the following formula.

User Satisfaction Index for 5-point scale= $\frac{f_{hs}\,(S_{hs})+ f_s\,(S_s)+f_u\,(S_u)+f_{ns}\,(S_{ns})+f_{nsal}\,(S_{nsal})}{N}$

User Satisfaction Index for 4-point scale= $\frac{f_{hs}\,(S_{hs})+ f_s\,(S_s)+f_{ns}\,(S_{ns})+f_{nsal}\,(S_{nsal})}{N}$

Where,

f_{hs} = frequency of highly satisfied, and S_{hs} = score of highly satisfied
f_s = frequency of satisfied, and S_s = score of satisfied
f_u = frequency of undecided, and S_u = score of undecideds
f_{ns} = frequency of not satisfied, and S_{ns} = score of not satisfied
f_{nsal} = frequency of not satisfied at all, and S_{nsal} = score of not satisfied at all
N = Total number of observations

The questionnaire contained questions related to service attributes unique to the service type. These attributes were then rated against performance using 5 point and 4-point Likert scaleTo determine the User's Satisfaction Index (USI), the following five parameters were used as given below:

- ❖ Accuracy of weather information (forecast) provided by the service organizations.
- ❖ Accessibility of meteorological information to the farmers provided by the service organizations
- ❖ Effectiveness of Meteorological forecast provided by the service organizations

The 5-point index for any individual attribute falls between 1 to 5. If the index happens to be above 3, it shows favourable opinion to the given attribute indicating the percentage of people with positive attitude towards the service provided by the service organizations. An index of below 3 would mean unfavourable opinion to the given attribute indicating the percentage of people with negative attitude towards the service, and exactly 3 would be suggestive of a neutral attribute or undecisive perception. The 4-point index is very similar where individual value falls between 1 to 4 with no neutral attribute or undecisive perception.

Though the level for different attributes has been measured by using both 5-point and 4-point Likert scale, an attempt has also been made to show the satisfaction level (or favourableness / unfavourableness) in percentage

As has been already mentioned that there were number of organizations established for providing weather related information to the farmers. However, only a small segment of the population having knowledge on it were found to have acquired this weather-related information. The degree of satisfaction level has been measured by using 5-point Likert scale as has been mentioned in the methodology section along with the satisfaction level in percentage. An index value of above 3 shows the favourable opinion to the given attribute indicating the percentage of people with favourable (or positive) attitude towards the service provided by the service organizations. An index of below 3 would mean unfavourable opinion (or negative) to the given attribute indicating that they are driven towards the negative attitude regarding the service, and exactly 3 would be suggestive of a neutral attribute or undecisive perception.

The degree of satisfaction level on the accuracy of weather-related information of the service provider perceived by the respondents is shown in Table 4.1.

Table 6.1: Satisfaction level on the accuracy of weather-related information (%)

Weather Components	Farmer's Response						Index	% of Satisfaction
	Highly satisfied	Moderately satisfied	Can't say (neutral)	Not satisfied	Not satisfied at all	Total Respondents		
Rainfall	7.46	13.43	38.81	24.63	15.67	100.00	2.724	44.48
	10	18	52	33	21	134		
Temperature	8.21	14.18	36.57	23.13	17.91	100.00	2.717	44.33
	11	19	49	31	24	134		
Wind (direction, speed)	0.00	1.49	48.51	26.12	23.88	100.00	2.276	35.522
	0	2	65	35	32	134		
Drought	1.49	3.73	43.28	27.61	23.88	100.00	2.313	36.262
	2	5	58	37	32	134		
Cold-wave	1.49	3.73	43.28	27.61	23.88	100.00	2.313	36.262
	2	5	58	37	32	134		
Heatwave	1.49	3.73	43.28	27.61	23.88	100.00	2.313	36.262
	2	5	58	37	32	134		
Nor 'wester	3.73	7.46	41.04	26.87	20.90	100.00	2.463	39.25
	5	10	55	36	28	134		
Lightening	0.00	1.49	50.75	26.12	21.64	100.00	2.321	36.42
	0	2	68	35	29	134		
Flood/Flash Flood	3.73	8.96	44.03	24.63	18.66	100.00	2.545	40.9
	5	12	59	33	25	134		
Salinity	0.00	15.45	39.84	25.20	19.51	100.00	2.512	40.25
	0	19	49	31	24	123		
Storm surge	1.49	14.18	37.31	26.87	20.15	100.00	2.5	40
	2	19	50	36	27	134		
Cyclone	5.97	13.43	36.57	26.12	17.91	100.00	2.634	42.69
	8	18	49	35	24	134		
Landslide	0.00	0.00	48.51	28.36	23.13	100.00	2.254	35.08
	0	0	65	38	31	134		

As revealed from the above table, none of the weather parameters have index of above 3. However, the highest index value among others are the forecast of rainfall, temperature and cyclone showing the index of 2.724, 2.717 and 2.634 and in percentage 44.48, 44.33 and 42.69% respectively. It is interesting to note that the index value of none of the attributes were found to be 3 or greater than 3 nor 2 or less than 2. This shows that neither the service recipients are satisfied/highly satisfied nor neutral/not satisfied at all. It shows that the overall

satisfaction level of the common people on the forecast of weather-related information is 'not satisfacied'. Hence there is a definite need of improvement in the service of the service organizations.

6.5 Knowledge about the service of Bangladesh Agriculture Meteorological Information System (BAMIS)

It is ironical to note that almost all respondents did not have knowledge about the service of Bangladesh Agriculture Meteorological Information System (BAMIS). The farmers having knowledge about is found to be only 2.45% of the total respondents while 97.55% farmers were still unaware about the weather forecast/BAMIS portal service from the AMISDP. This is indicating that there is a high need of further dissemination of information about it.

Table 5: Knowledge about the services of BAMIS by area (in%)

Knowledge	Response of the Farmer's (N=1020)	
	Number	Percentage
Have knowledge	25	2.45
Do not Have knowledge	1010	97.55
Total	**995**	**100**

6.6 Source of Agro-Meteorological Information

There was no agro-meteorological service for farmers in the country. Farmers were getting forecast information on meteorological matters such as rain, storm, cyclone, heat wave, cold wave, thunderstorm etc. through different sources. Majority (42.74%) farmers reported that they did not get any meteorological information while second highest (37.15%) farmers received meteorological information from the TV which was followed by DAE (30.39%), community people (30%) and radio (25.6%). However, the lowest (0.2%) farmers indicated that they received information from the other sources like DAE *IPM club/extension battayan club* which was followed by local level *micing* (8%), and mobile SMS (9.4%). Aside this around 2.15% farmers indicated that they received meteorological information from the social media.

Table 6: Meteorological related information in the project area

Source of getting information of weather, climate, rainfall and flood etc.	Multiple responses	
	Number	%
Radio	260	25.6
TV	379	37.15
Social media	22	2.15
Mobile SMS	95	9.4
Local level *miking*	81	8.0
Community people	305	30.0
None	436	42.74
DAE	310	30.39
Multiple responses	**1680**	

6.7 Perception about the Govt. organization providing weather & climate related information

Asking the question on knowledge about the name of government organizations that provided temperature, rainfall, cyclone, storm, heat wave, and cold wave information, the majority (56%) farmer reported that they didn't have any knowledge about the organization that provided this information. The second highest (25%) farmer indicated that they were getting this information from the Department of Agricultural Extension (DAE) field level officials and extension batayan/IPM club etc. Conversely, 19% farmers indicated that they are getting weather and climate related information from Bangladesh Meteorological

Department (BMD) through radio, TV or local level *miking*. However, none of them reported about BWDB.

