MODULE 4

Climate risk assessment at community level in the agriculture sector

This module identifies the tools and methods needed for assessing climate-related risks at community level, focusing on the agriculture sector[2]. It introduces some of the key concepts and steps for climate risk assessment in the context of livelihood adaptation to climate change in agriculture. This covers a range of climate risks with special emphasis on drought. At the end of this module, participants should:

1. understand the participatory tools and processes for assessing climate-related hazards, vulnerabilities and risks in agriculture,
2. identify key climate risks that have significant impact on communities in general and livelihoods in particular, and
3. assess the community perception of risks associated with past and current climate variability.

Rural communities and individual farmers face **risks** associated with climate variability and climate change. Their livelihoods are exposed to climate risks and associated impacts. Conventionally, risk is expressed by the notation: Risk = Hazards x Vulnerability.

Risk identification and **assessment** are the two important steps that form the basis for successful implementation of adaptation practices. This involves identification and assessment of current (climate variability) and future (climate change) risks and associated societal vulnerabilities.

Box 4.1: Risks, risk identification and assessment

Risk is the result of physically defined hazards interacting with exposed systems – taking into consideration the properties of the systems, such as their sensitivity or social vulnerability. Risk also can be considered the combination of an event, its likelihood and its consequences. Risk equals the probability of climate hazard multiplied by a given system's vulnerability.

Climate risk identification is the process of defining and describing a climate-related hazard, including its physical characteristics, magnitude and severity, probability and frequency, exposure and consequences.

Risk assessment is a methodology to determine the nature and extent of risk by analyzing potential threats and evaluating existing conditions of vulnerability that could pose a potential threat to property, livelihoods and the environment on which they depend.

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[2] Detailed guidelines on community risk assessment with cross-sectoral and multi-hazard perspective can be found in "*A facilitator's guidebook for conducting Community Risk Assessment*" prepared by Directorate of Relief and Rehabilitation (DRR), Ministry of Food and Disaster Management (MoFDM), Bangladesh.

Risk can be considered the combination of an event, the likelihood that it will happen and its consequences. **Hazard** is an event or physical condition that has the potential to cause fatalities, injuries, property damage, infrastructure damage, agricultural loss, damage to the environment, interruption of business or other types of harm or loss. Climate risk identification has three basic elements: **probability**, **exposure** and **consequences**.

Each climate risk can be identified by its own natural characteristics, including geographic area (areal extent), time of year it is most likely to occur and its severity. In most cases, a climate event may create multiple hazards: wind is a factor in thunderstorms and severe thunderstorms spawn tornados. Thus, it is necessary to identify the potential primary hazard but also its triggering effect on secondary hazards. Knowledge of the nature of risks, their geographic coverage and their potential future behaviour is fundamental for designing a viable adaptation practice to reduce the impact of climate change in the agriculture sector.

Box 4.2: Elements of risk identification

Probability measures how frequently an event is likely to occur. Frequency can be expressed as the average time between occurrences of an event or the percent chance or probability of the event occurring within a given time period, such as a year.

Exposure means the number, quality and monetary value of various types of property, infrastructure or lives that may be subject to undesirable outcomes.

Consequence means the full or partial damage, injuries or loss of life, property, environment and business that can be quantified, usually in economic or financial terms.

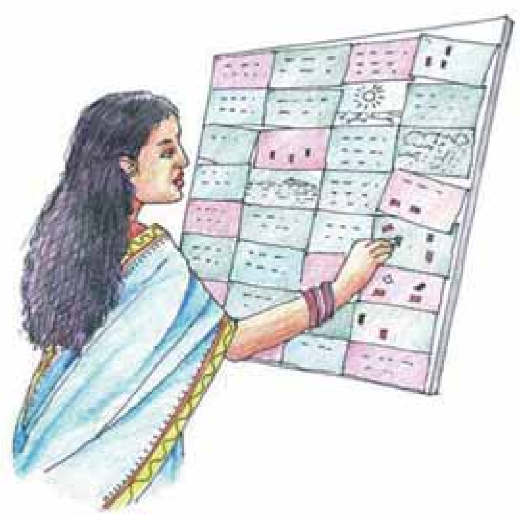
Participatory tools and methods for climate risk identification and assessment

Participatory tools are ideal for climate risk assessment with farmers in particular and the community in general. They can facilitate community participation, exchange of ideas and decisions among the community and other stakeholders. Using participatory methods can lead to community empowerment and commitment to address the risks. The following alphabetical list identifies some tools that can be considered for involving communities in climate risk identification and assessment.

- **Climate risk maps** – identifies areas at risk and vulnerable members of the community. This also includes analysis of available resources that can be used by community members for climate risk management and involves the community in preparing local risk maps.
- **Community history** (time line) – identifies frequency of shocks and local coping mechanisms.
- **Focus group meetings** – brings together community residents, farmers' groups and associations, formal and informal village cooperatives, landless labourers, fishers, livestock farmers, etc., to discuss specific issues.
- **Hazard Venn diagram** – allows participants to identify and analyze the common hazards that take place locally, their magnitude and likelihood.
- **Historical transect** – provides a graphic presentation of the history of climate risks and development in the community with emphasis on the agriculture sector.
- **Household composition** – provides a breakdown of human capital, looking at the labour force, migration, education and dependency status of various socio-economic groups, especially categories of farmers in the agriculture sector.
- **Local resource map** – pinpoints main land types, livelihood activities on each land type and physical infrastructure such as roads, farming methods, irrigated areas, water points, markets, electricity, banks and agricultural extension offices.

- **Matrix ranking** – prioritizes climate risks, needs and options.
- **Problem analysis** – analyses perceived livelihood problems, causes of problems, coping mechanisms, livelihood opportunities of women and men, and the impact of climate risks in the agriculture sector.
- **Ranking** – analyses problems in order to rate community priorities or the significant problems faced by the community.
- **Seasonal calendar** – tracks seasonal changes, climate-related hazards, community events and other activities related to a specific month. In the agricultural sector, this is used primarily to plot seasonal farm activities.
- **Seasonal activity calendar** – identifies times of working with crops or livestock, in forests, off-farm and domestic work as well as pinpointing gender roles.
- **Timeline** – narrates the history of climate risks and significant events that happened in the community.
- **Transect** – involves the facilitator and community members taking a walk together through the community to get a realistic picture of community vulnerability and the resources that are available or may be available for disaster risk management.
- **Vulnerability** – shows proportion of households affected by climate risks and reasons why they are vulnerable.
- **Vulnerability context** – looks at local shocks and stresses, proportion of households that are food insecure in an average year, bad year, good year and why, and the proportion of households/farmers who are income insecure in an average year, bad year, good year and why.
- **Wealth ranking** – identifies typical characteristics of wealth and well-being of groups in the community.

In addition, a certain amount of **secondary information** is needed for climate risk assessment. This includes



- daily rainfall, temperature and evaporation data to assess the moisture deficit and drought periods (early, mid and late season),
- agro-climatic indicators such as crop evapotranspiration and rainfall ratios,
- groundwater depths, dry spells, wet spells, and periods of water deficit,
- Trends of heat waves, extreme temperatures, hail storms and wind storms,
- climate change scenarios and anticipated future impacts on agriculture sector,
- land use changes over the years,
- onset of climate risks such as delayed monsoon, early withdrawal of rainfall, intermittent dry spells, extended wet spells, water stagnation, etc.,
- geographical coverage of the climate risk based on the past records (e.g. droughts),
- frequency of each risk based on past historical records.

Steps of climate risk identification and assessment

The following steps and processes of climate risk identification and assessment at community/farm level are not rigid. Participants are requested to think of these steps as a general guideline for risk identification and assessment. The climate risk assessment in this context serves to develop viable adaptation options for managing potential risks associated with climate change. The current risks need to be identified and future trends assessed based on the climate change scenarios. (Note: Module 1 gives a background of current climate variability and future climate change.)

