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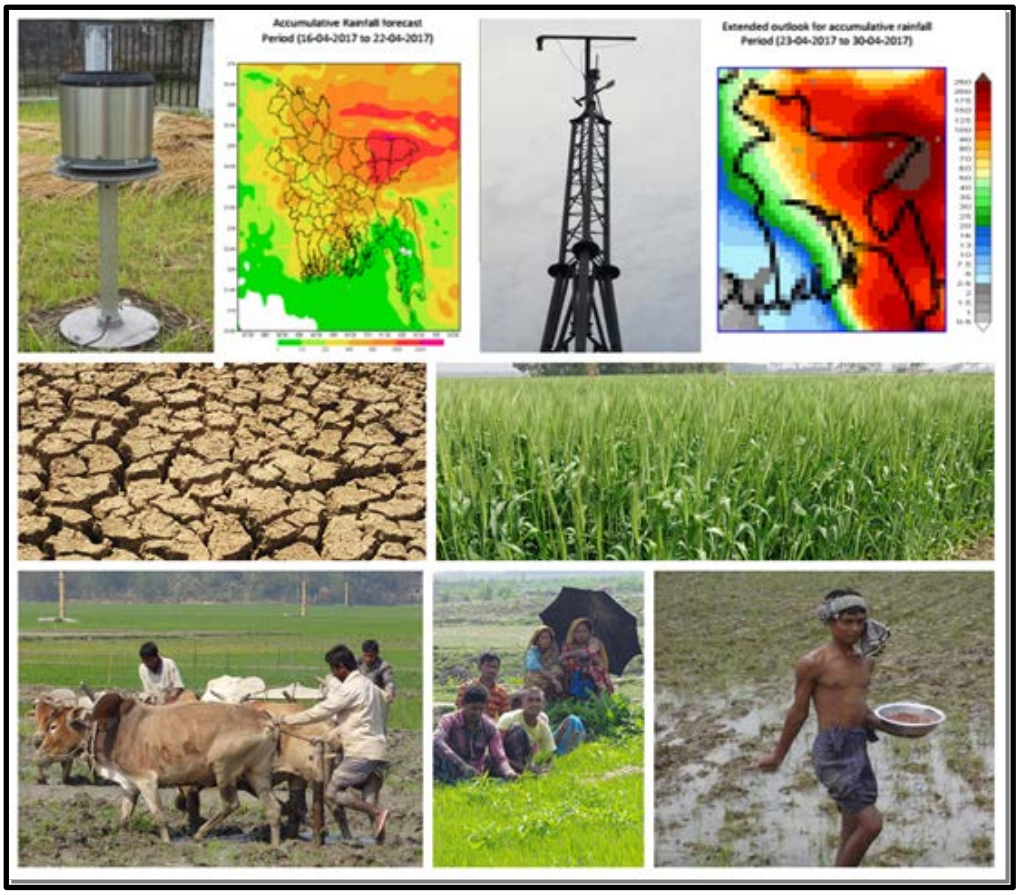
Climate Services for Resilient Development in South Asia and Bangladesh

Semi-Annual and Inception Period Report

April 2017



Report period covered:

November 1, 2016 to March 31, 2017

Partners

CIMMYT
International Maize and Wheat Improvement Center

ICIMOD

IRI International Research Institute for Climate and Society
Earth Institute | Columbia University

Strategic alignment

CGIAR RESEARCH PROGRAM ON Climate Change, Agriculture and Food Security

CCAFS

Grant Summary Information

Project name: Climate Services for Resilient Development (CSRD) in South Asia and Bangladesh

Organization Name: International Maize and Wheat Improvement Center (CIMMYT)

CGIAR Research Program: CSRD is mapped to Climate Change, Agriculture and Food Security (CCAFS)

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Submitted to:

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Acronyms and Abbreviations

ADB	Asian Development Bank
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agriculture Research Institute
BMD	Bangladesh Meteorological Department
BRRI	Bangladesh Rice Research Institute
BWD	Bangladesh Water Development Board
CCAFS	Climate Change Agriculture and Food Security
CHIRPS	Climate Hazards Group Infrared Precipitation with Station data
CIMMYT	International Maize and Wheat Improvement Center
CSISA	Cereal Systems Initiative for South Asia
CRAFT	CCAFS Regional Agricultural Yield Forecasting Toolkit
CPT	Climate Predictability Tool
CSRD	Climate Services for Resilient Development
CRP	CGIAR Research Program
DST	Decision Support Tool
DAE	Department of Agricultural Extension
DG	Director General
DSR	Direct-seeded rice
ERD	External Resources Division
FEWS NET	Famine and Early Warning System Network
GIS	Geographic Information Systems
GoB	Government of Bangladesh
HKH	Hindu Kush Himalaya
ICIMOD	International Center for Integrated Mountain Development
ICT	Information and Communication Technology
IOP	Investment Options Paper
IPCC	Intergovernmental Panel on Climate Change
IRI	International Research Institute for Climate and Society
IRRI	International Rice Research Institute
LoA	Letter of Agreement
MoD	Ministry of Defense
MoT	*Magnaporthe Oryzae Triticum*
NARES	National Agriculture Research and Extension System
NASA	National Aeronautics and Space Administration
PANI	Program for Advanced Numerical Irrigation

RNO	Request for No Objection
S2S	Seasonal to Sub-Seasonal
SSAOs	Sub Assistant Agricultural Officers
USAID	United States Agency for International Development
UPF	*Universidade de Passo Fundo*
WRC	Wheat Research Center

Executive Summary

Developing countries are at considerable risk from climate variability and climate change, both of which threaten poverty reduction and development efforts. The Climate Services for Resilient Development (CSRD) partnership is led by the United States Government has developed a consortium of global leaders in science, technology and development finance to assist at-risk nations to adapt to these problems. CSRD is aligned with the the Global Framework for Climate Services and works in Bangladesh, Ethiopia, and Colombia to creating and provide timely and useful climate data, information, tools, and services.

Within South Asia, efforts to develop agricultural climate services under CSRD are led by the International Maize and Wheat Improvement Center (CIMMYT). CSRD in turn works to support Investment Options Paper (IOP) for Climate Services for Resilient Development in Bangladesh, compiled by the Asian Development Bank (ADB) in 2016. CSRD's core objectives are to prepare farmers, extension services, and agricultural policy makers with actionable climate information and crop management advisories to reduce agricultural production risks and to increase the resilience of smallholder farming communities. This report summarizes CSRD activities, achievements, and challenges during the project's inception phase (from the end of November 2017 through April of 2017). Key CSRD highlights include the following:

- A consortium of core CSRD partners including the Bangladesh Meteorological Department, the Department of Agricultural Extension, the International Center for Integrated Mountain Development (ICIMOD), International Research Institute for Climate and Society (IRI) at Columbia University, the Bangladesh Agricultural Research Institute (BARI), and *Universidade de Passo Fundo* (UPF) is under formation with participation in work plan development.
- CSRD researchers are in the near final-stages of completion of a simple to use decision support tool to guide the development of appropriate climate services based on Bangladesh's predominant crop calendars, weather risks, and the timing of farmers' most crucial crop management decisions.
- Plans are under way for science exchanges and on-the-job trainings during June and July of 2017 for BMD, DAE, and CIMMYT scientists both in Bangladesh and at Columbia University's IRI in Palisades, New York.
- A preliminary irrigation scheduling decision support tool has been developed and incorporated into an Android mobile phone app platform. The tool will be updated to incorporate precipitation forecasts to deliver irrigation advisories to extension agents and farmers following validation by Bangladesh Agricultural Research Institute (BARI) scientists.
- CIMMYT is finalizing agreements to participate in the USAID and NASA supported SERVIR-Hindu Kush Himalaya program led by ICIMOD. This partnership will harness synergies with CSRD to develop timely and actionable seasonal and sub-seasonal drought forecasts for farmers in South Asia, with emphasis on expanding SERVIR activities to Bangladesh.

While considerable progress has been made on these and other work streams detailed in this report, CSRD has also encountered important implementation challenges. Most notable is delayed formalization of Government of Bangladesh agreements with the IOP that would permit full participation of BMD as the keystone organization in the CSRD partnership. BMD, CIMMYT and the ADB are working actively to overcome this challenge to speed up approval and partnership that would enable BMD's full participation, data sharing, and collaborative development in climate services. Despite these challenges, CSRD has succeeded in gaining BMD and DAEs' approval for CSRD's work plans and activities, indicating that formal collaboration can be accelerated once ADB is successful in stewarding the IOP to acceptance. Further details of CSRD's successes and challenges are detailed within the pages of this report.

Introduction

Climate Services for Resilient Development (CSRD) is a global partnership that connects climate science, data streams, decision support tools, and training to decision-makers in developing countries. The CSRD partnership is led by the United States Government and is supported by the UK Government Department for International Development (DFID), UK Meteorological Office, ESRI, Google, the Inter-American Development Bank, the Asian Development Bank, the Skoll Global Threats Fund, and the American Red Cross. The Partnership aims to increase resilience to climate change in developing countries by creating and providing timely and useful climate data, information, tools, and services. The translation of actionable climate information into easy to understand formats to spread awareness and use of climate services is core to CSRD's mission, which is strategically aligned with the Global Framework for Climate Services.

Working in South Asia and Bangladesh CSRD works to support implementation of the Investment Options Paper for Climate Services for Resilient Development in Bangladesh, compiled by the Asian Development Bank in the last quarter of 2016. CSRD activities in South Asia that focus on agricultural climate services are led by the International Maize and Wheat Improvement Center (CIMMYT). Through CSRD, CIMMYT and its partners focus on preparing farmers, extension services, and agricultural policy makers with actionable climate information and crop management advisories for day to day and seasonal weather that affects farm management decisions and crop and livestock productivity.

South Asia's farming systems are dominated by resource poor smallholder farmers who prioritize cereal crop production for food security, and increasingly for income generation. Climatic variability and weather related risks – including drought, unreliable precipitation patterns, extreme heat, and diseases triggered by humid meteorological conditions – however pose significant threats to sustained productivity. CSRD works to develop actionable climate services to aid farmers, extension agents, and agricultural decision makers to better manage farm productivity with increased resilience to climatic variability and extremes. Photo: Saikat Mojumder

These issues are particularly relevant for the South Asian region. The Intergovernmental Panel on Climate Change (IPCC), for example, identifies drought, variable precipitation patterns, and

extreme weather as major climate risks in South Asia. High temperatures and conditions that favor the spread of crop diseases also present important threats to farmers. While South Asia may be described as a 'data rich' environment with respect to the availability of climatic information, use of forecasts to improve farm management and agricultural resilience, and to make informed agricultural development decisions, remains rare.