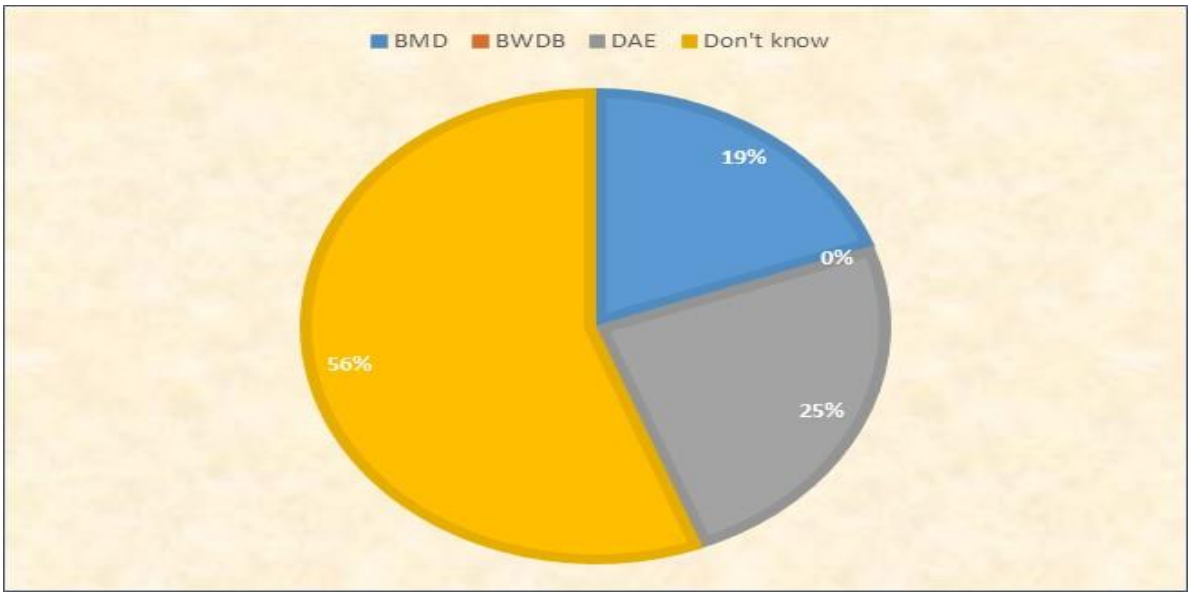


Figure 6.1: Knowledge about the organization providing weather & climate information

6.8 Perception about the govt. organization providing flood related information

Asking the question on knowledge about the organizations providing flood, flash flood, and coastal flood related information, the majority (58.73%) farmer reported that they didn't have any knowledge about the organization who was providing flood related information while 25.10% farmers indicated that they were getting these flood related information from the Department of Agricultural Extension (DAE) field level officials and extension batayan/IPM club etc. The lowest (1.37%) farmer indicated that they were getting this information from the Bangladesh Meteorological Department (BMD) local level officials which were followed by Bangladesh Water Development Board (14.80%). The above findings clearly indicated that farmers didn't have a clear idea about the government agency who was providing flood related information.

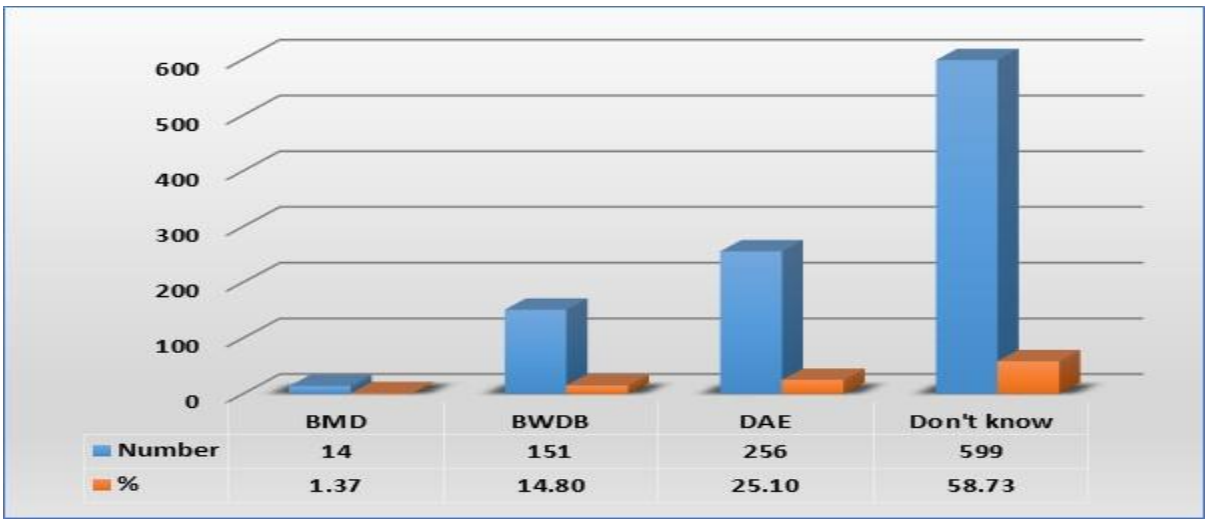


Figure 2: Knowledge about the organization providing flood information

6.9 Timing of information to save crops and properties from the damages

Most (86.6%) of the farmers indicated that they were not getting enough time after receiving information to save crops from the damage. Even they were not quite enough sure what to

do after getting this information as it was only information of weather not any services or advise which was required for farmers to save crop from the damages. However, only 13.4% farmers opined that they were getting enough time after getting information to save crop from the damages.

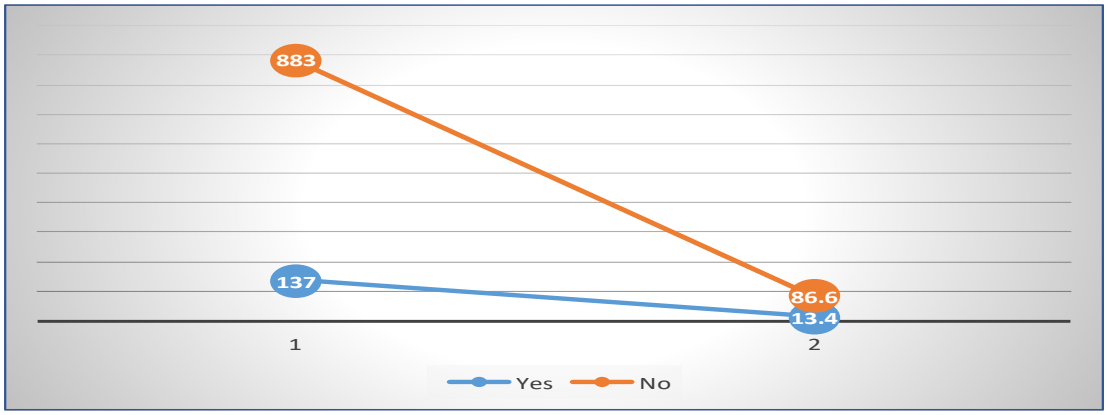


Figure 3: Timing of information to save crops and properties from the damages

6.10 Minimum advance forecast time

Majority (54.6%) farmers reported that they need at least 7 days' advance forecast information of weather and climate with advisories or services to save their crops from the damage which is followed by 15 days (29.3%). However, the lowest (1.5%) farmers reported that they need at more than 15 days' advance forecast information of weather and climate with advisories or services to save their crops from the damage which is followed by 3 days (14.6%).