Step 1: Describe the climate risks and impacts in the community

Tools and methods: Climate data analysis, agro-meteorological analysis, socio-economic data, production changes, past impacts and future anticipated impacts.

Outputs: List and describe the nature of climate risks using both participatory and scientific tools and secondary information.

Step 2: Conduct community-based climate risk mapping

Tools and methods: Mapping of key risks in terms of probability, exposure and consequence.

Outputs: Based on discussions with the community (farmers in particular), map the climate risks affecting agriculture and allied sectors.

Step 3: Assess the local perception on climate risks

Tools and methods: Validation of the identified risks by assessing local perception of the community about the risks using, ideally, participatory methods.

Outputs: Identify the local rules-of-thumb and assess local perceptions of past and current risks.

Step 4: Describe the vulnerabilities and capacities of the community

Tools and methods: Secondary data on vulnerable groups, enabling/disabling institutions, external support.

Outputs: Identify vulnerable groups and their capacities and coping ranges to manage current and future climate risks.

Step 5: Rank the climate risks

Tools and methods: Matrix ranking based on frequency, vulnerabilities, capacities and potential future impacts.

Outputs: Prioritize current and future climate-related risks through farmer's participatory interactions.

Step 6: Decide on acceptance of the risk

Tools and methods: Stakeholder discussion and participatory methods.

Outputs: Identify the thresholds of current and future climate risks in agriculture and allied sectors above which livelihood security is affected.

Step 7: Decide whether to prevent, reduce, transfer or live with the risks

Tools and methods: Stakeholder discussion and participatory methods.

Outputs: Develop strategies for integrated climate risk management. This activity is linked to development of viable adaptation options which is further explained in Module 5.

Climate risk identification and assessment must be conducted at community level through a participatory process in the agriculture sector. More efforts need to be dedicated to bottom-up identification rather than conventional top-down agro-meteorological approaches. The climate risk assessment also facilitates a process for determining the probable negative effects of future climate change.

Assessment of current vulnerability involves responding to several questions, such as:

- Where does the society stand today with respect to vulnerability to climate risks?
- What factors determine the society's current vulnerability?
- How successful are current efforts to adapt to current climate risks?

Answers to these questions become apparent after following these four steps:

- assess local perceptions of climate risks and impacts;
- identify vulnerable groups within the community;
- assess current climate risks (conventional agro-meteorological approaches may be complementary to the community-based participatory approaches);
- assess institutional frameworks, roles, gaps and comparative advantages.

An assessment of the **community perception** of climate risks can uncover the nature of the risk and its underlying factors and associated socio-economic consequences. Table 4.1 illustrates the local perception of climate risks in t.*aman* rice cultivation in the *Barind* areas of Bangladesh.

Table 4.1. Drought risk in t.*aman* rice cultivation as identified by the local farmers in the *Barind* areas of Northwest Bangladesh

The number of solid circles represents the intensity of the risk.

DAT	Stage	Drought intensity			
		July	Aug	Sep	Oct
0 – 10	Transplanting	●●			
10 – 25	Establishment	●●●			
25 – 50	Active tillering		●●●●●		
50 – 65	Panicle initiation			●●●●●	
65 – 70	Flowering			●●●●●	
70 – 85	Ripening				●●●●
85 – 100	Maturity				●●●
100 – 105	Harvesting				●

The risk assessment process also should identify the **rules-of-thumb** or “thumb rules” followed by farmers in particular and the community in general. Participatory risk assessment processes help identify the local thumb rules for risk, such as those developed by small and marginal farmers in the drought-prone *Barind* area to describe drought thresholds based on their experiences. For example, these farmers perceive that 12 days without rain during monsoon season in the high *Barind* tracts of Bangladesh could trigger drought while in the level *Barind* area, 14 days without rain could trigger drought at early stages of rice crop. As a result, farmers in the *Barind* areas respond to drought based on this threshold number of dry days and their visual observations.

Table 4.2. Farmers’ perception of drought, based on the length of dry spells and crop stages in high *Barind* tracts

Stage	Dry spell length (days)	Drought perception
Seedling stage	5 – 7	Mild
	7 – 15	Moderate
	>15	Severe
Vegetative	7 – 8	Mild
	8 – 18	Moderate
	>18	Severe
Flowering	5 – 7	Mild
	7 – 12	Moderate
	> 12	Severe

To explore farmers’ perceptions further, dry spell thresholds were identified for various stages of the crop, as illustrated in Table 4.2. In the high *Barind* areas, the threshold dry spell lengths, meaning the number of consecutive days without rain, varies considerably with respect to stages of growth. On average, a dry spell of five to seven days is considered mild drought at seedling and flowering stages, but in the vegetative state, it is seven to eight days. At flowering stage, the community considers a rainless period of more than 12 days to be a severe drought that could reduce crop yield by up to 40 percent. This analysis needs to be compared with agro-meteorological analysis using long-term rainfall data and projected climate change. Understanding of local thumb rules and local perceptions is necessary to identify a suitable adaptation practice that fits within the rules.

The climate risk analysis is the prerequisite for developing viable adaptation options to manage future anticipated risks. Once the analysis is done, the next step is to identify and prioritize the local adaptation options and test them through demonstration and implementation at local levels.

Training strategy

This training module needs to be delivered in at least one session (4-5 hours) on the afternoon of the second day. It consists of three LUs.

1. Explain the participatory tools and processes for climate risk assessment.
2. Explain steps for assessing climate risks in drought-prone areas.
3. Define the local perception of climate risks.

LU 1: Explain the participatory tools and methods for climate risk assessment

This LU increases participants' understanding of the terminology, participatory tools and methods to be employed during climate risk assessment. The facilitator presents the definitions and step-by-step processes for identification and assessment of climate risks (as covered in Module 3) by means of an interactive lecture and presentation of practical examples. For example, participants are shown tools such as diagrams from participatory Venn diagram, calendar and mapping exercises. The session also requires outlining of secondary information needed for climate risk assessment, indicating their possible sources – at national, district, *upazilla* and local levels.

LU 2: Explain steps for assessing climate risks in drought-prone areas

This LU introduces ways to identify and assess climate risk by using a method that is not prescribed or rigid. The facilitator explains the steps during an interactive lecture and participants undertake a series of practical exercises for assessing both current and future climate risks.

Exercise 1:

Gain your own understanding of climate risks

The facilitator provides a sample frame of the **climate risk calendar** to the participants to identify the risks. It is also necessary to provide data on past climate risks, including frequency and impact, in order for participants to develop the risk calendar. Participants may be requested to recollect their experiences for a specific region to prepare this calendar.

Hazards	*kharif* I				*kharif* II				*rabi*			
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
False onset of rain												
Early season drought												
Mid-season drought												
Terminal drought												
Seasonal drought												
Hailstorms												
Typhoons												
Wind storms												
High temperature												
Low temperature												

Exercise 2:

Rank (group) the above climate risks according to their frequency and severity based on your own experience and local perception

The criteria for categorizing severity might include an examination of potential damage, loss of produce, and the environmental and economic impacts on agriculture and allied sectors. This requires using the secondary data collected at district, upazilla and local level for impact analysis. The criteria for categorizing frequency might include the following options (although participants can also define their own frequency category based on the nature and severity of risks):

high frequency – events that occur more frequently than once in three years;

moderate frequency – events that occur from once in three years to five years;

low frequency – events that occur from once in five years to once in ten years;

very low frequency – events that occur less than once in ten years.

In this example, both the magnitude and frequency of a climate event are given qualitative measures that permit the prioritization of selected climate risks among multiple risks. Because the low frequency events may become high frequency events under climate change, they need to be given sufficient consideration.