CSRD focusses on building partnerships and exchanging ideas, data, technology, training, and communication and extension methods to increase the use of climate services in South Asia. This report details activities during the CSRD project's inception phase (first six months) in Bangladesh and South Asia, summarizing activities and partnerships achieved or under development with the Bangladesh Meteorological Department (BMD), the Department of Agricultural Extension (DAE), the International Center for Integrated Mountain Development (ICIMOD), the Bangladesh Agricultural Research Council (BARC), the International Research Institute for Climate and Society (IRI) and with *Universidade de Passo Fundo* (UPF) to collaboratively develop, test, refine, and extend climate services to farmers in South Asia with emphasis in Bangladesh. The provision of easily accessible, timely, and user oriented decision support tools and relevant science in the form of climate services is critical for the development of climate resilient and productive agriculture in South Asia.

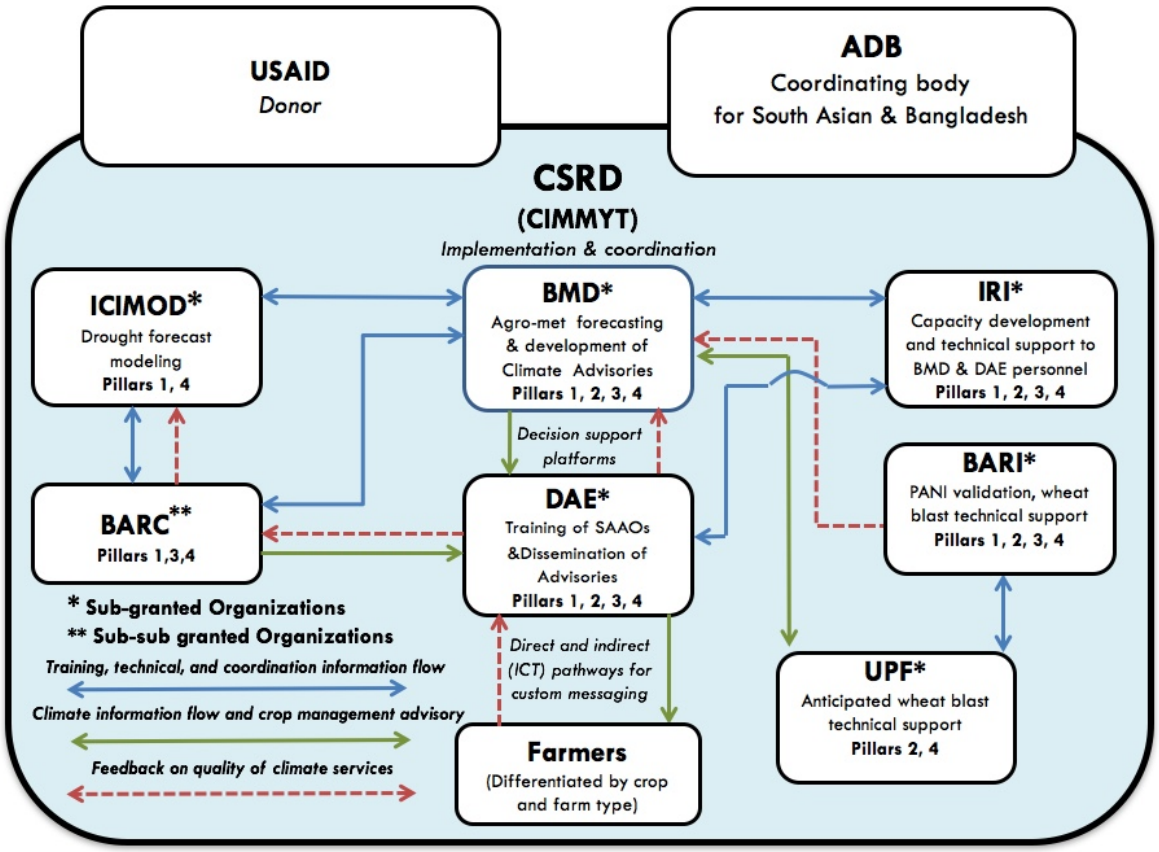
Partnership approach, theory of change, and strategic pillars

The CSRD approach in South Asia and Bangladesh

Led by CIMMYT, the CSRD project in South Asia and Bangladesh receives guidance from the United States Agency for International Development's (USAID's) Global Climate Change Office (Bureau for Economic Growth, Education and Environment) and the Asian Development Bank. ADB is the lead coordinating body for the CSRD consortium, which includes efforts to boost climate services in agriculture and other sectors across South Asia. CIMMYT serves as the facilitating organization for agriculturally oriented climate services in the region, and works to facilitate research, training, and coordination linkages between the Bangladesh Meteorological Department (BMD), the International Center for Integrated Mountain Development (ICIMOD), and the International Research Institute for Climate and Society (IRI). A key goal of this consortium is to improve the skill and quality of agriculturally relevant meteorological forecasting in Bangladesh through research, technical support and training.

CSRD also works to deepen links between BMD and Bangladesh's Department of Agricultural Extension (DAE). DAE is Bangladesh's apex agricultural extension and rural development organization, with over 14,000 extension agents providing technical and advisory assistance to farmers across Bangladesh. CSRD is in the process of formalizing partnerships with BMD and DAE to collaboratively develop decision support tools designed to provide meteorologically relevant and actionable agricultural advice to farmers during periods of the year when crucial farm and crop management decisions are taken.

Throughout the CSRD project, DAE will be supported to disseminate relevant climate and crop management advisories to farmers on both direct and indirect basis using information communications technologies (ICTs) and mass media platforms. CSRD ultimately aims to establish collaborative efforts in climate services research and development that will outlast the timeframe of the project, by developing capacity and building interest in both BMD and DAE to collaborate to extend the use of climate information to farmers and agricultural decision makers more broadly.



The CSRD project coordination and relationship among partners. Organizations marked with asterisks are in the advanced stages of sub-grant development and signature with CSRD at the time of reporting. Those with double asterisk are sub-sub grantees of CSRD partnership. Information feedback on the usefulness and quality of climate services is a key aspect of the CSRD project, which emphasizes feedback from farmers to DAE, DAE feedback to BARC and to ICIMOD, and DAE feedback to BMD. Research on meteorologically informed irrigation scheduling and crop disease forecasting is supported by BARI, with anticipated back-stopping from UPF.

The Bangladesh Agricultural Research Institute's (BARI's) involvement with CSRD constitutes another core plank of the project's foundation. Working with CSRD, BARI will focus on validating irrigation scheduling decision support tools collaboratively developed with CIMMYT. These tools will be improved by incorporating more precise precipitation forecasts. CSRD is also working with BARI in a technical support capacity to develop and implement wheat blast disease risk forecasts. The latter is important in the development of an early warning system for wheat blast disease, so that DAE and other stakeholders can warn and prepare farmers when disease outbreaks are anticipated.

CSRD is also pursuing strategic links with the *Universidade de Passo Fundo* (UPF) in Brazil to assist on wheat blast forecasting. UPF is an advanced research institution with considerable experience in climate-disease-crop modelling. Collaboration with UPF is expected to accelerate the speed of delivery for a disease risk forecasting system within the South Asian region. Because wheat blast disease also affects farmers in South America, UPF's scientists have made considerable progress in the development of a wheat blast forecasting system for South America. CSRD will build on this framework by adapting and validating this forecasting system for Bangladesh and South Asia.

Details of the primary scientists involved in implementing CSRD in South Asia and Bangladesh can be found in Annex 1 of this document. CSRD's key project subcontractors and partner

organizations can be found in Annex 2, which also details each partnership objective and the status of completed and anticipated sub-grants.

Theory of Change: CSRD in South Asia and Bangladesh

CSRD in South Asia and Bangladesh has developed a custom theory of change that is used to guide and provide reference for project activities (Figure 2). The project aims to have impact by increasing climate resilient farm management, indicated by increased use of climate services and climate information to inform farmers on how to better manage their production systems. CSRD also aims to develop and validate models for agricultural climate services that can be replicated in other regions with similar farming systems and climate risks. A series of sustained contributions to CSRD's Action and Learning Framework Pillars 1-4, detailed below, are envisioned as major project outcomes that flow from the communication of research results and relevant climate information to stakeholders. These outputs are generated by an iterative process of research uptake and capacity building, which are in turn supported and driven by USAID.