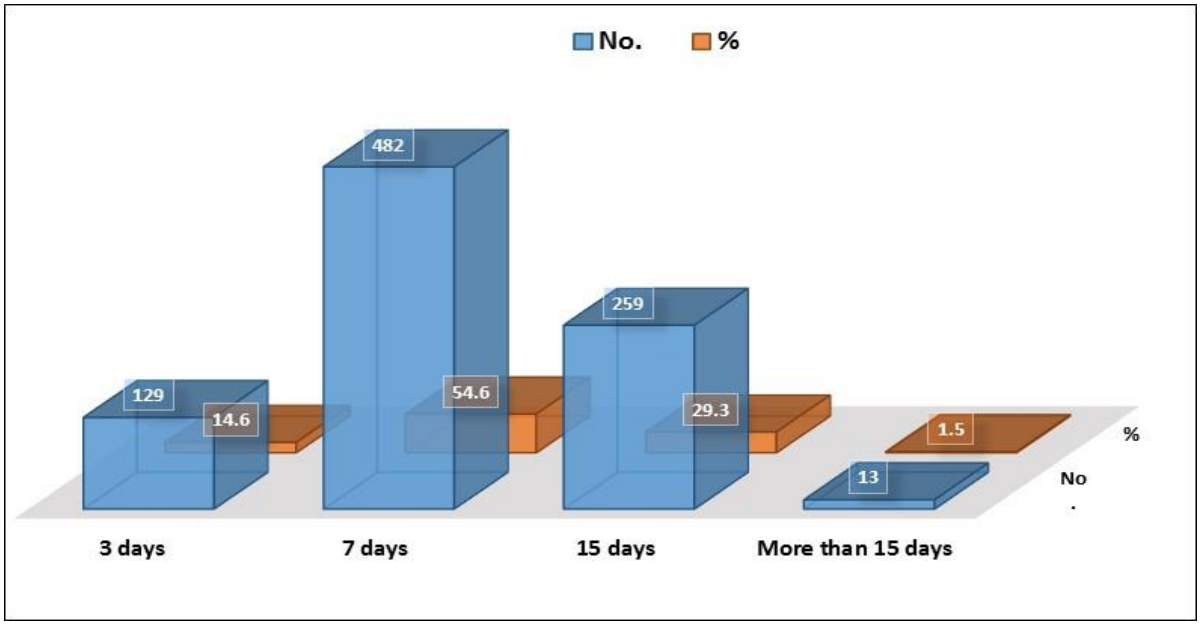


Figure 4: Minimum advance forecast time required to save crop from the damages

6.11 Knowledge about Role of BMD

Majority (80.78%) farmers opined that they had no knowledge about the roles of BMD whether it provided any services or advisories for protecting farmers' crops from the hazards like drought, high temperature, cold & heat wave, storms, cyclone and related calamities. Though only 19.22% farmers indicated that they had a little bit knowledge about the roles of BMD which was only provided meteorological information like temperature, rainfall and cyclone information but not any agro-met services or advisories for protecting farmers from

the hazards like drought, high temperature, cold & heat wave, storms, cyclone and related calamities

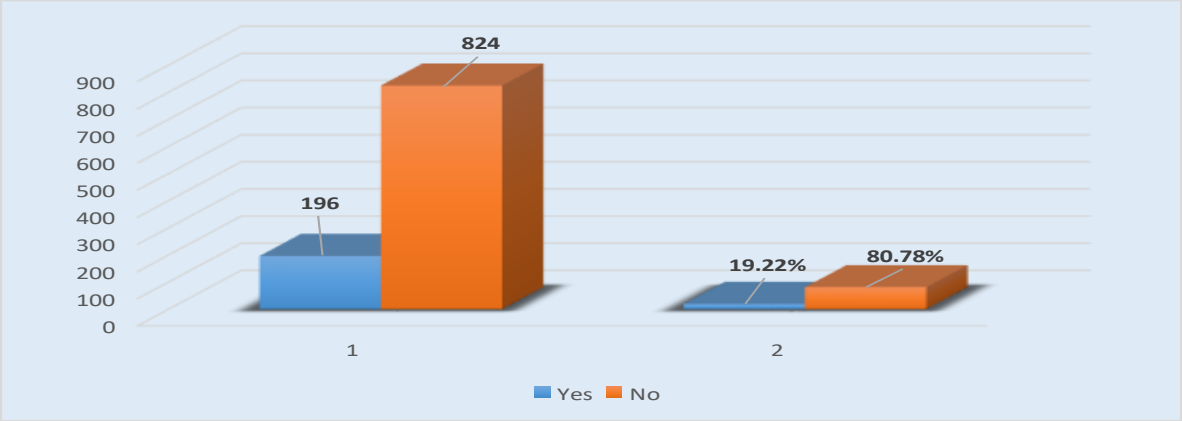


Figure 5: Perception about Roles of BMD

6.12 Knowledge about Role of BWDB

Majority (91.27%) farmers opined that they had no knowledge about roles of BWDB whether they provided any flood related services or advisories for protecting farmer crops from hazards like floods related calamities. However, only (8.72%) farmers indicated that they had a knowledge about roles of BWDB which only provided flood related forecasting information but not any agro-met services or advisories for protecting farmers' crops from the hazards like floods related calamities.

Table 7: Perception about Roles of BWDB

Response type	Response of farmers	
	№	%
Yes	89	8.72
No	931	91.27
Total	**1020**	**100.0**

6.13 Knowledge about the Role of DAE on agro-met services

Majority (79.61%) farmers opined that they had no knowledge about the roles of DAE whether it provided any agro-met services or advisories for protecting farmers' crops from the hazards related to weather, climate and flood like natural calamities. However, only 20.39% farmers indicated that they had knowledge about the role of DAE which was only provided rainfall and flood information to the farmers as received from the Field Service Wing of DAE via Ministry of Agriculture through BMD but not any agro-met services or advisories for protecting farmer crops from the hazards related to weather, climate and flood like natural calamities.

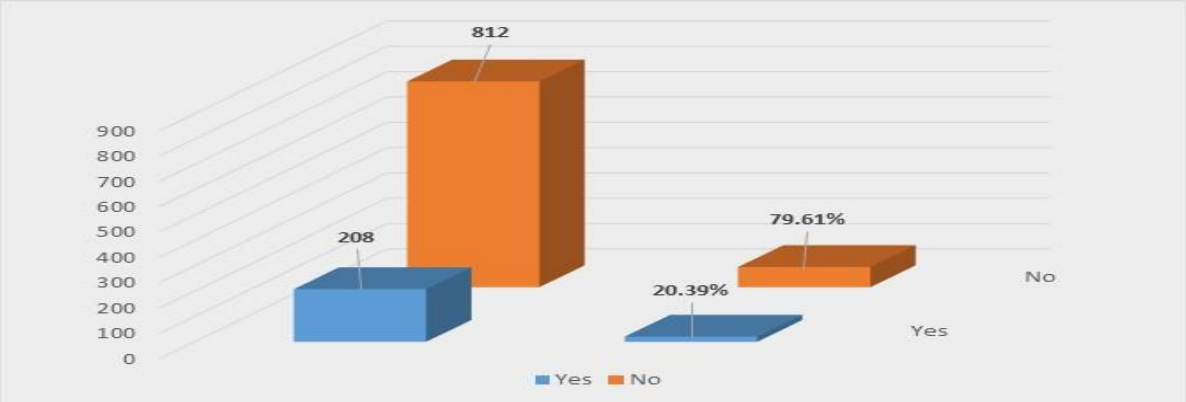


Figure 6: Perception about Role of DAE on Agro-met Services

6.14 Coordination among BMD, BWDB and DAE

Majority (89.80%) farmers opined that they had no knowledge about the coordination of BMD, BWDB and DAE to disseminate hydro-meteorological related information to the farmer communities. Though only 10.19% farmers indicated that they had a very little knowledge about the coordination of BMD, BWDB and DAE to disseminate hydro-meteorological related information due to field officials of DAE.

Table 9: Coordination among BMD, BWDB and DAE to disseminate hydro-meteorological information

Type of response	Response of farmers	
	№	%
Yes	104	10.19
No	916	89.80
Total	**1020**	**100.0**

6.15 Channel of meteorological information delivery

All farmers reported that there were not received any agro-meteorological services which were required to protect their crops from the damages. The highest (66.08%) farmers' indicated that they had not received any meteorological information or services from any channel or sources. However, second highest (26.37%) farmers reported that received general meteorological information from the TV which was followed by Radio (26.18%). Conversely, the lowest (3%) farmers stated that they received this meteorological information from mobile SMS of DAE field level officials such as SAAOs, *extension batayan club* or IPM club etc. which was followed by analogue board (1.76%).