Frequency ↑ / Severity →	Minor	Serious	Extensive	Catastrophe
High	C	B	A	A
Moderate	C	B	B	A
Low	D	C	B	B
Very Low	D	D	C	C

Class A: High-risk condition with highest priority for implementing adaptation measures

Class B: Moderate-to-high risk condition with risk to be addressed by adaptation

Class C: Risk condition sufficiently high to give consideration for further adaptation initiatives

Class D: Low-risk condition with additional adaptation initiatives

LU 3: Define the local perception of climate risks

Exercise:

Identify community/farmers' perceptions of current climate variability

Before prioritizing the identified risks, it is necessary for to evaluate them based on the community/farmers' perceptions. Table 4.1, based on field-level assessments in the ***Barind*** areas, is reproduced without the solid circles that indicate intensity. Participants are asked to complete the table, based on their own experience and perception. After the exercise the original table can be distributed and discussed further.

MODULE 5

Agricultural adaptation options to climate variability and climate change in drought-prone areas

This module can guide participants in developing agricultural adaptation options to manage climate variability and climate change in drought-prone areas of Bangladesh. These adaptation options should be based on the risks identified in the LUs and exercises found in Module 4. At the end of Module 5, participants should be able to:

1. prepare livelihood adaptation options to manage climate variability and change,
2. understand the relevance of adaptation options for livelihood development, and
3. gain understanding of changing livelihood portfolios in drought-prone areas.

Local communities try to cope with climate variability based on their past exposure and experience in managing climate extremes. These coping mechanisms evolve locally to deal with known and observed climate risks. For example, farming communities in the *Barind* areas cope with rainfall variability by adapting cropping systems with short-duration varieties that can be harvested before drought sets in during the later part of the monsoon season. When the variation in climate conditions is within a **coping range**, communities can absorb the risk without significant impacts. However, these local coping practices may not be sufficient to reduce the risk of increased climate variability and climate change appreciably.

Box 5.1: Adaptation and adaptive capacity

Coping range – is the range in which the effects of climate conditions are beneficial or negative but tolerable. Beyond the coping range, the damage or loss are no longer tolerable and a society (or system) is said to be vulnerable.

Adaptation – is a process by which strategies to moderate, cope with or take advantage of the consequences of climatic events are enhanced, developed and implemented.

Adaptive capacity – is the ability of a system to adjust its characteristics or behaviour in order to expand its coping range under existing climate variability or future climate conditions.

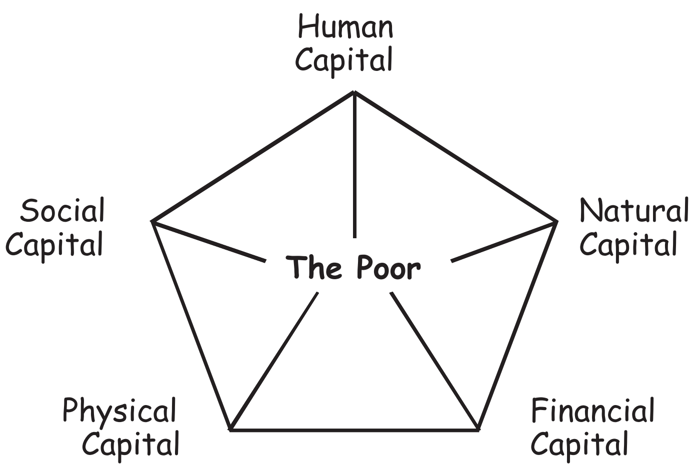
- Actions that lead to adaptation can enhance a system's coping capacity and increase its coping range thereby reducing its vulnerability to climate hazards.
- The adaptive capacity inherent in a system represents the set of resources available for adaptation, as well as the ability or capacity of that system to use these resources effectively in the pursuit of adaptation.
- In reality, success depends on many factors but, theoretically, the practice of adaptation has potential. It is possible to differentiate between the theoretical potential and reality by recognizing that the theoretical will be based on the level of existing expertise and anticipated developments that are dependent on existing information, technology and the resources of the system under consideration.

Future climate change and associated climate variability have the potential to lead to new risks in drought-prone areas of Bangladesh. Preparing for climate change is not something that individuals can do alone. It is a shared responsibility that requires partnerships across the community so that households, community groups, businesses and governments can make the necessary changes effectively and efficiently. Adapting to climate change is a primary way to manage the future climate risks.

Livelihood adaptation

To be effective, adaptation responses need to be tailored to individual circumstances based on the kind of risk faced (identified in Module 4). Adaptation options need to benefit the community and ensure community participation so that experiences of local-level adaptation strategies can be shared. Livelihood adaptation to climate change is a continuous process built on the socio-economic circumstances and adaptive capacity of the community. To implement adaptation measures in the agriculture sector, it is necessary to understand the potential impacts of climate change (identified in Module 3) and local perceptions (identified in module 4). The basic understanding in the context of climate change adaptation in drought-prone areas is that the adaptation option should have the potential to improve the livelihood assets (human, natural, financial, physical and social) of rural livelihoods.

Fig. 5.1. Livelihood assets of the rural poor



Steps for development of adaptation option menus

An adaptation option menu provides viable options for managing climate risks. It synthesizes adaptation practices that could catalyze long-term adaptation processes. As shown in Figure 5.2, there are four major steps for developing the tool.

- Identify improved adaptation options that are locally available and based on new research.
- Analyse adaptation options based on their constraints and opportunities.
- Validate and prioritize adaptation options against a set of key criteria.
- Consolidate the most suitable options into an adaptation options menu.

Through efforts to determine the viability of adaptation options, it is actually possible to create a menu of adaptation options for the development planning process with the potential to be integrated into the existing institutional agenda. The adaptation option menu also provides input and acts as a catalyst for field-level demonstrations of viable adaptation options with potential to improve the capacity of rural livelihoods to adapt to climate change.

Fig.5.2. Sequential tasks in designing viable adaptation options for drought-prone areas

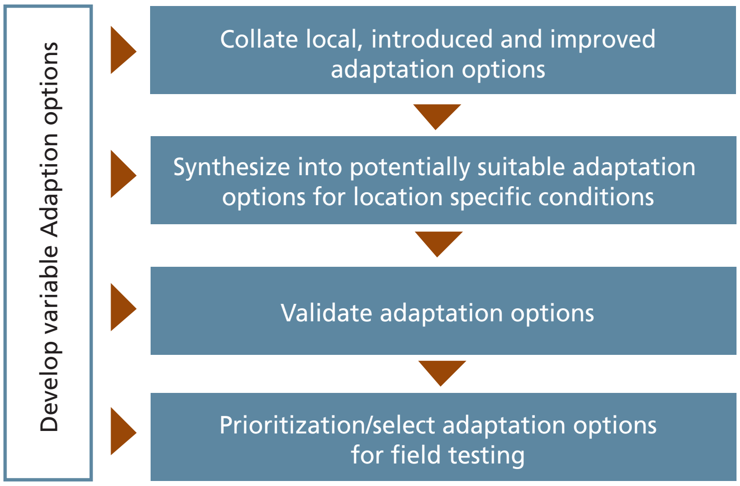
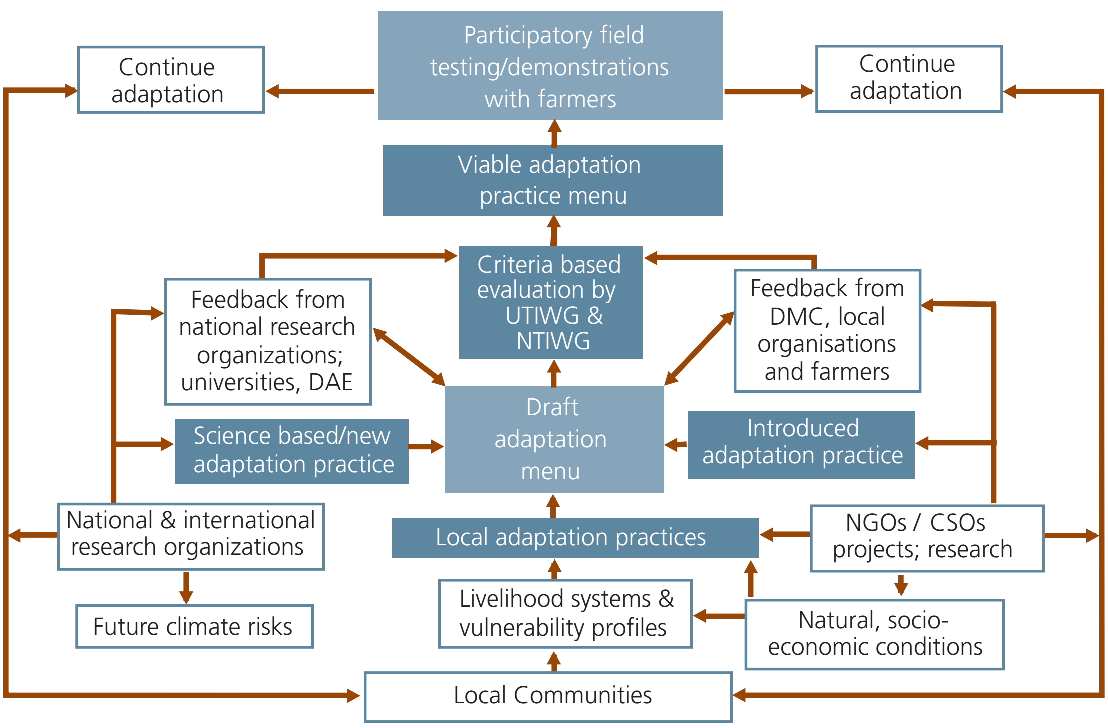