CSRD Action Learning Pillars and Strategic Framework

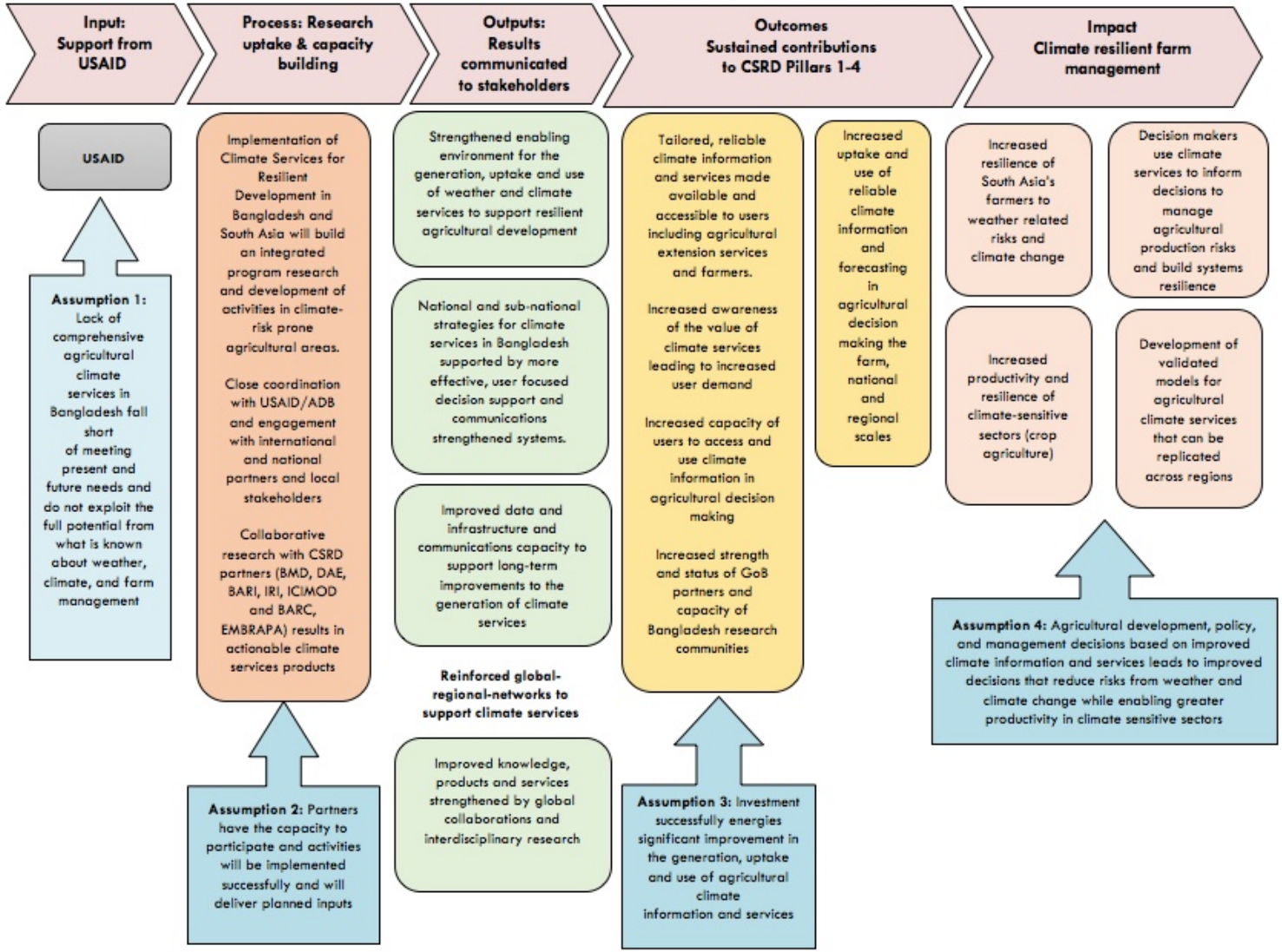
Each of the CSRD activities detailed within this report support an action and learning framework that is exemplified by four interrelated pillars. These pillars are as follows:

- ***Pillar 1: Create the solution space***
  The principles of this pillar are to establish a problem-focus, to engage key stakeholders, to create a platform for sustained communication and collaboration, and to build synergies among relevant programs.
- ***Pillar 2: Utilize quality data, products, and tools***
  The principles of this pillar are to provide access to useful and available information and technology, and to develop tailored products and services responsive to problem-specific needs.
- ***Pillar 3: Build capacities and platforms***
  The principles of this pillar are to support the use of targeted products and services, and to promote sustainability, scalability, and replicability.
- ***Pillar 4: Build knowledge***
  The principles of this pillar are to identify and promote good practices among the global climate services community, and to support research efforts and innovation that increase the effectiveness of climate services.

Within these pillars, CSRD maintains four objectives with aligned sub-objectives and activities. These are as follows:

- **Objective 1:** Development and refinement of impact-based national-scale decision tool platforms to support the Bangladesh Meteorological Department's Sector 3 agro-meteorology track
- **Objective 2:** Collaborative development and refinement of South Asian regional-scale decision support tools, services, and products
- **Objective 3:** Boosting the capacity of partners in Bangladesh to ensure the progress of the CSRD South Asia and Bangladesh working group

This report provides updates on the sub-objectives and activities under each of these objectives, and describes which CSRD pillars and associated milestones and indicators of success that each activity contributes to.



CSRD in South Asia and Bangladesh's customized theory of change used to guide and provide reference for project activities.

Objective 1: Impact-based national-scale decision tool platforms to support the Bangladesh Meteorological Department's (BMD) Sector 3 agro-meteorology track

Sub-Objective 1.1. Agricultural climactic information framework improved

Activity 1.1.1 Updating agro-meteorological information for major food and income staples in Bangladesh using farmer decision making frameworks

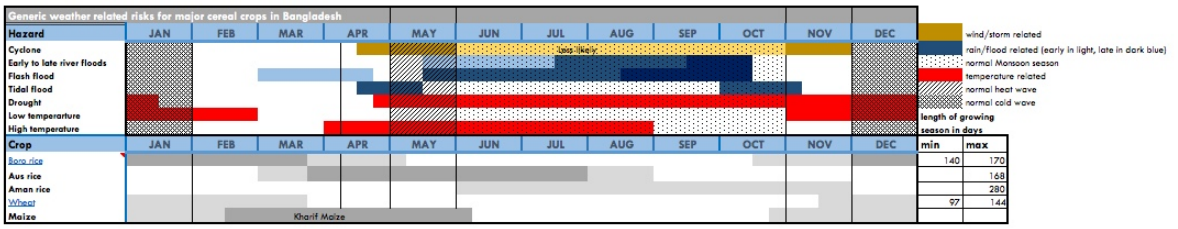
Background:
This activity focusses on applied research to better understand how farmers make decisions regarding crop and farm management. The goal of the activity is to identify critical management decisions that could result in increasingly resilient farm productivity outcomes through the incorporation meteorological information and climate services. Examples of climactic factors that may influence farm management and crop performance include the risk of encountering drought or flooding, the timing and intensity of predicted rainfall, and the probability of extreme heat, among others. These factors can influence the decisions farmers make, including but not limited to choice of crop species and variety, when to sow, fertilize, irrigate or harvest, in addition to key pest and disease management decisions.

In addition to the climate, farmers also consider other information while making crop and farm management decisions. Examples of factors that condition farm management decisions include the availability and cost of labour, input and output market prices, ability to store and sell farm produce, and household food security and income generation needs, among others. This activity therefore investigates the relative importance of climatic information compared to these factors, to identify ways to leverage and communicate relevant meteorological information in support of farming communities.

Progress to date:
Research undertaken under Activity 1.1.1 focusses on developing a framework to tailor agricultural climate services to key farm management decisions, and to identify thermal, precipitation and waterlogging stress thresholds for key cereal crops grown in Bangladesh. A literature review and report on this topic is in the near final stages of completion. Following an interactive workshop (planned for May 2017), during which CSRD's partners in Bangladesh will be asked to review

A farmer in Dumuria Upazilla, Khulna Division in southern Bangladesh examines his wheat crop for signs diseases caused in part by high humidity conditions. Farmers in Bangladesh have many factors to consider in managing their crops, including but not limited to climate. Applied research conducted in CSRD seeks to understand how to develop comprehensive and farmer-friendly climate services that provide meteorological information and crop advisories at crucial times of the year when farm management decisions – for example how and when to control crop diseases – are made. Photo: Ranak Martin.

and evaluate the report, this framework for how climate services can benefit farmers decision making and management choices will be refined and released as a guiding document for subsequent CSRD activities. This report will be accompanied by an interactive tool to provide information and preliminary guidance for CSRD partners interested in increasing the agricultural relevance of climate services. The beta-version tool is easy to use and has been developed in Microsoft Excel, as this software is widely used and understood by a variety of stakeholders (Figure 3).



Preliminary version of an interactive dashboard tool to provide information and preliminary guidance for CSRD partners. Users can explore the ramifications of weather hazards and crop stress threshold risks for major cereals grown in Bangladesh by clicking on links that provide detailed crop calendars depicting the timing and importance of meteorological information in crop management decisions (e.g., when to sow, fertilize, weed, harvest, etc.). The initial tool has been built in Microsoft Excel to increase user ease, though we are exploring the potential to embed the tool in Google Earth to incorporate spatially explicit information on crop and crop management decisions that are affected by weather conditions.

The tool allows users to explore predominant crop calendars and examine when particular weather related hazards, including cyclones, flooding, waterlogging, drought, and thermal extremes might be experienced in Bangladesh, while also retrieving up-to-date quantitative information on crop stress thresholds. The report draft is slightly behind schedule as it was planned for completion by the end of the first quarter of 2017, although it remains on track for scheduled completion following incorporation of CSRD partner comments well before the end of 2017.

Other activities in this work streams include farmer surveys to better understand the information prioritized by farmers and DAE field officers involved in making crop management choices, and indicating and testing what types of meteorological information may be of most use in farm management. These surveys are under development at the time of writing. Surveys are on-track for completion before the end of 2017,with a research report to be released in the first half of 2018. Insights from the report and these surveys will be used to refine strategies for communicating climate information to farmers through CSRD supported decision support tools and climate services portals, with at least 350 DAE field officers trained before the conclusion of 2019.

Contribution of Activity 1.1.1 to CSRD's Action and Learning Framework:
Pillar 1, Indicators 1.1 and 1.2, Pillar 2, Indicators 2.1 and 2.2, Pillar 3, Indicators 3.1, and 3.2, and Pillar 4, Indicator 4.1 (see Annex 3).

Sub-Objective 1.2. Climate services capacity development

Activity 1.2.1. Climate services capacity development in partnership with the International Research Institute for Climate and Society

Background:
The usefulness of agricultural climate services is highly dependent on the precision of meteorological forecasting. BMD has made strong initial efforts in developing agriculturally

relevant forecasts, including maps of expected and cumulative (two-week) precipitation. Maximum and minimum temperature forecasts are also reported weekly on an administrative District-wide basis. Through the CSRD project, BMD has expressed interest in increasing the skill and resolution of these forecasts, and in articulating them in ways that can be more useful to agricultural decision makers.

Progress to date:
Working with the International Research Institute for Climate and Society (IRI) at Columbia University, both BMD and DAE will participate in an assessment of meteorological forecasting skills combined with an evaluation of extension services' abilities to communicate climate information to farmers. CIMMYT is in the process of finalizing a partnership agreement with IRI to undertake this skills assessment in June of 2017. IRI scientists are scheduled to visit Bangladesh for one to two weeks to conduct a thorough assessment geared towards identifying areas for improvement and providing advice for how BMD can increase the quality of their seven-day precipitation forecasts and 15-day accumulative rainfall outlooks. IRI will also evaluate and provide advice for how BMD can increase the skill of their seasonal to sub-seasonal precipitation and temperature forecasts, as well as near-term forecasts of relative humidity and dew point. The latter are particularly relevant in the prediction of crop fungal disease outbreaks (see Activity 1.3.1below). An assessment of extension agents' abilities to interpret and communicate the relevance of meteorological information and forecasts to farmers will also be undertaken simultaneously. Activities will include discussions at DAE headquarters in Dhaka, as well as field visits to anticipated CSRD working locations to meet with DAE sub-assistant agricultural officers and farmers to observe and gage DAE's ability to communicate the relevance of climatic information.