Table 10: Channel of meteorological information delivery

Media type	Response (Number)	Response (%)
Analogue board	18	1.76
Radio	267	26.18
TV	269	26.37
Mobile SMS	30	3.0
Others (None)	674	66.08
Multiple Responses	**1258**	

6.16 Satisfaction of the information provided by BMD, BWDB and DAE

Asking question about their satisfaction of information provided by the BMD, BWDB and DAE related to weather and climate information, almost all (90.99%) farmers reported that they were not satisfied enough of present information provided by BMD, BWDB and DAE as it was only an information not any services or advisories so farmers were unable to take any measures to protect their crop from the damages. However, only (9.01%) farmers expressed their satisfaction with the information provided by the BMD, DAE and BWDB.

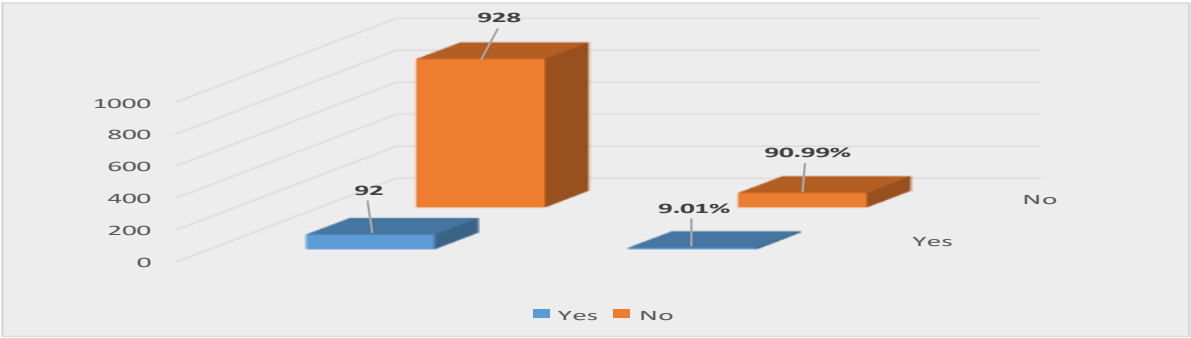


Figure 7: Satisfaction of the information provided by BMD, BWDB and DAE

6.17 Source of getting information

If they were not satisfying about the information provided by the BMD, BWDB and DAE then it was asked them, how they would like to get this information. The highest (51.50%) farmers opined that they would like to get this information from mobile SMS which was followed by Union Parishad Office (38.1%), and Upazila Agricultural Office (35.88%). The lowest (3.23%) farmers indicated that they would like to get this information from electronic & social media which was followed by Community people/farmers club etc. (32.6%).

Table 11: Source of getting hydro-meteorological information

Source of getting information	Number	%
Upazila Agriculture Office	333	35.88%
Union Parishad Office	388	38.1
Community people	269	32.6
Electronic & Social Media	30	3.23
Mobile SMS	478	51.50
Multiple responses	**1498**	

6.18 Information on seasonal variation data of weather and climate

Asking question to the farmers whether they are getting information on seasonal variation of temperature, rainfall and other weather and climate data, all (91.66%) farmers strongly reported that they had not received any seasonal variation of temperature, rainfall and other weather and climate data which was very important for their crop planning considering weather and climate while 8.34% farmers indicated that they had no knowledge about this.

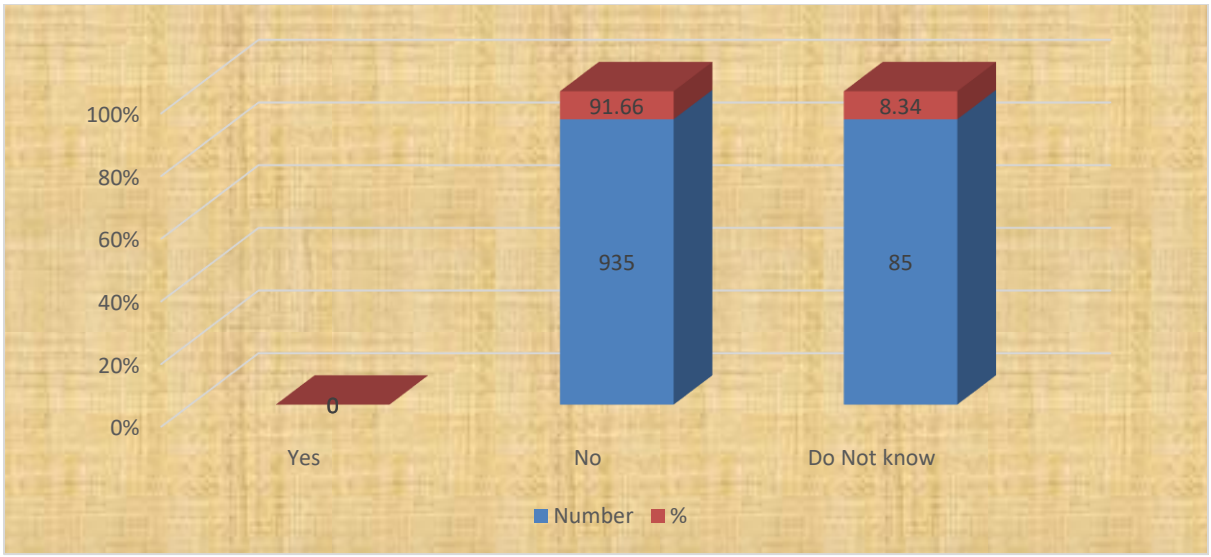


Figure 8: Information on seasonal variation data of weather and climate

6.19 Benefit of meteorological information

Majority (61.8%) farmers opined that meteorological information could be very useful for insect pests and disease management strategy of crops followed by crop production planning (58%), harvest and processing plan of crops (43.7%) and crop management plan (40.2%). However, the lowest (0.6%) farmers indicated that it could be useful for others category like storage and marketing purposes followed by irrigation planning (28.8%).

Table 12: Benefit of meteorological information

Type of benefit	Number	%
Crop Production Planning	498	58.0
Irrigation Planning	247	28.8

Crop Management	345	40.2
Harvest and processing	375	43.7
Insect pests and disease management of crops	530	61.8
Others	5	0.6
Multiple responses	**2000**	

6.20 Necessity of agro-meteorological advisories and services

Almost all (95.10%) farmers opined that they need agro-meteorological products, advisories and services to protect their crops from the damage while only 4.90% farmers reported they had no requirement of agro-meteorological products, advisories and services to protect their crops from the damage. It was due to their lack of knowledge on agro-met services and advisories.