Fig 5.3. Overall framework and institutional structure describing activities and the processes of selection, evaluation and prioritization of adaptation practices for drought-prone areas in Bangladesh



Local adaptation practices and those practices introduced by national development, research and extension organizations need to be collected from the respective organizations and evaluated at different levels. The following example illustrates how current and future climate risks can be managed through adaptation options (identified through the comprehensive methodology presented in Fig.5.3).

Context 1:

Barind areas, currently dominated by rice during monsoon season, face various risks at different stages

Current risks	Future trend	Anticipated impacts	Adaptation practice	Relevance to livelihood asset development
Delayed onset of monsoon rainfall in June	Associated with variability and possibly of future increase	Delayed seedbed preparation and late planting; shortened growing period	Dry seedbed method for t.*aman* rice	Seedlings available for transplanting immediately after onset of rains
Low water-holding capacity of *Barind* soils	Land pressure may increase nutrient mining	Reduced crop yields due to low nutrient content and inadequate soil moisture	Manures and composting from locally available materials	Improves physical capital of local livelihoods
Short, dry spells during early stages of t.*aman*	Climate change may increase dry spell lengths due to greater rainfall variability	Young transplanted seedlings affected by dry topsoil and reduced root proliferation may lead to reduced yields	Transplanting at deeper depths means better root proliferation and facilitates moisture extraction during drought	Reduces labour requirement for re-planting in case of early season drought
Weed infestation competes for nutrients and water	Climate change may aggravate the complex, intense crop-weed competition	Intense competition for solar radiation, nutrients and moisture, weeds' smothering effect reduces yield	Controlling weeds manually combined with closing soil cracks	Saves water and nutrients and leads to financial gain due to yield increase
Loss of field water due to lateral seepage	More intense monsoon rainfall may lead to excessive loss of rain water	Increased exposure to mid-season drought due to lack of water in the field	Strengthening field bunds to conserve more rain water	Increases water availability and adequate water supply throughout the crop growth period

module 5

Context 2:

Communities in *Barind* areas of Northwest Bangladesh face water scarcity for their livelihood activities due to lack of rainwater storage facilities and low water use efficiency

Current risks	Future trend	Anticipated impacts	Adaptation practice	Relevance to livelihood asset development
Traditional ponds have lost their full water storage capacity	High intensity rainfall and heavy erosion may aggravate the risk	Lack of water for fish cultivation and supplemental irrigation	Re-excavation of traditional ponds	Improved water storage facilities; water available during dry season
Traditional *khari* canals affected by excess weed growth and silting	Higher rate of erosion and weed spread increases the risk of water loss	Reduced community-level water storage structures; blockage of water flow	Re-excavation of *khari* canals and other water conveyance structures	Assured water availability in dry season; minimized health risk for the rural poor
Improper water control structures and excessive rain water loss	Increased monsoon rainfall intensity; loss of excessive rain water	Excessive run-off, soil erosion and uncontrolled water flow may cause localized inundation	Building of water control structures; check dams across the water ways	Increased access to community water resources and reduced health risks from stagnant water
t.*aman* rice and rabi pulses face drought at various growth stages	Increased rainfall variability and longer dry spells	Reduced crop yield affects diet and nutrition	Construction of mini-ponds, shallow and deep tube wells	Increased farms access to water resources; diversified livelihood activities
Low water productivity in terms of yield/ unit of water	Higher temperature and evaporation lead to excessive water use	Decline in surface and groundwater resources; over exploitation of groundwater causes heavy metal contamination	Adoption of more intense rice cropping system	Increased water use efficiency and yield; water more accessible during dry season
Transplanting method requires more water and longer duration	Low yield due to high temperature and water scarcity	Increased high temperature stress; more evaporation	System of direct-sown rice using drum seeder	Requires less labour because of shorter duration; saves water
Local rice varieties are not tolerant to drought	Local varieties might be more sensitive to drought and high temperature	Excessive yield reduction	Drought- resistant, short- duration varieties that fit in monsoon rainfall pattern	Avoids excessive yield loss

Context 3:

In recent past, crop intensification has taken place in all seasons, exposing the agricultural systems to climate risks throughout the year

Current risks	Future trend	Anticipated impacts	Adaptation practice	Relevance to livelihood asset development
Declining yield of t.*aman* rice due to mono-cropping	Crop intensification, with rice only, to meet growing food needs	Susceptibility of rice varieties to climate events such as drought, intense rainfall	Introduction of green manure before t.*aman* rice system	Increased use of and accessibility to natural resource
Extreme climate events affect current rice systems	Crop intensification, with cereals only, may dominate	Exposure of rice to extreme events	Introduction of *Chini Atap* rice after t.aus season	Increased income at household level
Poor diet due to non-availability of oilseeds	Crop intensification, with cereals only, may dominate	Local poor have unbalanced diet	Introduction of mustard and linseed after t.*aman* season	Improved, proper use of available natural resources
Lack of protein in diets of the rural poor	Crop intensification, with cereals only, may dominate	Non-availability of protein-based diet	Introduction of mung bean and chickpea after t.*aman* rice season	Healthier population and better resource use
Seasonal famine conditions (*monga*)	Anticipated drought conditions would increase the seasonal famine conditions	Reduced capacity for food production and community to absorb seasonal shocks	Growing famine reserve crops such as cassava and yam	Reduced migration; increased employment opportunities; *monga* minimized

Context 4:

Diversified enterprise and enterprise mixing is required in drought-prone areas to improve the household financial position throughout the year

Current risks	Future trend	Anticipated impacts	Adaptation practice	Relevance to livelihood asset development
High temperatures induce ripening of existing mango varieties	Climate change models project increased temperature	All varieties will ripen at the same time causing price drop	Introduction of high- temperature-tolerant mango and jujube (ber) varieties	Autonomous adaptation by farmers in *Barind* tract would expand, to reduce drought impact
Existing crops are not sustainable under climate change	Cereal-dominated systems affected by temperature increase and drought	Yield reduction and decreased income	Mulberry intercropping in rice fields	Drought-tolerant mulberry would not cause shade on rice crop
Livestock face severe fodder problems during drought years	Intensification of food crop cultivation to meet growing food needs leaves less area for fodder cultivation	Area under fodder crop would be reduced	Small-scale fodder cultivation	Maintaining crop-animal mixture in small farms of *Barind* tract would help farm income generation
Lack of water in traditional ponds affects small-scale fish production	Drought intensity and frequency may increase and affect small- scale fish production	Small-scale seasonal fish production would be affected	Small-scale fish cultivation in mini-ponds	Enhanced alternative livelihood options for rural poor
Poor people lack access to financial resources for investment	Livelihood activities in drought-prone areas would face increased impact of drought; livelihood activities would suffer	Household income would be reduced	Enhancing facilities for cottage industries	Alternative earning sources for rural populations to meet household expenses
Household income is not sufficient to meet daily needs, income is seasonal, lack of off-season employment opportunities for family labour	Climate change may increase need for off-farm employment	Household income would be reduced	Homestead gardens	Gender integration in agriculture, nutritional security, year- round income