After the completion of the skills assessment, the focal points for both BMD and DAE (see Annex 1) are scheduled to visit IRI headquarters in Palisade, New York, for between two to three weeks. At BMD's request, CIMMYT is currently working with IRI to develop a customized curricula for each day of this visit, which aims to provide hands-on training for BMD and DAE staff by interacting with IRI's scientific staff. A preliminary curricula will be discussed with BMD and DAE before mid-May, in order to allow revisions and additions based on CSRD partners' interests for technical and skill set development. Some preliminary topics include the following:

- Overview of agricultural climate services and lessons from different regions
- Training on forecasting principles and tools to improve seasonal and sub-seasonal forecasting at agriculturally relevant scales
- Integration of climate information with agricultural modeling
- Design and effective communication methods for extending climate information and meteorological advisories to farmers and extension services
- ICT and media platforms for increasing farmers' awareness of climate information and crop advisories
- Introduction to IRI's Climate and Society Map Rooms
- Refinement of the Climate Predictability Tool for seasonal forecasting to increase agricultural relevance in Bangladesh
- Weather index insurance advantages and constraints

Daily planning discussions will also be held during which subsequent work stream activities for CSRD will be clarified and agreed on by project stakeholders. The ultimate goal of the training period at IRI will be to introduce scientists from both BMD and DAE to the key tools and techniques, and global leaders in climate services, and to empower participants with the skills needed to deliver reliable climate services benefiting farmers. Each organization will produce a CSRD activity plan document that has been vetted and agreed upon by DAE or BMD,

respectively, in order to assure clear lines of communication and collaboration in implementing CSRD activities following scientists' return to Bangladesh.

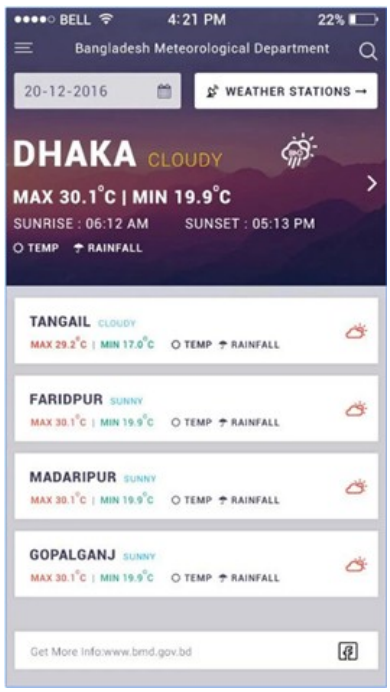
These activities are on schedule for completion by mid-2017 as articulated in the CSRD Scope of Work. Both the skills assessment and exchange visit at IRI are anticipated to be completed by July.

Contribution of Activity 1.2.1 to CSRD's Action and Learning Framework:
Pillar 1, Indicator 1.1and Pillar 4, Indicator 4.1 (see Annex 3).

Sub-Objective 1.3: Development of forecast products, impact assessments, and decision support tools for agriculture, fisheries and/or livestock

Activity 1.3.1: *Iterative development and refinement of decision support platforms with improved agro-meteorological services visualization and communications tools*

Background:
Work undertaken in Activity 1.3.1 responds to work streams prioritized by BMD for CSRD following consultation with USAID for the Sector 3 Agro-meteorology track on 12 July of 2016. These include (1) forecast for integrated irrigation management services, (2) development of "impact based agro forecast" systems incorporating improved forecast and vulnerability to identify impacts, with emphasis on the development of crop specific pest and disease models, and (3) provision of GIS maps displaying climatic stress identification. Each of these areas were identified by BMD as important for improved agricultural climate services in Bangladesh, and have therefore been prioritized in CSRD.



The Bangladesh Meteorological Department Android phone application. Work within CSRD focuses on refining the application to present agriculturally relevant meteorological information at user demand. A related goal is to increase use of the application among DAE field officers so they can provide timely weather information and advisories to farmers.

The activities below detailed respond to BMD's priorities, and include steps taken to develop (a) agriculturally relevant seven-day precipitation and temperature forecasts with 15-day rainfall accumulation graphically depicted as climactic stress risk maps for major cereals, (b) an ITC platform for meteorologically integrated irrigation management services, and (c) spatially explicit and meteorologically driven wheat blast (*Magnaporthe oryzae* Triticum, MoT) disease risk assessments for Bangladesh.

Progress to date:

Agriculturally relevant seven-day precipitation and temperature forecasts with 15-day rainfall accumulation articulated as climactic stress risk maps for major cereals

Four planning sessions have been held with BMD to outline collaborative work plans for the development of agriculturally relevant seven-day precipitation and temperature forecasts with 15-day rainfall accumulation maps. The maps to be produced under this activity will be informed by the crop climatic stress thresholds identified in Activity 1.1.1 (see above). Despite not yet having formal approval to sub-grant to and collaborate with BMD (see 'Implementation challenges' section), initial agreement on activities and methods to improve maps have been outlined during discussions with BMD and DAE. Emphasis will be placed refining the skill of existing seven-day forecasts and 15-day cumulative precipitation predictions that have already been developed by BMD, with emphasis on increasing precision and downscaling resolution to reduce the risk of incorrect predictions that might frustrate farmers.

Further emphasis will be placed on making maps available through BMD and DAE's websites, and on BMD's Android Phone application, as this is expected to be the most expedient way to communicate crop advisories to DAE field agents. Building on this initial progress, activities and methods under this work stream will be refined following skills assessments and scientist exchanges with IRI (see Activity 1.2.1). Preliminary outputs in the form of maps and crop advisories, inclusive of both online desktop and mobile Android formats are planned for completion in the last quarter of 2018. Activities are therefore on schedule in accordance with the CSRD Scope of Work, although delays in formalizing agreements with BMD under CSRD present some risk to timely implementation (see 'Implementation challenges').

Farmers and CIMMYT field technicians work together to measure irrigation rate and volume in Barisal, Bangladesh. Photo: Timothy J Krupnik.

ITC platform for meteorologically integrated irrigation management services

The Program for Advanced Numerical Irrigation (PANI) is a mobile smart phone based application (app) that provides farmers and irrigation pump owners with irrigation recommendations for specific fields one week ahead of time. PANI was developed by CIMMYT under previous research efforts and has been tested only with a limited data set. Within the context of the CSRD project, PANI will be enhanced, so that it can make use of forecasted and downscaled precipitation data that will be generated by BMD to provide field-specific irrigation scheduling recommendations. Field specific recommendations may however be logistically difficult to deploy in the context of Bangladesh where there are millions of farmers, many of whom still lack access to smart phone devices.

For this reason this work stream will also emphasize geographically broader and generic irrigation scheduling recommendations that will most likely be deployed at the sub-District level. Refined PANI algorithms will provide users with a general irrigation recommendation, indicating whether fields should be irrigated "as usual", or sooner or later, depending on historic and forecasted precipitation and temperature data. These

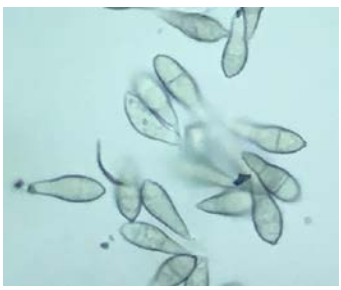
recommendations can then be broadly communicated to large numbers of farmers using mass media. Both PANI applications focus on many non-rice crops that farmers in Bangladesh grow for food security and income generation.

More calibration and validation work is needed, however, in order to assure that PANI provides reliable recommendations for different agro-climactic zones within Bangladesh. CIMMYT is in the final stages of reaching a sub-grant agreement with BARI to validate and collaborate on the development of the field and generalized irrigation schedule decision support tools, respectively. Agreement is expected in June of 2017, with BARI expected to lead field experiments to calibrate and validate the field scale application a number of locations within Bangladesh. BARI is also expected to provide technical advice and participate in the design and development of the generalized and area-wide irrigation scheduling advisory system.

In addition to these activities, a preliminary business case study is underway to better target both PANI applications to increase user potential. There are many different types of payment for irrigation services in Bangladesh. Farmers for example may pay irrigation pump owners a fixed rate per season depending on the crop grown, or they may pay for water by giving a percentage of their harvest to irrigation pump owners under sharecropping arrangements. Other examples of irrigation payment include payment by land area, time irrigated, and through pump rental arrangements, etc. Irrigation is rarely priced on a volumetric basis. In many areas, irrigation service providers also allocate water from one field to another in a rotational pattern that may hinder farmers' ability to react to climactically informed irrigation scheduling advisories within the recommended time frame. For these reasons, a business model study articulating where and how the recommendations from both PANI applications are most likely to be adopted by farmers and will be completed by the end of 2017. CSRD activities to develop meteorologically informed irrigation scheduling services are therefore on schedule for completion as detailed in the CSRD Scope of Work, though some implementation challenges may be expected if formal agreements with BMD are not completed by mid 2017 (see the 'Implementation challenges' section of this report for further details).

Spatially explicit and meteorologically driven wheat blast (Magnaporthe oryzae Triticum) disease risk assessments for Bangladesh.

For the first time ever outside South America, wheat blast disease (*Magnaporthe oryzae* Triticum (MoT)) was detected on over 15,000 hectares in Bangladesh in 2016. The fungal disease caused rapid and in some cases complete yield loss. Blast's initial outbreak had a significant and negative impact on wheat production in southern Bangladesh in 2017. Wheat area shrunk from roughly 62,763 hectares in 2016 to just 14,238 hectares in the districts that were initially affected, as the Government of Bangladesh (GoB) discouraged farmers from growing wheat in these areas.



Left: A farmer in Meherpur, Bangladesh showing the devastating effects of wheat blast in his field. Center: Wheat blast spores under the microscope: Right: Detailed photo of wheat blast infection on maturing wheat heads. Photo left-right: E. Duevellier, Poritosh Kumar Malakar, Subrata Sarker.

Women in Faridpur, Bangladesh winnowing wheat grain after harvest. Wheat is commonly grown in South Asia's rice–wheat farming systems during the dry winter '*rabi*' season after monsoon '*kharif*' rice is harvested. Predominantly grown by resource-poor smallholder farmers, wheat is the region's second most important food security crop after rice, including in Bangladesh. Per capita wheat demand is currently about 17 kg per year^{-1}, approximately 20% of rice consumption. Yet with 3% more protein than rice on average, wheat makes an important contribution to nutritional diets and protein intake at 4.3 g per person per day. Photo: Saikat Mojumder.