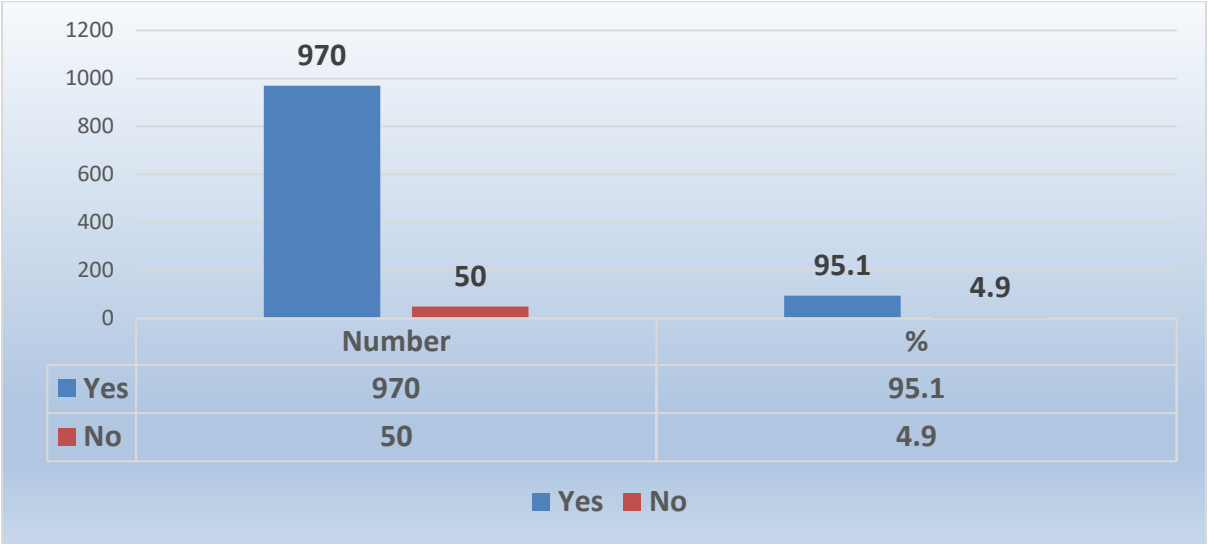


Figure 9: Necessity of agro-meteorological services

6.21 Knowledge on existing weather forecast to protect crop production

Around three fourth percent (74.71%) farmers out of 1020 respondents indicated that the existing weather forecast was not enough to protect crop production from the damage due to natural calamities while 24.51% farmers opined that they had no idea about this. However, only 0.78% farmers reported that they had knowledge of existing weather forecast to protect crop production from the damages.

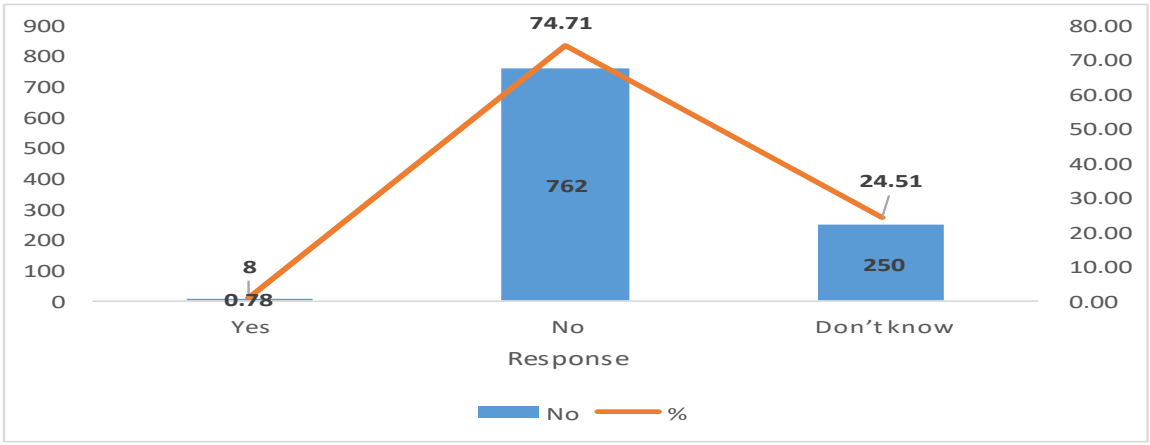


Figure 10: Knowledge of existing weather forecast to protect crop production

6.22 Accessibility of meteorological information to the farmers

More than fifty percent (54.9%) farmers indicated that they had not any access of meteorological information or available for them followed by sometimes (36.4%). However, the lowest (2.2%) farmers reported that meteorological information was highly accessible or available for farmers followed by when I look for it (6.6%).

Table 13: Accessibility of meteorological information to the farmers

Frequency of information	Number	%
Not at all	560	54.9
Sometimes	371	36.4
When I look for it	67	6.6
Highly accessible	22	2.2
Total	**1020**	**100.0**

The degree of satisfaction level has been measured by using 4-point Likert scale as has been mentioned in the methodology section along with the satisfaction level in percentage.

Table 14: Satisfaction level on the accessibility of meteorological related information (%)

Component	Farmers Response						
	Not at all	When I look for it	Sometimes	Highly accessible	Total Respondents	index	% of Satisfaction
Accessibility	54.9	6.6	36.4	2.2	100	1.861	34.025
	560	67	371	22	1020		

The above values inferred that neither the information recipients are satisfied/highly satisfied nor unsatisfied at all, showing that overall satisfaction level of the common people on accessing meteorological related information is on unsatisfied level and need to be improved in this regard.

6.23 Effectiveness of Meteorological forecast

Almost all (91.37%) farmers reported that current meteorological information or forecast was not effective as it was just a general information not agro-met services thus farmers were unable to take any measures to protect their crops from the damages. If they received agro-meteorological information with advisories that helpful for them to protect their crops from the damages. Currently, they had not no knowledge about the measures to be taken upon received weather and climate information to protect crop from the damages.

The second highest (6.86%) farmers indicated that it was less effective to protect their crop from the disaster. However, the lowest (0.69%) percent farmers reported that current meteorological information specially rainfall, temperature and flood were very effective to protect crop from the damages or risks of weather and climate while 1.08% farmers stated that it was effective to protect crop from the damages.

Table 15: Effectiveness of Meteorological forecast

Degree of effectiveness	Number	%
Very effective	7	0.69
Effective	11	1.08
Less Effective	70	6.86
Not Effective	932	91.37
Total	**1020**	**100.0**

The degree of satisfaction level has been measured by using 4-point Likert scale as has been mentioned in the methodology section along with the satisfaction level in percentage.

Table 16: Satisfaction level on the effectiveness of meteorological forecast (%)

Component	Farmers Response						
	Very effective	Effective	Less Effective	Not Effective	Total Respondents	index	% of Satisfaction
Degree of Effectiveness	0.69	1.08	6.86	91.37	100	1.1109	15.2725
	7	11	70	932	1020		

The above values inferred that neither the information recipients are satisfied/highly satisfied nor unsatisfied, showing that overall satisfaction level of the common people on effectiveness of meteorological forecast is on 'not satisfied at all' and need definite improvement in this regard.

6.24 Traditional methods used for applying weather forecasts

Due to lack of agro-met services, farmers were mostly used traditional method to protect their crops from the weather and climate induced problems. Majority (56.2%) farmers reported that they were currently planned their crop production based on past two years' weather while 54.1% farmers informed that they were followed last year weather for crop planning. However, the lowest (7%) percent farmers reported that they were followed others such as weather and climate forecast of government agencies while 38.9% farmers depend on prediction or suggestions of older person of the family.

Table 17: Methods used for applying weather forecasts.

Weather forecasts method	Number	Percentage (%)
last year weather	545	54.1
past 2 years weather	566	56.2
prediction of older person of family	392	38.9
Others (weather forecast)	71	7.0
Multiple Responses	**1574**	

6.25 Perception of traditional weather forecasts

Farmers are mostly using traditional method to protect their crops from weather and climate induced problems. While asking about the perception of traditional weather forecast, the majority (80.78%) farmers informed that this forecast was not reliable at all but they need to depend on it as there was no agro-meteorological products or services. Around (17.94%) farmers reported that traditional weather forecasts were sometimes reliable while 1.07% farmer opined that it was always reliable.