Examples of good adaptation practices

Mini Ponds for rain water harvesting

Re-excavation of ponds can be undertaken in areas of extreme water scarcity preferably in high Barind Tract areas. If land is found on a voluntary basis, new excavation may be taken up with the concurrence of the owner. In farmlands with no irrigation source, rainwater harvesting can be done through these mini-ponds for supplemental irrigation. Mini-ponds of 5m x 5m x 2m (length x breadth x depth) size is preferred in small farms. It is also proposed to excavate larger ponds (10m x 10m x 2m) as per requirement. Some farmers wanted to have these mini-ponds in a corner of the field. Adequate awareness about the utility of ponds needs to be created with the local community.

Resources required: limited family labour.
Potential maladaptation: none.
Non-climatic benefits: growing short duration vegetables along the farm pond; supplemental irrigation.

Homestead gardening

The indigenous knowledge of the local population regarding environmentally friendly land management needs to be encouraged. In the Barind Tract, tree species such mango, mahogany and jackfruit are being grown in uplands (*chalas*) around homestead, and are some times used for growing vegetables. The lowlands (*baid*) are generally used for growing paddy. This practice increases moisture retention, improves soil fertility and crop yield and reduces surface runoff , thus halting soil erosion.

Home garden systems in drought prone areas provide healthy ecosystem for humans, animals, birds, livestock and miscellaneous flora and fauna. Homestead bamboos are also planted because these develop rapidly and are good soil binders. Use of homestead litter, ash supplements and organic matter in the soil keeps insects away. Homestead gardening helps produce vegetables for household requirements and sometimes for external marketing. Women are engaged in homestead gardening as an income diversification activity. As the rainfed Barind Tract is mostly dominated by rice during *kharif* II season, integration of homestead gardening within the household system provides varied nutrients and thus helps to ensure household nutrient security. Practicing homestead gardening in drought-prone areas helps integrate gender concerns within the climate change adaptation framework.

BARI has developed economically feasible homestead garden models for Barind Tract areas. The components of the homestead garden models include drought-resistant fruit trees and vegetables.

Resources required: homestead land, propagation materials and seeds of drought resistant vegetable seeds.

Potential maladaptation: none.

Non-climatic benefits: gender integration in agriculture, nutritional security, year round income.

Mango and Jujube cultivation

Mango and Jujube (*Ziziphus jujuba* Mill) are alternative and promising crops to manage drought in Barind areas. Area under mango is increasing every year, as the region is known for its quality mango production and higher yield. The crop is many times more profitable than T.*aman* rice. The inter-spaces in the young mango plantations are intercropped with T.*aman* and *boro* rice. Many varieties of different maturity groups are widely grown in this region.

All varieties flower at the same time of the year, normally in February, showing a synchronized flowering behavior. Maturity of these mango varieties depends on temperature pattern during summer months from March to May, and their harvest windows vary from 15 May to 15 August. According to farmers' experience, varieties such as *langra* are highly suitable for the region as damage due to abnormal weather during flowering is not significant compared to other varieties. The disadvantage of mango intercropping, however, is that intercropping with rice is no more possible after three years of growth to the shading cover of mature mango trees.

The jujube (*Ziziphus jujuba* Mill) is a tropical fruit crop able to withstand a wide range of temperatures. One of the outstanding qualities of the jujube is its tolerance of drought conditions. The crop can be cultivated successfully in Barind Tracts with little irrigation. The jujube filed can be intercropped with T.*aman* rice during *kharif* II season.

Resources required: pits for planting mango/jujube saplings, drought tolerant mango/jujube saplings; low cost fencing and limited labour.

Potential maladaptation: synchronized maturity under high temperature and associated market problems. Jujube has the potential to withstand high temperature.

Non-climatic benefits: improved standard of living, additional employment opportunities if pulp industries are developed.

Training strategy

This training module needs to be delivered in at least one session (4-5 hours) on the morning of the third day. It consists of three LUs.

1. Presenting livelihood adaptation options to manage climate variability and change.
2. Explaining the relevance of adaptation options for livelihood development.
3. Increasing understanding of anticipated changes in livelihood portfolios in drought-prone areas.

LU 1: Presenting livelihood adaptation options to manage climate variability and change

This LU explains the steps for preparing livelihood adaptation options to manage climate variability and change. The facilitator conducts an interactive lecture, including material from Box 5.1 and Figures 5.1, 5.2 and 5.3, that introduces key definitions, concepts of livelihood assets and steps for preparing adaptation options. Participants also learn about the methodology and processes for developing viable adaptation options to manage climate risks in agriculture sector.

LU 2: Explaining the relevance of adaptation options for livelihood development

This LU explains current and anticipated future climate risks, adaptation practices and their relevance to livelihood development in drought-prone areas of Bangladesh. The facilitator can explain Context Tables 1-4 briefly, to raise awareness of the identified adaptation practices under future climate change. The adaptation practices are targeted to manage both current and future climate risks. The facilitator need to include the climate change scenarios presented in Module 2.

Exercise 1:

Gain experience in managing drought risks

Facilitator asks participants to prepare a matrix similar to the one used in the Context Tables in order to list new sets of adaptation practices for the agriculture, water resources, livestock and fishery sectors.

Exercise 2:

Suitability of adaptation practices

Facilitator and participants discuss the adaptation practices listed in the Context Tables for their suitability, cost effectiveness and adaptability for drought-prone areas in Bangladesh.

Exercise 3:

Developing extension strategy for pilot testing adaptation practices

It is very important to have follow-up to the climate risk assessment at community level. An appropriate strategy needs to be developed to test viable adaptation practices. Participants are asked to complete the table below. The extension strategy may include brief procedures. The adaptation practices in the following table have been identified through community-level interactions.

Sl. No	Adaptation practice	Extension strategy
1.	Seedbed method for t.*aman* rice	
2.	Manures and composting	
3.	Depth of transplanting for t.*aman*	
4.	Weed control/reduce water seepage	
5.	Manual closing of soil cracks	
6.	Strengthening field bunds	
7.	Re-excavation of traditional ponds	
8.	Re-excavation of *khari* canals	
9.	Canals	
10.	Water control structures	
11.	Mini-ponds	
12.	Supplemental irrigation	
13.	Shallow and deep tube wells	
14.	System of rice intensification	
15.	Direct-sown rice (drum seeder)	
16.	Drought-resistant rice varieties	
17. a)	Green manure – T.*aman* system	
b)	T.aus – *Chini Atap* system	
c)	T.*aman* – mustard/linseed system	
d)	T.*aman* – chickpea system	
e)	T.*aman* – mungbean system	
f)	Famine reserve crops	
18.	Mango/*jujube* (ber) cultivation	
19.	Homestead gardens	
20.	Mulberry intercropping in rice	
21.	Fodder cultivation	
22.	Fish cultivation in mini ponds	
23.	Cottage industries	
24.	Manufacturing industries	
25.	Community-based biogas production and tree planting	
26.	Seed storage for higher viability	

LU 3: Increasing understanding of anticipated changes in livelihood portfolios in drought-prone areas

The following table looks at recent changes in livelihood patterns, some of which are attributed to climatic risk over the years. The fact that the projections for drought-prone areas of Bangladesh predict significant climate change indicates that the livelihood patterns may also change.

> **Exercise 1:**
> Review past changes in livelihood portfolios among rural women and men
> This includes discussion of possible future changes to livelihood portfolios in drought-prone areas that are likely to occur with increased climate variability and climate change.