Wheat blast is triggered by presence of the fungus, suitable wheat cropped area, and relatively humid conditions that cause fungal sporulation and that assist in dispersal of the disease. Although wheat area was reduced during the 2017 season, CIMMYT and its partners found symptoms of blast disease in 9 Districts, including two new ones (Faridpur and Rajshahi, though only one field in the latter) not detected in 2016. The severity of infection was however very light, a result of unusually low precipitation and humidity conditions. Yield losses were therefore limited in 2017. Yet despite the unfavorable meteorological conditions for wheat blast and low level of infection in Bangladesh, initial media reports have indicated that the disease has spread to India. Efforts to mitigate wheat blast in CSRD therefore focus on developing MoT forecasting models that be used to predict where potential wheat blast outbreaks might occur, and to warn farmers where and how to take preventative action.

Collaborating with the Cereal Systems Initiative for South Asia (CSISA) project, CRP WHEAT and researchers from Cornell University, scientists involved in CSRD participated in detailed field surveillance and monitoring of wheat blast in February through March of 2017, collecting 1,680 wheat samples from over 800 fields in 25 districts of Bangladesh. These samples are now being processed to confirm presence of MoT at BARI's laboratories. The spatially explicit data from these samples are integral to the testing and validation of the algorithms and models used to predict wheat blast occurrence using meteorological data. These predictive systems are now under development through CSRD.

The first step in developing a predictive tool for disease outbreaks is to examine how models perform in confirming past occurrences, using historical data and the including the data collected in February-March of 2017. Details of the status of the preliminary analysis and consequent short report can be found in Annex 3. In addition to these analyses, CSRD is planning to partner with Brazil's *Universidade de Passo Fundo* (UPF). Wheat blast has been present in South America

for over 30 years, and researchers at UPF have been working on wheat blast disease modeling for over a decade. Strong progress has been made by UPF in the development of generic disease forecasting models that can be applied to wheat blast. In particular, a within season forecasting tool coupled with a dynamic crop simulation model for wheat development and risk of blast outbreak has been developed, although they remain to be tested outside of South America. Collaborating with UPF, CSRD undertake with the following activities to develop climate services for wheat disease forecasting:

CIMMYT, Cornell and BARI scientists collaborating in the CSISA and CSRD projects planning wheat blast surveillance in February of 2017 in Dinajpur, Bangladesh. Photo: Maricelis Acevedo.

(1) Adaptation, testing, and validation of coupled wheat crop simulation models that incorporate meteorological factors and soil conditions on wheat growth and yield, and which can predict interactions between fungal diseases and the physiological rate of wheat development. The fully coupled model is expected to have two components that field surveillance data can be used to validate: one model for wheat, based on a FORTRAN coded sub-routine model included in the DSSAT-Decision Support System for Agrotechnology Transfer simulation model, and a generic disease model parameterized for wheat blast in South Asia. The latter is to be coded in C++. Importantly, BMD makes use of FORTRAN coding language in much of their meteorological modeling work. C++ is universally standard programming language. This means that once adapted to South Asian conditions, the wheat blast model should be operated with relative ease and maintained for season-to-season use by CSRD partners in Bangladesh.

(2) Adaptation of 'Pic-a-wheat field' smartphone application in Bangla language for wheat blast surveillance within Bangladesh. The main goal of the 'Pic-a-wheat field' app is to facilitate improved wheat blast surveillance information and assemble global information in single online database and portal for information on wheat blast occurrence. GPS coordinates will be extracted from submitted photos of wheat blast affected fields and instantly mapped and presented online. Users of the app and associated online portal can view the map to analyze the spatial distribution of wheat fields with blast. As Bangladesh's wheat blast occurrence database becomes populated, it will enable iterative fine tuning of weather-based simulation models. In addition, the blast distribution map will facilitate preparedness in the presence of disease outbreaks.

(3) A web-based decision support tool for wheat blast sub-seasonal forecasts using hourly weather data from BMD's network of automated weather stations. This DST will produce wheat blast risk maps depicting infection potential using interpolation techniques for point estimations from weather stations and numerical weather forecasts within Bangladesh's primary at-risk wheat growing areas.

A collaboration agreement with UPF is under development and expected to be completed by mid-May of 2017. We expect to have a prototype DST ready for field testing and validation

prior to November 2017 before the start of wheat planting in Bangladesh. This activity is therefore on schedule for completion, with a prototype blast validation model, mobile phone surveillance system, and preliminary analytical portal and predictive disease risk tool completed in 2018, though some implementation challenges may be expected if formal agreements with BMD are not completed by mid 2017 (please see the 'Implementation challenges' section of this report for further details).

Contribution of Activity 1.3.1 to CSRD's Action and Learning Framework:
Pillar 2, Indicators 2.2 and 2.3, Pillar 3, Indicator 3.1 and Pillar 4, Indicator 4.1 (see Annex 3).

Activity 1.3.2: *1.3.2. Agro-meteorological forecast services applications and systems for crops, fisheries and/or livestock developed and refined for medium-term decision making co-developed and refined*

Background:
As with Activity 1.3.1, work under Activity 1.3.2 of CSRD is a response to the request by BMD for CSRD following USAID's consultation for the Sector 3 Agro-meteorology track on 12 July of 2016. Activity 1.3.2 focusses on the targeted improvement of seasonal forecasts and refinement of crop-specific climactic stress maps, which will ultimately be made available on BMD's website, and which can be used by DAE and other development organizations to assist farmers in crop choice and pre-season crop management planning. This work is expected to build on the skills assessment and scientist exchange with IRI (see Activity 1.2.1), and incorporate and adapt IRI's existing Climate Predictability Tool (CPT) to present seasonal and crop-specific forecast information. Subsequent to the refinement and validation of the tool, which is to take place in late 2017 and early 2018, field agents from DAE will be trained how interpret CPT outputs to improve advisories to farmers in their working areas.

Farmers in coastal Bangladesh are increasingly growing mungbean, as pictured here, which fetches high prices in the market. Mungbean is however highly sensitive to large late-season rainfall events that can defoliate the crop, cause diseases, and destroy bean pods. Pre-season predictions of early or heavy rainfall as a climate service could help farmers prioritize other, less risk-prone but remunerative crops. Photo: Ranak Martin.

Progress to date:
As part of the planned exchange meetings at IRI to be held in July of 2017, CIMMYT, DAE, and BMD will work together to assess the usefulness of CPT forecasts for specific crops within Bangladesh. This activity is therefore on track, with preliminary refined seasonal crop stress risk maps to be completed by the end of the year provided agreement with BMD to collaborate formally with CSRD and share data resources is finalized (please see the 'Implementation challenges' section of this report for further details).

Contribution of Activity 1.3.2 to CSRD's Action and Learning Framework:
Pillar 2, Indicators 2.2 and 2.3, Pillar 3, Indicator 3.1 and Pillar 4, Indicator 4.1 (see Annex 3).

Objective 2: Collaborative development and refinement of South Asian regional-scale agro-climate decision support tools, services, and products

Sub–Objective 2.1: Support to facilitate the development and refinement of regional decision support decision support tools, services, and products

Activity 2.2.1: *Coordination support for the International Centre for Integrated Mountain Development (ICIMOD) and partners in drought forecasting*

Background:

The USAID supported SERVIR-Hindu Kush Himalaya (HKH) program of ICIMOD aims to increase use of earth observation information and geospatial technologies for environmental management and improve resilience to climate change in the HKH region, including Bangladesh. Through this program, a major effort is ongoing to establish new drought monitoring and early warning systems within by incorporating suitable earth observation datasets and linking them with local cropping systems and meteorological data. The products generated through the climate service system developed through ICIMOD's integration with CSRD will be utilized by both national meteorological agencies and institutions involved in the agriculture sectors in each country.

SERVIR-HKH partners at the International Centre for Integrated Mountain Development (ICIMOD), CSRD's core partner on drought forecasting, at work at ICIMOD headquarters in Kathmandu, Nepal. Photo: Faisal Mueen Qamer

Progress to date:
Six consultation discussions between ICIMOD and CIMMYT on behalf of CSRD, including meetings in Nepal at ICIMOD headquarters. CSRD project will provide support to ICIMOD's ongoing efforts in regional drought monitoring and forecasting in alignment with SERVIR-KHK efforts ongoing in Afghanistan, Nepal, and Pakistan. In Bangladesh, ICIMOD has already initiated partnership with the Bangladesh Agricultural Research Council's (BARC's) Computer and GIS unit through the SERVIR-HKH program. CSRD will provide technical and logistic support to ICIMOD and BARC, linking the latter to DAE for forecast dissemination to farmers in drought prone regions of Bangladesh.

Establishing regional drought monitoring and forecasting information infrastructure in ICIMOD

Scientists at the Famine and Early Warning System Network (FEWS NET) used 30 years' (1982-present) worth of multiple satellite data sources and ground observations to produce a 5 km^2

grid resolution and 5-day temporal resolution operational rainfall data product called Climate Hazards Group Infra-Red Precipitation (CHIRP). Along with data products, the group also produced tools to incorporate meteorological station point data for improving overall accuracy of the gridded CHIRP data products at local level. ICIMOD is also collaborating with Johns Hopkins University to develop a sub-seasonal to seasonal (S2S) forecast systems of hydrological extremes in the region, including drought. Building on these activities, CSRD is working with ICIMOD to project to establish a S2S data assimilation system. The following activities will be conducted through CSRD:

- Upgrading of computing facilities at ICIMOD's Geospatial Solutions lab in Kathmandu, Nepal, to increase computational power and provide increasingly precise drought prediction
- Establishment of a regional drought monitoring and warning system server based at ICIMOD headquarters in Kathmandu, Nepal.
- Incorporation of drought monitoring and warning systems data in a regional server based on CHIRPS data, National Aeronautics and Space Administration's (NASA's) Land Information System, and JHU's South Asia Land Data Assimilation System data.
- Development of a publically accessible web-based information system to disseminate regional drought monitoring and forecast products in South Asia.
- Establishment of improved computing facilities at BARC to assure quality drought forecasting

Establishing a Bangladesh national drought monitoring system

While the regional data products can aid in drought monitoring at a regional scale, is crucial to analyze finer-scale meteorological data to develop locally relevant indices and dissemination information systems to aid tactical decision making. CSRD is therefore working to establish a drought monitoring and warning system for Bangladesh at a 5 km^2 spatial resolution. Downscaled 1 km^2 forecasts will also be tested. Key activities will include:

- Enhancement of the satellite-based rainfall products with station observations from BMD to produce an integrated gridded rainfall product
- Development of automated software, embedded in the above mentioned portal, to produce standardized precipitation indices based on near real time satellite precipitation data and station observation.
- Production and validation of S2S forecast of soil moisture and precipitation outlooks within Bangladesh at both 5 km^2 and 1 km^2 resolutions. Emphasis will be placed on the dry *rabi* season and late monsoon season onset monitoring and forecasting.
- If downscaled drought forecasting products appear to be of high quality, forecasts will be embedded in the above mentioned publically accessible web-based information system to disseminate regional operational drought monitoring products.
- In addition to on-the-job training for BARC staff, a national training workshop on drought monitoring using satellite precipitation data is planned for 2018/19.