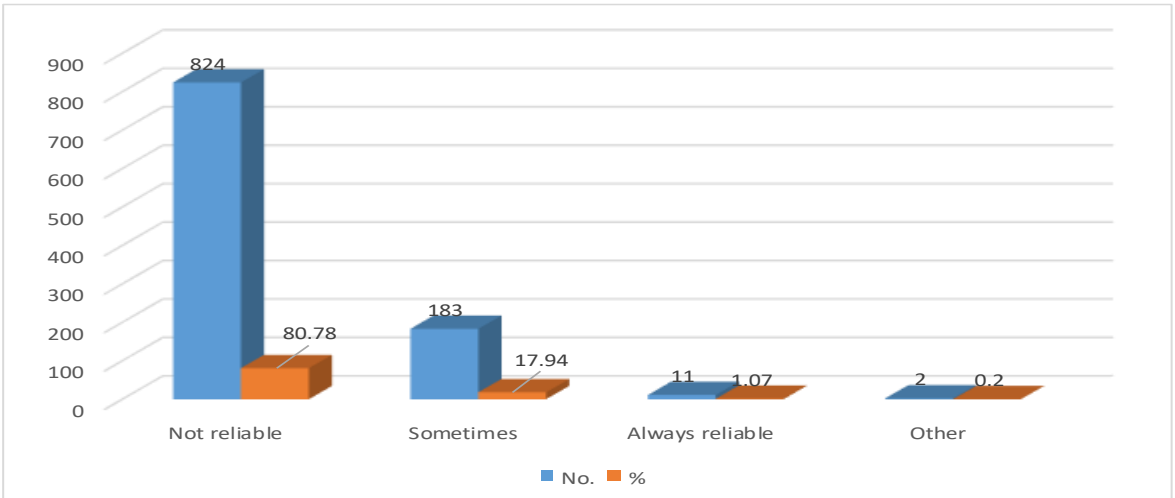


Figure 11: Perception of traditional weather forecasts

6.26 Participated in any awareness campaign/training regarding weather forecast

All (100%) farmers informed that they had not participate in any awareness campaign or training regarding weather forecast as there was no such kind of opportunities created in their area but they were interested to participate in awareness campaign or training regarding agro-meteorological weather forecast and services.

Table 18: Participation in any awareness campaign or training regarding weather forecast

Type of response	N	%
Yes	0	00
No	1020	100
Total	**1020**	**100.0**

CHAPTER-7

TRAINING AND AWARENESS

This chapter describes overall weather and climate related training and awareness. The objective of the study was to identify existing training and awareness on weather and climate and future requirement of agro-meteorological services training and awareness. As per the objectives, findings of the study had been presented herewith mainly based on the primary and secondary data.

7.1 Knowledge on agro-meteorological weather forecast and cope-up technique

It was asked to the farmers whether they have any knowledge on agro-meteorological weather forecast and cope-up technique, almost all (98.52%) farmers reported that they had not any knowledge on agro-meteorological weather forecast and cope-up techniques while negligible 1.48% farmers stated that they had knowledge on agro-meteorological weather forecast and cope-up technique. It might be their lack of knowledge about agro-meteorological weather forecast which is not available right now.

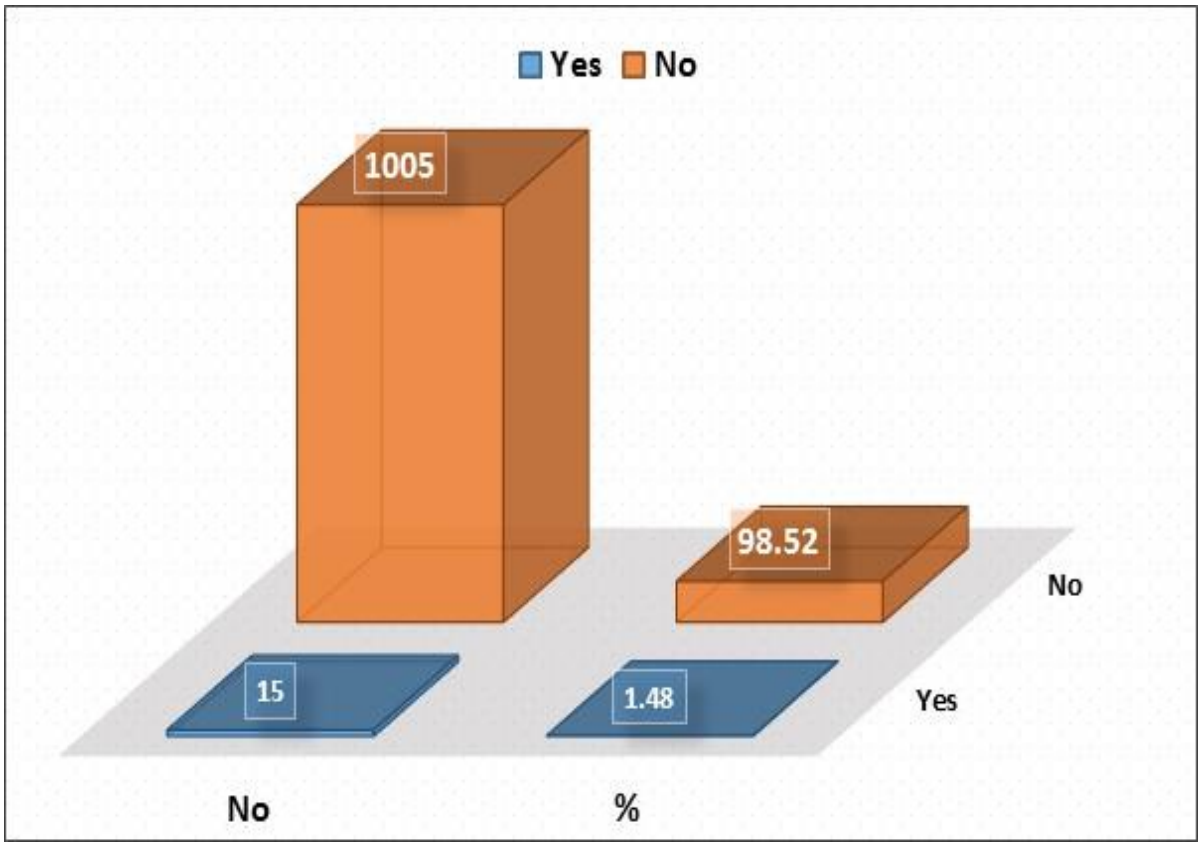


Figure 7.1: Knowledge on agro-meteorological weather forecast and cope-up technique

7.2 Techniques of coping-up this problem

If there are any reliable agro-meteorological services based on crop and region, farmer can coping-up this problem with cropping pattern, varietal change or adjustment of management practices etc. Based on this question were asked to the farmers where majority (89.1%) farmers reported that they can use the techniques of varietal change for copping up this problem which is followed by changing of crop (71.4%). Aside from this, 13.3% farmers indicated they will cope-up with the adjustment of management.

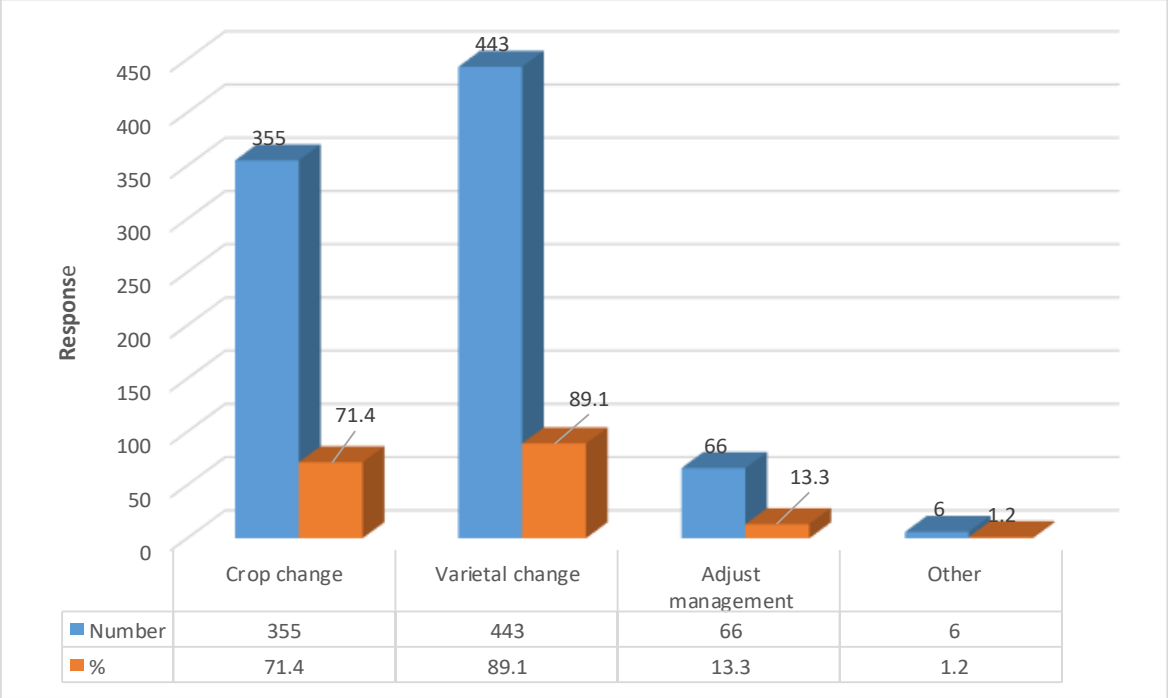


Figure 6.1: Technique for coping-up this problem

7.3 Participated in any awareness campaign/training regarding weather forecast

All (100%) farmers informed that they had not participate in any awareness campaign or training regarding weather forecast as there was no such kind of opportunities created in their area but they were interested to participate in awareness campaign or training regarding agro-meteorological weather forecast and services.