Livelihood activities	In the past	At present	In future
Women			
Household work as maid	Common	Less common	
Paddy husking	Common	Rare	
Boiling paddy and selling	Common	Rare	
Cleaning	Common	Less common	
Embroidering and stitching garments	Absent	Common	
Craft manufacturing (rope, containers, hand fans, mats, etc.)	Common	Common	
Earth-work labour sale	Rare	Common	
Running a small grocery store	Absent	Less common	
Sowing seedlings	Absent	Less common	
Weeding	Absent	Less common	
Irrigating commercial vegetable plots	Absent	Less common	
Harvesting commercial vegetables	Absent	Common	
Harvesting root crops	Common	Common	
Post-harvest processing	Common	Common	
Regular private jobs	Absent	Common	
Traditional poultry, goat rearing	Common	Common	
Traditional cattle rearing	Less common	Common	
Small-scale poultry rearing	Absent	Common	
Cocoon rearing	Absent	Common	
Vending foods at markets	Absent	Less Common	
Vending garments at the village level	Absent	Less common	
Pottery	Common	Less common	

Livelihood activities	In the past	At present	In future
Men			
Farming on own land	Common	Less common	
Traditional ploughing	More common	Common	
Mechanized ploughing	Absent	Increasing	
Farming on rented land	Less common	Common	
On-farm (agri) day labour	Common	Less common	
On-farm contract labour	Common	Less common	
Non-agri (off-farm) day labour	Less common	Increasing	
Non-farm (rickshaw/van pulling)	Absent	Common	
Factory/industrial worker	Rare	Common	
Mechanics	Rare	Common	
Bus/truck driving	Less Common	Common	
Fishing	Common	Less common	
Grocery shop in the village	Rare	Common	
Small business (vending)	Less common	Common	
Medium business	Less common	Common	
Service in government offices	Rare	Common	
Service in NGOs	Absent	Common	
Service in private offices	Rare	Common	
Part-time service	Absent	Less common	
Cattle rearing	Less common	Common	
Commercial poultry rearing	Absent	Common	
Commercial vegetable production	Absent	Common	
Cutting of trees for timber and fuel	Common	Common	
Nurseries (fruit trees)	Absent	Common	
Goat rearing	Common	Less common	
Dairy production	Common	Increasing	
Crafts production	Less common	Common	
Pottery	Common	Less common	

MODULE 6

Climate forecast application to improve adaptive capacity

The purpose of this module is to introduce the forecast products currently available in Bangladesh and explain their utility for improving the adaptive capacity of rural livelihoods to climate risks. Upon completion of this module, participants should be able to:
- describe the various types of forecast products available in Bangladesh,
- elaborate how current forecast products may be used for drought risk management in agriculture and allied sectors, and
- understand rainfall forecasts and their use in decision-making

Improved climate information and prediction is one of the most important elements of adaptation. Adaptation requires working in multiple time scales, from short term to the very long term, addressing climate variability and change through a range of forecasting systems to add incremental value to the entire adaptation process.

Climate change models possess inherent uncertainties. Thus, generating locally usable climate change information in drought-prone areas requires additional considerations. There will be a need to incorporate short-, medium- and long-lead climate forecast information products in order to develop location-specific impact outlooks and agricultural response options.

Box 6.1: Weather and Climate forecasting

Weather forecasts predict the behaviour of the atmosphere over the course of a few days.

Climate forecasting looks at the likely patterns of climate variables such as rainfall and temperature for longer periods (months or seasons) with sufficient lead-time (before the start of the season).

Forecasting weather refers to the likely behaviour of the atmosphere in advance or foretelling the likely status of the atmosphere in relation to various weather parameters such as rainfall, temperature or wind. Generally, forecasts involving weather and climate are divided into three major types based on their lead-time: short range, medium range and long range.

Short-range forecasts, covering a period of 24 to 72 hours, are based on atmospheric circulation patterns that are monitored by satellites and synoptic observatories. Their accuracy is high, as they cover only a few days. This method is used to forecast cyclones, associated wind speed and temperature and is useful for timing decisions on sowing/planting, harvesting, fertilizer application and post-harvest operations.

Medium-range forecasts, covering a period of three to ten days, are based on numerical weather prediction models (mathematical formulae) that explain physical atmospheric processes. This method can provide information about rainfall, wind speed, wind direction, cloud cover and temperature and, on occasion, can extend forecasting to 25 or 30 days. This type of forecasting is useful for timing decisions on such activities as sowing/planting, irrigation or harvesting.

Long-range forecasts, covering a period of a month up to a season or more, are generated using statistical relationships between rainfall and various atmospheric and oceanic variables. Currently, General Circulation Models (GCMs) are used for seasonal or long-range forecasting which is also referred to as climate forecasting or seasonal climate forecasting. Seasonal climate forecast maps are usually qualitative, indicating probability of wetter/drier than normal conditions. Such seasonal forecasts, including analog and climatology forecasts, are adequate for understanding general trends. The long-range forecasts are highly useful for drought risk management in agriculture. The long-range forecasts support decisions on such matters as choice of crop/cropping systems, selection of crop varieties and resource allocation.

Weather and climate forecasts in Bangladesh

The Bangladesh Meteorological Department (BMD), under the Ministry of Defense, provides relevant weather forecasts on a regular basis. It operates 35 meteorological stations throughout the country, of which ten provide agro-meteorological data, reporting daily to the central office in Dhaka. The BMD Storm Warning Centre (SWC) issues daily forecasts based on analysis of meteorological charts and satellite and radar images.

Special bulletins on drought

In addition to routine daily forecasts, BMD issues special weather bulletins for heavy rainfall, droughts, tropical cyclones and associated storm surges. In addition, it issues one-month forecasts for the general public and authorities and long-term agro-meteorological forecasts valid for three months (updated every month). Medium-range, 10-day agro-meteorological advisories are also issued.

Observation network

In the above forecasts, meteorological observations are used as basic input. BMD has a meteorological observation network throughout the country consisting of 35 surface observatories recording observations eight times a day. Ten Pilot Balloon Observatories record upper wind direction and speed four times a day, three Radiosonde Stations record upper-air wind, temperature, humidity and pressure twice a day. The BMD also operates 10 agro-meteorological stations.

The Agro-meteorological Division of BMD issues a bulletin every ten days with meteorological data from 32 meteorological stations, highlights the rainfall situation and offers 10-day forecasts. The Department of Agricultural Extension (DAE) operates 64 rainfall stations, one at each district agricultural office. Daily rainfall data is compiled by the BMD Deputy Director's office and communicated to the DAE in Dhaka.

Application of climate forecasts

The effective use of climate forecasts requires that:

- the right audience receives and correctly interprets the right information at the right time,
- the information is relevant to decisions concerning drought risk reduction, and
- the forecast information is supplemented with impact outlooks and a drought management plan.

The criteria for effective communication of climate forecasts are:

- forecast products should contain relevant information that is important to the user community (local extension officers and farmers),
- a probabilistic forecast should accompany information on the possible impact of drought and risk management measures.

Preparation of drought risk and management plan matrix

The adaptation options to climate change require appropriate use of climate information. Achieving potential crop yield requires increased resource management through appropriate use of climate information. It is essential to identify the key drought risks during the crop growth cycle and the management alternatives.

Drought during the monsoon as well as in the dry season is very common due to the high level of rainfall variability. Aus rice is affected by early drought or the false start of monsoon rains with breaks at the beginning that cause poor crop establishment. The *aus* and t.*aman* crops are constantly affected by mid-season and terminal drought in the high *Barind* tracts. In medium highlands, t.*aman* is affected by late season drought during October and November. Adjusting the time of transplanting of t.*aman*, based on climate forecast information, can reduce the impacts of drought. Alternative options would be to select drought-tolerant varieties.