These activities are on schedule in accordance with CSRD's Revised Scope of Work for CIMMYT activities under USAID/E3/GCC:

- A sub-grant to ICIMOD to pursue these activities are anticipated to be signed by the first week of May.
- Purchases are being made and BARC computing facilities will be upgraded by mid-May of 2017.

- Studies of 5 km^2 drought forecast grids will be implemented by Q4 of 2017, with refinement by Q1 of 2018.
- Downscaled 1 km^2 resolution validation tests (field monitoring) are planned for Q4 of 2017.

Contribution of Activity 2.2.1 to CSRD's Action and Learning Framework:
Pillar 1, Indicator 1.1, Pillar 2, Indicator 2.2, and Pillar 4, Indicator 4.1 (see Annex 3).

A maize farmer in Barisal, southern Bangladesh checks his maturing crop for signs nutrient deficiency. Photo: Ranak Martin.

Activity 2.2.2. Regional learning platform for climactically refined decision support tools to support precision nutrient management (PNM) by smallholders

Background:
The optimal rate and timing for fertilizer application are highly dependent on the capacity of the soil to supply nutrients to the crop. Crop yield potential – the highest yield obtainable by farmers without biophysical constraints – is also of particular importance. Both factors are influenced by climatic factors, in addition to crop genetic and management influences. Activity 2.2.2 is designed to be synergistic with CIMMYT's ongoing research efforts in the USAID supported CSISA program and through CCAFS with the International Rice Research Institute, the International Plant Nutrition Institute (IPNI), and the Indian Council for Agricultural Research (ICAR). The ultimate goal of this work stream is to improve the precision of existing fertilizer decision support tools[1] by incorporating accurate seasonal and sub-seasonal precipitation forecasts. Ongoing work in the CSISA program in India has blended crop simulation modeling with forecasted meteorological information to help farmers decide when and how much fertilizer is needed to approach yield potential. Insights from this work are being leveraged in CSRD to improve the algorithms used to recommend fertilizer application timing and rates in Bangladesh.

Progress to date:
Initial work in Activity 2.2.2 commenced during the 2016/17 dry *rabi* season in Bangladesh. Partnering with the CSISA project, 400 farmers participated in experiments aimed at fine-tuning yield predictions and nutrient requirements for maize in southern Bangladesh. These data will be integral in the refinement of algorithms used to generate nutrient recommendations through CSRD. Building on the learning and modeling processes developed in India, further experimental and crop simulation modeling work is anticipated in the 2017/18 *rabi* season in Bangladesh. Lateral learning workshops with researchers involved in the development of nutrient management decision support systems and precipitation forecasting in India and Bangladesh are anticipated in Q2 or Q3 of 2017. Refined algorithms that can be used to incorporate forecasted precipitation information into nutrient management recommendations are expected before the

[1] Beta versions of these tools include the following: http://webapps.irri.org/bd/mcm/, http://software.ipni.net/article/nutrient-expert

completion of CSRD. These activities are on schedule in accordance with CSRD's Revised Scope of Work for CIMMYT activities under USAID/E3/GCC:

- At least two seasons of experimental data are required for this activity. One season has been completed, the next will begin in October-November of 2017.
- The ultimate product of this activity will be new algorithms incorporating precipitation forecasting into existing decision support tools, scheduled for completion in Q1 of 2019.

Contribution of Activity 2.2.2 to CSRD's Action and Learning Framework:
These efforts contribute to Pillar 2, Indicator 2.1, and Pillar 4, Indicator 4.1(see Annex 3).

Activity 2.2.3. Application of historical, near-term, and future climate data applied to develop spatially explicit wheat blast (*Magnaporthe oryzae* Triticum) disease risk assessments for South Asia

Background:
Activity 2.2.3 is intended to build on wheat blast forecasting efforts undertaken in Activity 1.2.1. Although delegates from Bangladesh, India, and Nepal provisionally endorsed the need for forecasting systems for wheat blast during the 'Regional Consultation Meeting in Response to the Wheat Blast Epidemic in Bangladesh', held in Kathmandu in 2016, the subject of wheat blast remains politically sensitive in countries outside Bangladesh due to the risks the disease poses to regional wheat productivity. Although wheat blast infections were not severe in 2017, media reports of cross-border spread from Bangladesh into West Bengal in India have surfaced, with local agricultural officials in India responding by burning infected fields. The Government of India however has not yet officially announced that wheat blast may be present within its borders. No incidence of wheat blast has conversely been reported in Nepal.

Progress to date:
CSRD's ability to produce regional forecasts of the risk of wheat blast outbreak is strongly conditioned by the availability of appropriate and high frequency meteorological and forecasting information in India and Nepal, both of which are contingent on achieving official cooperation in each country to pursue early warning systems as part of wheat blast mitigation efforts. As such, CSRD is waiting for clearer guidance from our governmental partners in India and Nepal on how they choose to proceed in this area. In the interim period, CSRD's efforts will focus on using available historical meteorological data for 'virtual experiments' to assess the geographically explicit risk potential for wheat blast across South Asia. Despite these uncertainties, this activity remains on-track a preliminary spatial risk analysis for India and Nepal is planned for completion in Q2 of 2018, contingent on outcomes from Activity 1.2.1.

Contribution of Activity 2.2.3 to CSRD's Action and Learning Framework:
Pillar 2, Indicator 2.2, Pillar 4, Indicator 4.1 (see Annex 3).

Objective 3: Coordination with the Asian Development Bank and other CSRD partners in-country to ensure progress on the work streams under the CSRD South Asia and Bangladesh working group

Sub-Objective 3.1. Coordination of Bangladesh CSRD partners and support to the ADB

Background:

A core part of CSRD activities include coordination and support for activities and consortium partners within Bangladesh, including ADB.

Progress to date:
Contributions towards this sub-objective are underway as part of CSRD's inception phase. Most notably, ADB and CSRD partner ESRI have begun work on an ArcGIS Online portal to provide climactically relevant geospatial data layers and products to the public. CIMMYT as the lead agency for CSRD in South Asia is coordinating with ADB and ESRI and was the first CSRD partner to supply climactic information for the portal. Examples of Bangladesh-specific data that have been and will be shared (within the second quarter of 2017) following the completion of associated meta-data files are listed below.

Datasets shared in April of 2017	Datasets being processed for sharing in May of 2017
• Agro-climactic zones	• Extreme Temperature Zones
• Long-term climate patterns	• Dry Season Drought Zones
• Surface water recession	• USGS Surface Geology
• Soil drainage classes	• Soil moisture holding capacity zones
• General soil types	• Soil Texture
• Weather hazard frequencies	• Flooding Land type
• Population census	• Soil Permeability Class
• Administrative boundaries and divisions	• Soil Depth Class
	• Road Networks
	• River Networks
	• Water bodies
	• Irrigation Census
	• Bangladesh Land uses: 1989
	• Bangladesh Land uses: 2014-2016
	• STRM 90 m Digital Elevation Model
	• SRTM 30 m Digital Elevation Model
	• Global DEM 30 m Digital Elevation Model

In addition to data supply, CIMMYT is working to negotiate the terms by which other CSRD partners might be willing to share spatial and climatic data to enhance the ArcGIS online portal.

Contribution of Sub-Objective 3.1 to CSRD's Action and Learning Framework:
Pilar 2, Indicator 2.2 (see Annex 3).

Sub-Objective 3.2. Policy maker, agro-metrological services, extension, and farmer awareness of agro-meteorological forecasts and decision support tool platforms for agriculture increased

Background:
CSRD focusses not just on the development, testing, refinement, and implementation of climate services. The project also endeavors to create awareness of the importance of climate services among the public. Trainings, media events, and round-table discussions are envisioned for the Ministry of Agriculture, BARI, BRRI, DAE, BMD, ADB, the Bangladesh Agricultural Development Corporation (BADC), the Bangladesh Water Development Board (BWD), among others. These events will begin approximately one year after the inception of CSRD activities in Bangladesh, and will continue until the project's completion.

Progress to date:
In alignment with CCAFS, an inception workshop for CSRD was planned for early 2017. This event however has been put on hold until formalization of the CSRD partnership has been agreed on with the Ministry of Defense on behalf of BMD (see "Implementation challenges"). Without

clearance of the ADB stewarded Investment Options Paper through Bangladesh's Ministry of Finance, or agreement by the Ministry of Defense to accept a letter of agreement (LoA) option for BMD to partner with CIMMYT, BMD is unable to engage in an inception event. We therefore expect to hold an implementation workshop within Q2/Q3 of 2017, as soon as official permission for collaboration is formalized. BMD's Director and CSRD focal points are nonetheless supportive of and enthusiastic about an inception event, and have agreed to host the event and a day-long workshop on climate services at BMD's premises in Dhaka as soon as Ministry of Defense clearance is granted.

Contribution of Sub-Objective 3.2 to CSRD's Action and Learning Framework:
Pillar 3, Indicator 3.1(see Annex 3).

Implementation challenges

While most of the Objective 1-3 activities discussed in this report are on schedule for completion, full implementation of CSRD activities have not yet been possible due to the delayed submission of the Request for No Objection (RNO) to the CSRD Investment Options Paper (IOP) to Bangladesh's Ministry of Finance. This Ministry is responsible for approving permissions for development cooperation activities that involve financial exchange with Government of Bangladesh Ministries and associated line organizations. As the regional coordinator for South Asian CSRD activities, the ADB submitted the IOP to the GoB in late November of 2016. While this coincided with the start of CIMMYT organizational activities under CSRD, the IOP was under review by the GoB for several additional months following submission. ADB submitted the RNO to the GoB on 16 March, 2017, 4.5 months after project activities began, although the RNO has still not been approved of at the time of writing.