Table 7.1: Participation in any awareness campaign or training regarding weather forecast

Type of response	N	%
Yes	0	00
No	1020	100
Total	**1020**	**100.0**

7.4 Willingness to participate in any awareness campaign or training

Almost all (98%) farmers opined that they were interested to participate in any awareness campaign or training on weather and climate at DAE regarding weather forecast or agro-met products and services while 2% farmers indicated that they are not interested to participate in any awareness campaign or training on weather forecast.

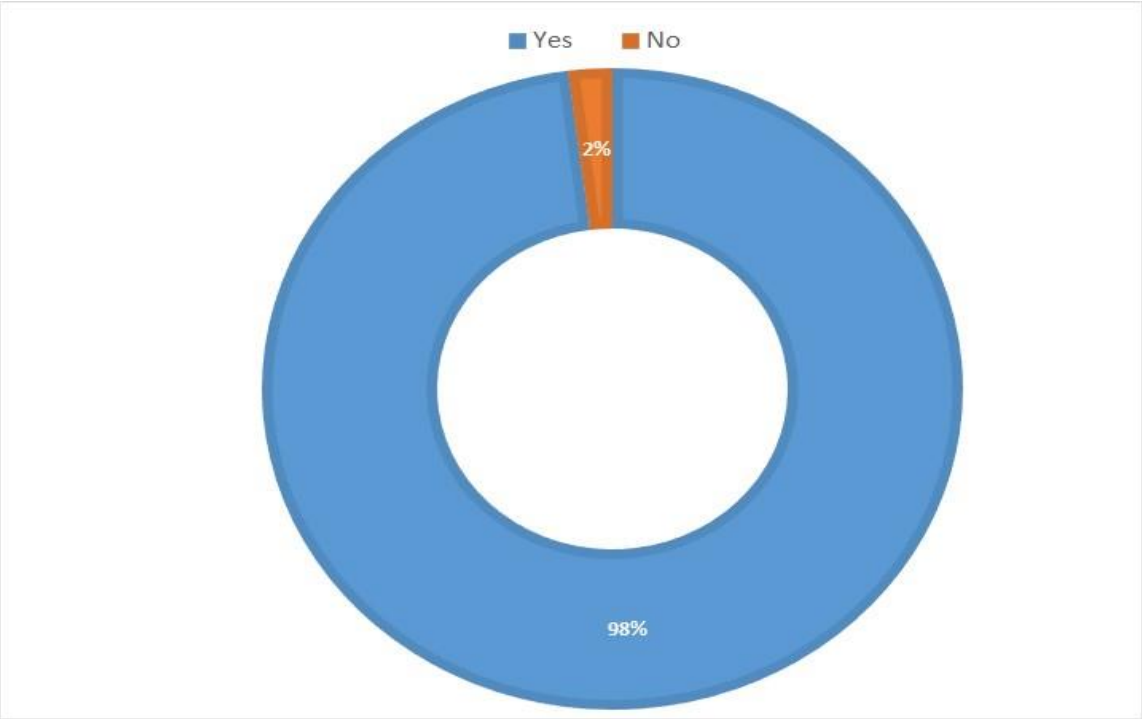
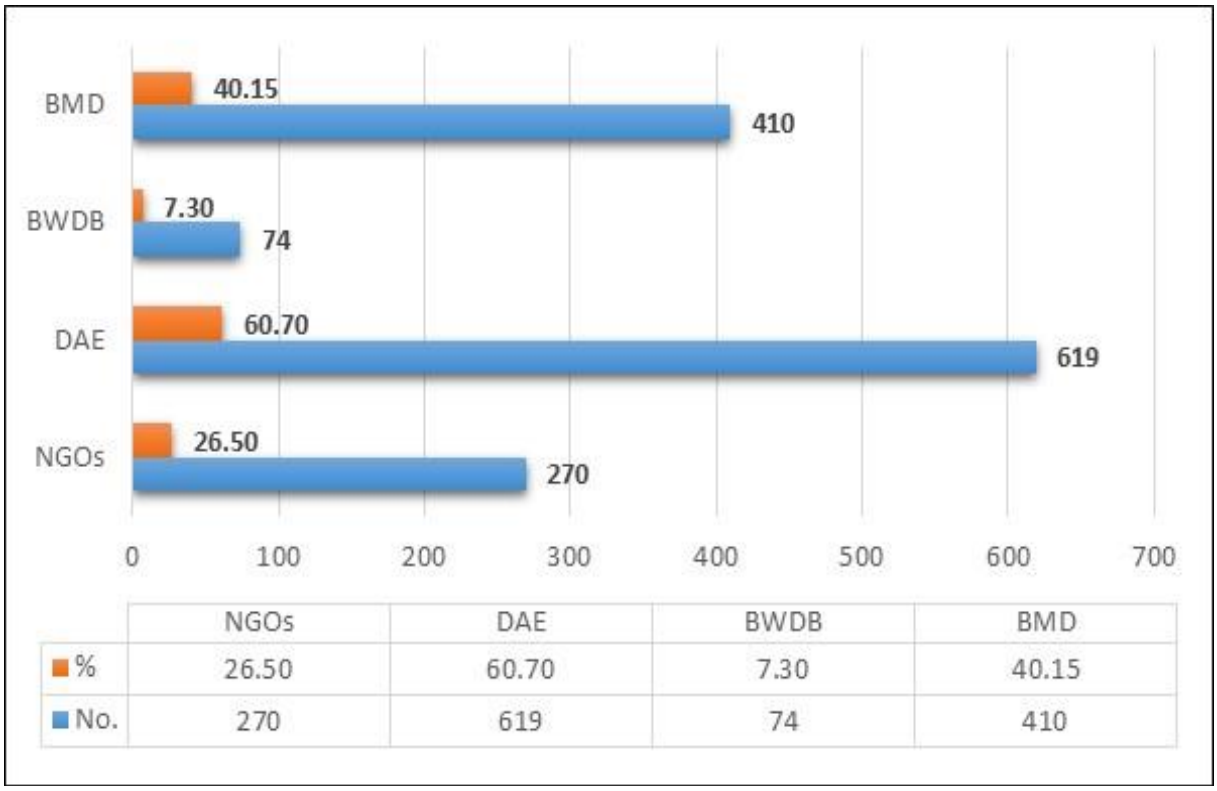


Figure 7.2: Willingness to participate in any awareness campaign or training on weather forecast

7.5 Location of training

Majority (60.7%) farmers stated that they would like to participate training at DAE regarding weather forecast or agro-met products and services while 41.5% farmers indicated that it would be better if the training is in BMD. However, the lowest (7.3%) farmers reported that they would like to participate in this training in BWDB followed by NGOs (26.5%).



	NGOs	DAE	BWDB	BMD
%	26.50	60.70	7.30	40.15
No.	270	619	74	410

Figure 7.3: Location of training regarding weather forecast

7.6 Areas of interest for awareness campaign or training

Around three-fourth percent (71.5%) farmers indicated that they were interested in awareness campaign or training in the field of location specific and crop-based weather and climate related forecast followed by agro-mets services or information of weather and climate related problems (69.9%). Less than fifty percent (44.4%) farmers stated that they were interested in awareness campaign or training in the field of crop management followed by planning of irrigation (42%).