Table 6.1. Key drought risks and management plan matrix for applying climate forecasts

Crop	Agri-practice	Decision window (time)	Type of climate risk	Information needed for drought preparedness	Time lag (days)	Management plan to reduce risk
Aus	Sowing	Mar 15 – Apr 30	False onset of rain and subsequent dry spell	Onset of rains	15	Timely or delayed sowing
T.*aman*	Sowing	July 1 – Aug 15	Dry spell affects the early establishment in highlands	Chance of dry spell	15	Delayed sowing
Boro	Sowing/ seed bed	Nov 15 –Dec 31	Inadequate rainfall during Nov/Dec affects establishment	Chance of rainfall	15	Early/delayed sowing of *boro* coinciding with rainfall during Nov/Dec
Boro	Harvesting	Apr 1 – May 15	Hail storms damage crop	Hail storms/ Nor'westers	10	Advanced harvest to reduce yield loss

Short- to medium-range rainfall forecasting is useful for decision-making related to:

- planning for early harvesting,
- planning rice transplanting,
- planning for extra seedlings to replant,
- managing water scarcity for culture fisheries,
- taking precautionary measures to protect livestock from excess heat.

Long range/seasonal forecasts are useful for decision-making related to:

- planning cropping systems,
- planning drought-response activities,
- organizing logistics for humanitarian response.

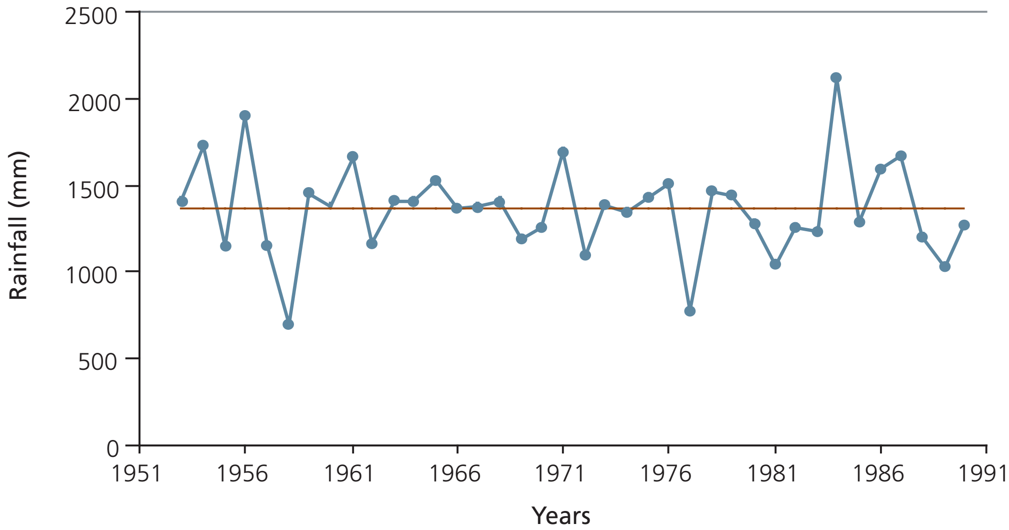
Table 6.2. Key decisions associated with climate related risks and decision responses

Crop	Key decisions	Decision window	Type of risk	Information requirement	Time lag (days)	Decision response
Wheat	Sowing	Nov 10 – Dec 31	Low temperature during flowering causes yield reduction	Possible range of minimum temperature	30	Advance/delayed sowing to skip low temperature injury
Rabi crops	Sowing	Nov 10 – Dec 15	Inadequate soil moisture could cause low plant stand	Possible soil moisture content	15	Arranging seeds and other inputs
	Plant protection	Dec 15 – Jan 30	Pest and disease attack due to unfavourable weather	Possibility of pest and disease outbreak	10	Arranging plant protection chemicals

Understanding probabilistic climate forecasts

Considering the uncertainty of the atmosphere, probability forecasts are considered the most appropriate method for predicting possible future events. Probability forecast methods generally are used in long-range/seasonal forecasts. Probability here refers to the chance of a certain amount of rainfall occurring.

Fig.6.1. Times series of monsoon season rainfall for Dhaka from 1953 to 1990 (38 years)



For example, Fig. 6.1, which gives the monsoon (June to September) rainfall of Dhaka from 1953 to 1990, shows that the rainfall varies from 703 mm to 2 120 mm in four months. The mean seasonal rainfall is 1 361 mm but that is an average, it does not mean that one can expect 1 361 mm during summer monsoon.

Table 6.3. Expected quantity of rainfall at Dhaka (1953-1990) under various probability levels

Rainfall (Jun to Sep)	Rainfall (mm)
Highest on record (mm)	2 120
10% of years, rain was at least	1 692
20%	1 541
30%	1 449
40%	1 408
50% (median rainfall)	1 377
60%	1 280
70%	1 248
80%	1 161
90%	1 032
Lowest on record (mm)	703
Years in historical record	38
Standard deviation (mm)	273
Average rainfall (mm)	1 361

Table 6.3 indicates the lowest recorded rainfall in the 38-year period 1953-1990 was 703 mm (1958). Based on the records, one can expect that the rainfall during the coming season will be more than 703 mm as it was the lowest amount ever recorded. Note that all 38 monsoon seasons had at least 703 mm of rainfall. The second driest monsoon rainfall on record was 772 mm in 1977. Out of 38 years, 37 years had at least 772 mm of rainfall. If the expectation is more than 703 mm, the chance declines considerably.

The same is true for the wettest year. The highest amount of rainfall recorded in the 1953-1990 period was 2 120 mm (1984). The second wettest year had 1 896 mm (1956). Interpreting this indicates that the chance (probability) of getting at least 1 896 mm is only 5 percent. In 50 percent of the years, the rainfall was at least 1 377 mm. This further indicates that there is only a 50 percent chance to receive 1 377 mm and above.

Extension personnel and farmers understand and regularly employ a range of drought preparedness strategies. Climate forecasts decrease the risk of drought impact only when uncertainty associated with forecasts is communicated properly. Failure to communicate or understand the uncertainty of forecasts exposes users to excessive risk.

Figure 6.2 indicates the summer monsoon rainfall recorded at Dhaka in the 38 year-period from 1953-1990. The curve indicates that there is an extremely high chance of receiving the lowest amount of rainfall. In other words, the chance of receiving 1 100 mm of rainfall is 88 percent, while the chance of receiving 1 500 mm is only 22 percent.