Without approval of the RNO, CIMMYT cannot formalize a sub-grant agreement with BMD. This is due to BMD's placement within the Ministry of Defense; while CIMMYT maintains MoUs with Ministry of Agriculture line organizations such as BARC and DAE, BMD is a new partner and the protocol for collaboration with Ministry of Defense agencies is more procedurally complicated. As BMD is the keystone organization for CSRD activities in Bangladesh, the lack of governmental permission to formalize collaboration has meant that while regular ongoing meetings have been held with BMD under CSRD, meteorological data cannot be shared, nor can official agro-forecasting and climate services development activities be undertaken.

With support of USAID, CIMMYT has attempted to facilitate a sub-granting agreement with BMD by making use of a Letter of Agreement (LoA) given to the Secretary in Charge with the Ministry of Defense on March 22, 2017. The letter proposed use of an LoA in place of the RNO approval to kick-start formalization of CSRD activities (see Annex 5). CIMMYT and BMD have jointly followed up on this option, by having discussions with the Brigadier General responsible for BMD activities, and also with the Secretary of Defense. Both have pledged provisional support for CSRD, and are exploring the implications of an LoA agreement in place of the RNO approval. However, this process is also taking considerable time as permissions have to be granted from multiple offices within the Ministry of Defense to adhere to Bangladesh's governing structure regarding development cooperation and financial investments. Until either the LoA or the RNO is approved by the Ministry of Defense or the Ministry of Finance, respectively, core CSRD activities are effectively on 'hold' and can only be discussed (rather than acted on). This has been problematic as other sub-agreements planned under CSRD have consequently been put on 'hold' as they require that BMD is able to share staff time, meteorological data, forecast models and facilities to collaboratively develop climate services products.

BMD has nonetheless been enthusiastic in partnering with CIMMYT and CSRD, and has agreed to work plans for each of the activities detailed above. BMD has also assigned focal point meteorologists to collaborate with CSRD (Annex 1), and expects that the focal points will be able to participate in the climate services skills assessment planned for June and July of 2017 under Activity 1.2.1. Agreement to common work plans and goals in advance of approval of the LoA or RNO options are a major milestone for the inception of CSRD in Bangladesh, as it will expedite the process of sub-granting once approved. Core CSRD staff at ADB have communicated that the RNO should be approved by the GoB within the month of May, 2017. This would then signal the full implementation of the project in Bangladesh. If the RNO is however is delayed beyond this period, or the LoA 'avenue' for formalizing collaboration with BMD under CSRD is not approved, further delays are likely that could compromise the timely completion of activities by the end of May in 2019.

Annex 1. Key Staff and Core Partner Designations

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***Universidade de Passo Fundo* (UPF)[2]**					
Dr. José Maurício Cunha Fernandes	Senior Scientist – Plant Epidemiology	UPF	Brasília, DF, Brazil	--	mauricio.fernandes@embrapa.br

[1.] CIMMYT is in the process of hiring an additional position to support the CSRD project. The position is for "Agricultural Climate Scientist". An offer to a candidate with significant experience in climate prediction, climate modeling, and with considerable knowledge in data management and programming has been made and is in the final stages of negotiation. We expect that the new Agricultural Climate Scientist will begin from June of 2017 forward.

[2.] Partnership with UPF has not yet been formalized, though discussions are ongoing and are likely to result in a sub-grant or consultancy agreement in the near future.

Annex 2. Project subcontractors and key partners

Partner	Partnership Objective	Strategic Alignment	Leveraging Opportunity	Anticipated or committed funding (USD)	Objective and activity contributions (Core activity contributions)	Status of Partnership
Bangladesh Meteorological Department (BMD)	Integrative CSRD partner to produce and control the quality of climate information and forecasts. Iterative development of climate services frameworks and decision support tools.	Pillars 1, 2, 3, and 4	BMD is Bangladesh's lead agency for meteorological forecasting in Bangladesh and is interested to improve the quality of their ag-meteorological forecasts. Improvement of short-term and seasonal forecasts and integration of the resulting information as crop specific climate service advisories will be deployed through CSRD partners.	$282,149	Sub-Objective 1.1., Activity 1.11., Sub-Objective 1.2, Activity 1.2.1., Sub-Objective 1.3: Activity 1.3.1 (all three sub-activities), Activity 1.3.2, Sub–Objective 2.1, Activity 2.2.1, Objective 3, Sub-Objective 3.1.	BMD has assigned focal points for CSRD and we are in regular discussion with BMD's Director. Formalization of the partnership with BMD through a sub-grant arrangement has however not been possible as there was delay in submission of the 'Letter for no objection' to the CSRD Investment by ADB to Bangladesh's Economic Relations Division (under the Ministry of Finance) in early April of 2017 (more than five months after CSRD activities began in Bangladesh). CIMMYT has pursued alternative means for formalization collaboration with BMD through a letter of agreement supported by USAID, although this alternative is also taking time as it requires approval from the Ministry of Defense. Until the Economic Relations Division and/or the Ministry of Defense approves of CSRD, a formal working partnership with BMD is not possible (see 'Implementation challenges' section). BMD is more than willing to engage in training and planning activities prior to either of these solutions, and has strongly contributed in this capacity. Detailed work on forecast improvement, decision support tools, or collaboration with DAE is however not possible. We hope and expect that a solution will be found by June at the latest to support formal collaboration and dedication of significant BMD staff time to these aims.
Department of Agricultural Extension (DAE)	Iterative development of climate services frameworks and communication strategies. Extension and dissemination of agriculturally relevant meteorological information and advisories to farmers.	Pillars 1, 2, 3, and 4	DAE has over 12,000 field extension agents operating throughout Bangladesh. DAE also has capabilities in ICT tools for extension purposes.	$95,000	Sub-Objective 1.1., Activity 1.11., Sub-Objective 1.2, Activity 1.2.1., Sub-Objective 1.3: Activity 1.3.1 (all three sub-activities), Activity 1.3.2, Sub–Objective 2.1, Activity 2.2.1, Objective 3, Sub-Objective 3.1.	CIMMYT maintains a formal partnership MoU with the DAE, collaboration in CSRD has been initiated and is ongoing, although a formal sub-grant for DAE has not yet been signed as it is contingent on integration of activities with the sub-grant to be allocated to BMD (see above details).

Partner	Partnership Objective	Strategic Alignment	Leveraging Opportunity	Anticipated or committed funding (USD)	Objective and activity contributions (Core activity contributions)	Status of Partnership
Bangladesh Agricultural Research Institute (BARI)	Validation and improvement of irrigation scheduling decision support tools (PANI). Collaborative research to develop and improve wheat blast forecasts and decision support systems.	Pillars 1, 2, 3, and 4	BARI is Bangladesh's lead institute for research in non-rice crops, with significant technical capacity in irrigation and wheat related research.	$35,000	Sub-Objective 1.3: Activity 1.3.1 (PANI and wheat blast activities)	CIMMYT maintains a formal partnership MoU with the BARC which enables close collaboration in CSRD. Collaboration on irrigation scheduling work (PANI) is underdevelopment with BARI's Irrigation and Water Management Division, with formal sub-granting for a research partnership to validate PANI expected in early June, 2017 to coincide with BARI's annual work plan development. BARI's Wheat Research Center (WRC) is a long-term collaborator with CIMMYT; WRC scientists actively advise on blast modeling efforts.
International Research Institute for Climate and Society (IRI)	Skills assessments and advanced forecasting and agriculturally relevant climate services training for BMD and DAE, consistent technical backstopping and support.	Pillars 1, 2, 3, 4	Scientists at IRI have been collaborating with BMD for over four years. CSRD is leveraging this partnership provide consistent technical support and backstopping to BMD, and to develop improved climate services communications and extension strategies with DAE through IRI's contributions to *CCAFS's Research Theme on Adaptation through Managing Climate Risk*.	$300,000	Sub-Objective 1.1., Activity 1.11., Sub-Objective 1.2, Activity 1.2.1., Sub-Objective 1.3: Activity 1.3.1 (all three sub-activities), Activity 1.3.2, Objective 3, Sub-Objective 3.1.	Sub-grant in near final stages of development, signatures and formalization expected by approximately the third week of May, 2017.
International Centre for Integrated Mountain Development (ICIMOD)	Collaborative development and refinement of South Asian regional-scale decision support tools, services, and products with emphasis on seasonal to sub-seasonal drought forecasts	Pillars 1 and 4	Drought modeling downscaling at different resolutions and development of seasonal to sub-seasonal forecast of drought aligned with ongoing work in the SERVIR-Hindu	$195,000	Sub-Objective 1.1., Activity 1.11., Sub-Objective 1.2, Activity 1.2.1., Sub-Objective 1.3: Activity 1.3.1 (all three sub-activities), Activity 1.3.2,	Sub-grant in final stages of development, signatures and formalization expected first week of May, 2017.

Partner	Partnership Objective	Strategic Alignment	Leveraging Opportunity	Anticipated or committed funding (USD)	Objective and activity contributions (Core activity contributions)	Status of Partnership
	and integration with BARC[1].		Kush Himalaya (HKH) program		Objective 3, Sub-Objective 3.1.	
Universidade de Passo Fundo (UPF)	Collaborative development and refinement of disease forecasting model and decision support system for wheat blast early warnings, supporting BARI	Pillars 2, 4	Collaborating scientists at UPF	Under negotiation	Objective 1, Sub-Objective 1.3, Activity 1.3.1: (MoT forecasting) Objective 2, Sub–Objective 2., Activity 2.2.3.	Discussions on structure of collaboration ongoing, but agreement and sub-grant and/or consultancy agreements are expected within May, 2017. Discussions have been highly enthusiastic so far.