Table 7.2: Areas of interest for awareness campaign or training

Type of awareness campaign or training	Number	%
Location and crop-based weather forecast	706	71.5
Agro-met services of weather & climate problems	691	69.9
Planning of Irrigation	415	42.0
Crop management	439	44.4
Others	10	0.8
Multiple Responses	**2261**	

7.7 Preferred ways of receiving weather and climate forecasts

Around 90.68% farmers informed that their preferred ways to get agrometeorological services through SMS followed by television (78.82%) and radio (73.43%). However, lowest (3.4%) percent farmers reported that their preferred ways to receive agrometeorological services through agriculture field level officials followed by *miking* (34.41%).

Table 7.3: Preferred ways of receiving weather and climate forecasts

Type of preferred ways	Multiple response of farmers	
	Number	Percentage (%)
Provide agricultural information through Television	804	78.82
Provide agricultural information through radio	171	44.3
SAAO should provide agricultural support to every farmers	749	73.43
Agricultural officer should inform farmers	13	3.4
Miking in every village	350	34.31
Others SMS	925	90.68

Findings of Qualitative Analysis

Under qualitative data collection and analysis, 197 participants participated in 16 FGD meetings. On an average, more than 50% of farmers informed that forecasts especially rainfall and temperature were dependable. Forecast on cyclones, storm, drought, floods and flash floods were also dependable recently but farmers need crop specific and location-based agro-meteorological forecast at least 15 days before. It would help farmers for making decision on what type of crops to be grown and type of management practices to be followed to protect the crop from the weather and climate risks. Presently they have received general weather and climate information which was not sufficient for farmers to make decision on crop protection.

Over 70% of participants in all 16 FGDs informed that there is significant change in weather such as, rain, storm and high temperature compared to prior to last five years. Due to weather and climate change, they are incurring huge losses as they don't have crop and region-based weather forecast. Though they are trying to cope-up with the changes situation but they need services so that they can understand what to do which situation. With careful use of irrigation facilities, respondents are increasing cropping intensity and crop production with assistance of new crops.

Regional level data validation: Consultants organized and participated in five regional level data validation meeting at Satkhira, Naogaon, Rajshahi etc. and informed that DAE field level officials are presently providing weather and climate related information upon getting from this to the DAE head Quarter Field Service Wing. DAE quarter used to get this information from the Ministry of Agriculture via BMD. It is general information which did not serve any purpose of farmers to make any decision of crop planning. Therefore, agrometeorological services and products are very much needed specially on region and crop-based so that farmers have enough time to make a decision of cropping pattern, variety, management practices etc. UAO office used to record rainfall at their respective upazilas to provide data to the headquarter. More weather and climate related data is required for farmers which can designate through SMS, social media, digital display board and UNO and Union Parishad etc.

Upazila level agricultural information: Enumerators and consultants interacted with all 16 Upazila Agricultural Officers (UAOs) of the selected upazilas. UAOs and SAAOs assisted filed enumerators in data collection and interviewing respondents. Information like average temperature, average rainfall, and information on cyclone in last years, nature of drought and thunder storms in previous two years, salinity intrusion in last two years and deforestation in respective upazilas were provided by UAOs. Extent of damages by natural calamities in last two years was also provided by UAOs. It indicated that nature is changing and crops are affecting. Therefore, agro-meteorological services are time-bound requirement for the farmers which can be available through SMS/Apps/Website and social media, TV, radio, display etc.

CHAPTER-8

MAJOR FINDINGS AND RECOMMENDATIONS

8.1 Major findings

Major findings of the study are:

- There was no existence of agro-meteorological framework for effective service delivery
- There was no dissemination mechanism of weather and climate information
- Presently farmers were not getting any agro-meteorological products, advisories or services other than weather and climate information
- Farmers were getting weather and climate information from TV, Radio, DAE and mobile SMS.
- Farmers were not happy enough of present weather and climate information provided by BMD, BWDB and DAE
- Most farmers would like to get agro-met services through mobile SMS, Union Parishad Office, Upazila Agricultural Office of DAE, community people or extension batayan club, and electronic & social media in addition of TV and Radio.
- Currently, farmers were not getting any seasonal variation forecast on temperature, rainfall & flood etc. This would helpful for them in crop production planning and management etc.
- Farmers were interested to receive agro-meteorological products, advisories and services
- Existing weather forecast was not enough to protect crop production from the damage caused due to natural calamities.
- Sometimes farmers were getting meteorological information but not agro-met services
- Current meteorological information was less effective as it was just a general information not agro-met services
- Farmer needs at least 7-15 days' advance forecast information
- Farmers had little knowledge about the roles of BMD and BWDB regarding weather and climate as well flood related services
- Farmers were currently planning their crop production based on past two year's weather forecast which was not reliable at all.
- Farmer had no wait for weather forecast for deciding what type of crop will grow as there was no crop and region-based agro-meteorological forecast/services.
- Farmer used to follow usual season for making decision for planting of crop.
- Major weather and climate related problems in Kharif-1 season are diseases, insect pests in addition of salinity, thunderstorm, drought and lightening while flood, flash flood, storm surge.
- Major weather and climate related problems in Kharif-2 season were insect pest and diseases, flood, flood inundation, coastal flood, flash flood, salinity, storm surge thunderstorm, drought, cold-wave, heatwave, lightening, cyclone, forest degradation, etc. are minor
- Major weather and climate related problems in Rabi (Boro) season are drought, cold-wave, salinity etc. in addition of insect pests, diseases are the major problems while floods, storms and cyclone etc. are the minor problems
- Crop damages due to weather and climatic problems were moderate where weather and climatic problems occurred at least 1 to 4 times during crop production
- Past two years' major problems in the study districts are: insect pests attack, disease, flash flood, weed infestation, drought, cold-wave, thunderstorm, landslide, coastal flood, storm surge, cyclone, flood, flood inundate, and heatwave.
- Average production loss was 20-100 kg in per acre land in the study area due to weather and climate problems

- Farmer present source of meteorological Information are TV, community people, radio, *miking*, mobile SMS, and social media.
- Farmers had some extend knowledge about weather and climate and flood information providing agency but need more awareness campaign
- Farmer's had no knowledge on agro-meteorological weather forecast and cope-up techniques which were needed for coping-up the problem with the varietal change, changing of crop and adjustment of management practices
- Farmer had not the opportunity to participate in any awareness campaign or training
- Farmers were interested to participate training on region and crop-based weather and climate forecast, crop planning & management and irrigation management.

8.2 Recommendations

The following recommendations are made by the consultants based on the study findings;

- Farmer needs agro-meteorological products/services or advisories in location-specific (up to union) and crop-based so that they can take necessary measures to protect their crop from the weather and climate induced problems.
- Agro-meteorological framework need to be formulated immediately for effective agro-met service delivery
- Need-based dissemination mechanism of weather and climate services should be developed
- Farmer needs reliable seasonal variation data of temperature, rainfall, and flood etc. forecast
- Advance forecast of agro-met services should be at least 7 to 15 days so that farmers can act to save damages
- Agro-met services may be disseminated by mobile SMS, digital display board at Union Parishad Office, Upazila Agricultural Office, community people or extension *batayan* club/IPM club, and electronic and social media.
- Radio and TV should have a predefined schedule and station/channel for weather forecast/agro-met services.
- Weather and climate services mobile Apps and website should be developed for agro-met forecast
- Awareness campaign and training on agro-met service may be organized for farmers, UAO, and community people for awareness and capacity building
- Two-way feedback mechanism for weather and climate induced problems and solutions of farmers need to be introduced through SMS platform, call center/e-mail etc.

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- Webpage of Bangladesh Jute Research Institutes (BJRI)
- Webpage of Bangladesh Sugarcane Research Institutes (BSRI)
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