Fig. 6.2. Monsoon rainfall amount and associated probabilities

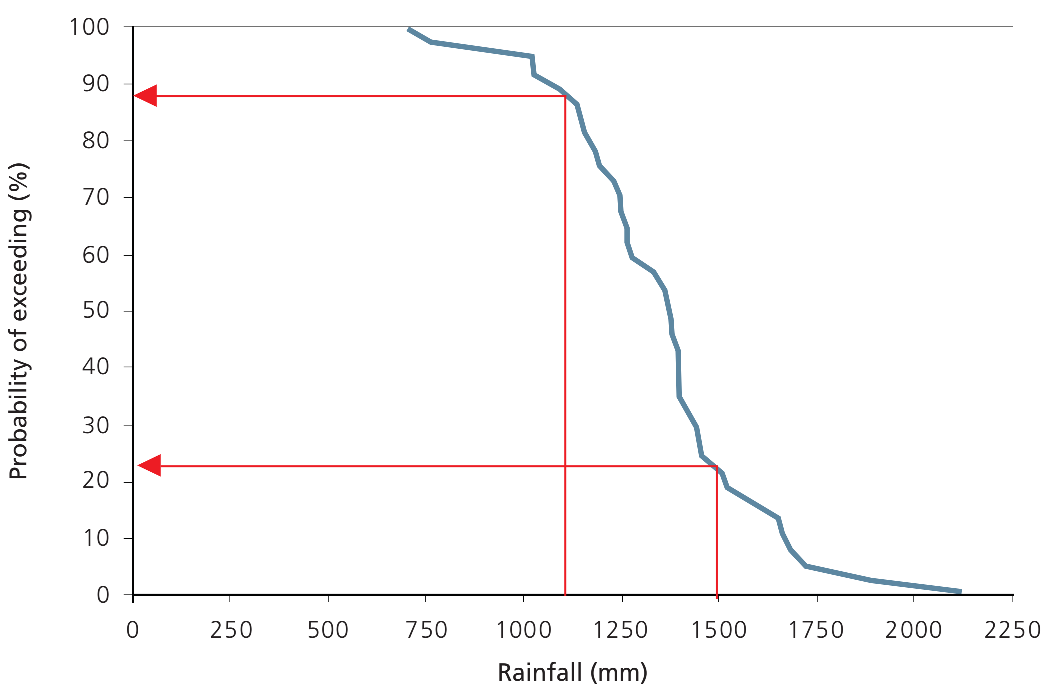
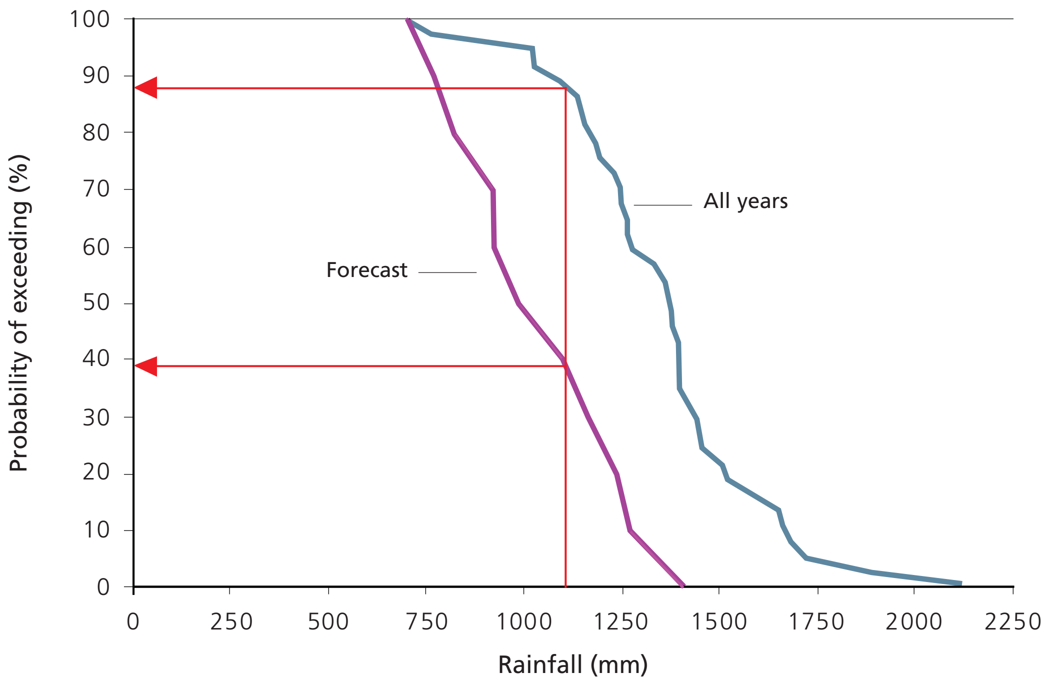


Fig.6.3. Monsoon rainfall amounts and associated probabilities based on all year distribution and forecast distribution



On the other hand, Fig. 6.3 indicates the rainfall received in two groups of years. One line describes the observed rainfall in all years between 1953 and 1990, while another line describes a group of years that received lowest rainfall. Obviously the two lines are different – the "all years" line indicates that the chance of receiving 1 100 mm is 88 percent, while the line describing the rainfall amount for selected years (forecast distribution) indicates the chance of receiving 1 100 mm is only 38 percent. This second line actually indicates that the chance of receiving the amount of rainfall necessary for a successful crop season is comparatively lower. Thus, in order to make an agricultural adjustment to manage cropping, it is important to consider the forecast distribution as well as the "all years" line, because it indicates the higher risk of drought. With the forecast line giving this extra information that an upcoming season will be drier than normal, it is possible to advise farmers to initiate their drought management practices.

Training strategy

This training module needs to be delivered in at least one session (4-5 hours) on the afternoon of the third day. It consists of three LUs.

1. Explanation of the types of forecast products available in Bangladesh.
2. Guidance on use of current forecast products for drought risk management.
3. Looking at probabilistic rainfall forecasts and their potential use for decision-making.

LU 1: Explanation of the types of forecast products available in Bangladesh

This LU is designed to explain different types of forecast products available in Bangladesh. This includes an interactive lecture on key definitions and background about each forecasting type.

Exercise: Review of forecast bulletins – Participants review the forecast products and interpret them. The facilitators should ensure that all participants understand how to interpret the bulletins. Alternatively, selected participants can be requested to present forecast bulletins that can then be discussed by the group.

LU 2: Guidance on the use of current forecast products for drought risk management

This LU is prepared to familiarize the participants with how to use the forecast products for drought risk management. Application of forecast information for climate risk management involves three major steps: interpretation, translation and communication. Interpretation is addressed in LU 1. Translation involves preparation of alternative management plans to reduce the impact of drought. This task may be addressed by use of the following table. The facilitator introduces the subject and then gives a copy of the table to the participants and asks them to complete it. Once it is completed, the facilitator presents tables 6.1 and 6.2 for review.

Crop	Agricultural practices	Decision window (time)	Type of climate risk	Information needed for drought preparedness	Time lag (days)	Management plan to reduce risk
aus						
T.*aman*						
Boro						
Wheat						
Other rabi crops						

LU 3: Looking at probabilistic rainfall forecasts and their potential use for decision-making

Understanding probabilistic forecasts is one of the challenges in forecast application. In this LU, the facilitator introduces the participants to probabilistic forecasts. This session involves a brief lecture and exercise. The section "understanding probabilistic forecasts" needs to be explained to the participants. The lecture should be followed by an exercise using available long-term rainfall data (preferably 30 years). Participants are asked to prepare a table similar to Table 6.3, putting the highest rainfall amount on top and then in descending order with the lowest rainfall on record at the bottom. The facilitator should explain the chance of getting each amount of rainfall. The following questions may be helpful to increase understanding:

- What is the expected rainfall at 50 percent chance?
- What was the wettest monsoon?
- What was the driest monsoon?

Further reading

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Climate variability and change: adaptation to drought in Bangladesh

A resource book and training guide

The impacts of increasing climatic variability and change are global concerns but in Bangladesh, where large numbers of people are chronically exposed and vulnerable to a range of natural hazards, they are particulary critical. Agriculture is the largest sector of the economy, but agricultural production is already under pressure from increasing demands for food. Increasing climate variability and climate change are expected to aggravate vulnerabilities further by causing more frequent and intense droughts and increasing temperatures. Within this context, FAO and the Asian Disaster Preparedness Center are guiding the project "Livelihood adaptation to climate variability and change in the drought-prone areas of Northwest Bangladesh", which is implemented under the Comprehensive Disaster Management Programme and in close collaboration with the Department of Agricultural Extension. It is specifically designed to characterize livelihood systems, profile vulnerable groups, assess past and current climate impacts, and increase understanding of local perceptions of climate impacts, coping capacities and existing adaptation strategies.

As part of this initiative, a series of capacity-building and training activities on climate change impacts and adaptation to drought has been undertaken for national and local-level technical working group members, disaster managers and community representatives.

This resource book, *Climate variability and change: adaptation to drought in Bangladesh*, has been tested and prepared as a reference and guide for further training and capacity building of agricultural extension workers and development professionals to deal with climate change impacts and adaptation, using the example of drought-prone areas of Bangladesh. It also presents suggestions for a three-day training course that would be readily adaptable for any areas of Bangladesh affected by climate-related risks. The information presented on climate change adaptation would enable participants to prepare, demonstrate and implement location-specific adaptation practices and, thus, to improve the adaptive capacity of rural livelihoods to climate change in agriculture and allied sectors.

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