Action and Learning Framework Report for November 2016 – April 2017

Climate Services for Resilient Development (CSRD) in South Asia and Bangladesh Inception Period

Pillar	Indicator(s)	Milestones	Measurement method	Progress report (November 2016 – April 2017)
Pillar 1: Create the solution space	**1.1.** Number of collaborative climate services development processes (e.g., working groups) established with identified problem focus and participation of key stakeholders.	• Collaboration among the International Maize and Wheat CIMMYT-CSRD partners in an integrated way, including Bangladesh Meteorological Department (BMD), International Centre for Integrated Mountain Development (ICIMOD), Department of Agricultural Extension (DAE), International Research Institute for Climate and Society (IRI), and the Bangladesh Agricultural Research Institute (BARI)	• Number of formal climate services working groups that have a clearly defined problem focus and participation of approved and designated stakeholders	**Achieved:** • 1 working group established: Focal Points from DAE and BMD have been nominated by the Director General (DG)/Director of each respective organization and two coordination meetings were held. • Four meetings have been held with BMD's Director on CSRD. One meeting has been held with DAE's DG. **In Progress:** • Discussions with ICIMOD are ongoing. Focal points for CSRD have been assigned by the ICIMOD Director General (DG). Six consultations have been held, including an in-person meeting hosted by ICIMOD. CIMMYT is assisting ICIMOD in coordination with the Bangladesh Agricultural Research Council (BARC). Upon signature of ICIMOD sub-grant, ICIMOD will join the formal CSRD working group with national research and extension partners (NAREs) in Bangladesh. • Five consultation meetings have been held with IRI. Focal points for IRI are close to being defined, with negotiations for a sub-contracting mechanism under way. Upon signature of IRI sub-grant, IRI will join the formal CSRD working group focused on Bangladesh. • One consultation meeting has been held with BARI. Focal points for BARI have been defined by BARI's Irrigation Management Division, with negotiations for a sub-contracting mechanism under way. Upon signature of BARI sub-grant, BARI will join the formal CSRD working group with Bangladesh NARES. • Two consultations with UPF have been held at the time of writing.
		• Sub-grants awarded to CSRD partners awarded	• Signed documentation of sub-grant agreements with five CSRD partners (BMD, DAE, ICIMOD, IRI and BARI)	**In Progress:** • The BMD sub-grant has been delayed due to slow transfer of the Letter of Request for No Objection to the Ministry of Finance (MoF) Economic Relations Division (ERD) by the Asian Development Bank (ADB), which is CSRD's Asian coordinating organization. The letter was submitted to ERD only on 2 April 2017 by ADB. CIMMYT efforts in CSRD however began on 30 November of 2016. Without formal permissions from either ERD or the Ministry of Defense, which is the umbrella organization for BMD, sub-granting to BMD is not possible. Sub-granting to BMD is crucial for the entire project's success, as BMD they keystone organization for CSRD and holds the relevant meteorological data and models needed to complete Objectives 1 and 2. Hence without formal agreement or the

Pillar	Indicator(s)	Milestones	Measurement method	Progress report (November 2016 – April 2017)
				clearance of the Request for No Objection, it is not possible to advance substantially on collaboration with the other CSRD partners that must rely on data streams supplied by BMD. CIMMYT has attempted to overcome this obstacle by meeting directly with the Ministry of Defense (MoD) to arrange BMD participation in CSRD on a Letter of Agreement (LoA) basis. To this end, one formal meeting has been held with the Brigadier General responsible for BMD under MoD. A second informal meeting was held with the Secretary of Defense, who approved further discussions with the MoD via the Brigadier General. CIMMYT is now actively pursuing this option to accelerate the BMD sub-grant • The DG of DAE has approved sub-granting from CIMMYT to DAE using an existing Memorandum of Understanding (MoU) between the organizations. Efforts are ongoing to coordinate with BMD and DAE to assure both organizations agree on their key points of collaboration. Once defined, the sub-grant to DAE will be completed (anticipated May 2017. • The ICIMOD sub-grant is at advanced stage and is expected to be completed by May 1, 2017. See Objective 2, Sub-objective 2.2, Activity 2.1 for more details on activities with ICIMOD. • Discussions with IRI are ongoing regarding their sub-grant, which is expected to be completed by mid-May, 2017. See Objective 1, Sub-Objective 1.2, Activity 1.2.1 for details. • Both DAE DG and BMD Director Sub-granting to BARI is expected before June, 2017. Discussions with the Irrigation Management Division are under way to define collaboration terms. Sub-granting before June is not possible as the Irrigation Management Division wishes to announce the sub-grant as part of their Annual Research Planning meetings, held at this time. See Objective 1 for more details on activities with BARI.
		• National scientist training, exchange, between CSRD partners and IRI	• Completion of at least 10 days of exchange training with DAE and BMD focal points at IRI at Columbia University.	**In Progress:** • Curricula for training is under development with IRI and will be formalized as part of the IRI sub-grant. See Objective 1, Sub-Objective 1.2, Activity 1.2.1 for details. • Both DAE DG and BMD Director have approved participation of CSRD focal points in the exchange events at IRI
		• BMD and DAE knowledge and technical skill gaps identified	• Completion of BMD forecast and communication skill, and DAE communication skills completed	**In Progress:** • Terms for skills assessment is under development with IRI and will be formalized as part of the IRI sub-grant. See Objective 1, Sub-Objective 1.2, Activity 1.2.1 for details.

Pillar	Indicator(s)	Milestones	Measurement method	Progress report (November 2016 – April 2017)
Pillar 2: Utilize quality data, products, and tools	**2.1.** Number of and type of information and technology resources identified and offered, or brokered, by CSRD to meet problem needs and support targeted climate services.	• Crop specific forecasting maps + management advisories refined and made publically available with ongoing refinement following user feedback	• Report on planning sessions to develop crop specific forecasting maps + management advisories • Prototype crop specific forecasting maps + management advisories • Public launch of crop specific forecasting maps + management advisories • Refinements made in crop specific forecasting maps + management advisories	**In Progress:** • Two planning sessions on the development of crop specific forecasting maps + management advisories have been held with BMD and DAE. Further progress in this area has not been possible because of the lack of Government of Bangladesh (GoB) mechanism for sub-granting to BMD. • Planning sessions have been initially fruitful in generating a number of ideas for improvement in crop specific forecasting maps + management advisories. Refinement of these ideas is expected to take place in Q2 of 2017 as part of the training exchange with IRI at Columbia University. • Upstream climate products, for example the Climate Predictably Tool, developed by IRI but which is anticipated to be refined to present agriculturally relevant data, is expected to be an integral part of this work, pending agreement with IRI.
	2.2. Number of tailored products developed to support specific decisions	• Establishment of Program for Advanced Numerical Irrigation (PANI) prototype, subsequent field calibration experiments incorporating precipitation forecasts implemented with BARI	• Availability of PANI prototype application • Protocols for field experiments, and upload of resulting datasets to publically available databases • Revised PANI prototype following CSRD partner and farmer evaluation.	**Achieved:** • A PANI prototype application (decision support tool, or DST) has been developed and is under refinement based on experimental trials initiated in November of 2016. **In Progress:** • 2017-18 dry season experimental protocols are under discussion with BARI and are expected to be clarified as part of the BARI sub-grant in June/July of 2017. Experiments will begin in October-December 2017. • Discussions are under way with BARI regarding the feasibility of different public platform (portal and/or application DSTs) for the longer-term housing of PANI. • Refinement of PANI will take place in 2018/19.
		• interactive DST to guide climate services program planners on crop-specific weather constraints and farmers' decision making processes with respect to crop management and weather in in Bangladesh	• Prototype DST completed with BMD, IRI, ICIMOD, DAE, BARC, BARI, UPF • Prototype DST refined with feedback from CSRD partners • Interactive DST to guide climate services program planners on crop-specific weather constraints and farmers' decision making processes made publically available	**Achieved:** • Prototype DST completed as a simple to use Excel tool (will be refined into spatially explicit Google Earth or similar platform for public access) **In Progress:** • Feedback on the DST will be garnered from CSRD partners in May, 2017 • Public access to the DST and associated report is anticipated before the end of Q3 of 2017.
		• Agriculturally relevant seven-day precipitation forecasts with 15-day accumulative rainfall outlooks articulated as	• Prototype availability of seven-day precipitation forecasts with 15-day accumulative rainfall outlooks articulated as climactic stress risk maps	**In Progress:** • Preliminary discussions have been held on two occasions between CIMMYT, DAE and BMD on the development of seven-day precipitation forecasts with 15-day accumulative rainfall outlooks articulated as climactic stress risk maps

Pillar	Indicator(s)	Milestones	Measurement method	Progress report (November 2016 – April 2017)
		climactic stress risk maps generated	• Refinement of seven-day precipitation forecasts with 15-day accumulative rainfall outlooks articulated as climactic stress risk maps based on CSRD partner and farmer feedback • Formal establishment of seven-day precipitation forecasts with 15-day accumulative rainfall outlooks articulated as climactic stress risk maps on BMD website, with links from other CSRD partner websites	• Further progress on this milestone is not possible until the sub-grant with BMD is formalized (see above) • Further details on progress are provided in Objective 1, Sub-Objective 1.3, Activity 1.3.
		• Spatially explicit and meteorologically driven wheat blast (MoT) disease risk assessments model for Bangladesh and South Asia	• Preliminary back-casting and forecasting models for MoT disease risk competed • Prototype of MoT forecasting DST completed • Refinement and public availability of MoT forecasting DST	**Achieved:** • Initial modelling and preliminary back-casting model for MoT disease risk completed • CIMMYT has established regular communications with the Wheat Research Centre of BARI's pathologists to leverage intellectual support on this work stream. **In Progress:** • MoT forecasting DST is reliant upon regular access to BMD data streams, and to improving the skill of these streams. In addition, further progress on this milestone is not possible until the sub-grant with BMD is formalized (see above). • Discussions have been initiated with *Universidade de Passo Fundo* regarding the potential to integrate previous wheat blast forecasting model work conducted in South America to Bangladesh, and to incorporate particulate dispersal models into wheat blast forecasting efforts in Bangladesh. Collaboration with the former organization is most feasible and likely at this time. • Efforts to implement regional forecasting efforts are heavily dependent on the Government of India and Nepal's directives in mitigating risks of wheat blast. Through CIMMYT, CSRD is well positioned to interact with the relevant Indian and Nepali research and meteorological agencies. Next step decisions will be taken depending on how each Government chooses to respond to the risk of wheat blast.
		• New algorithms linking meteorological and yield forecasting to improve the precision of in-season nutrient management recommendations for cereals	• Availability of algorithms, coding and datasets used to update algorithms for in-season precision nutrient management	**Progress:** • Due to the complexity of agronomic and meteorological work required to achieve these goals, this work stream requires at least two seasons of experimental data collection, and will therefore be completed in early 2019. • Lateral learning workshops with researchers in Nepal, India, and Bangladesh are anticipated in Q2 or Q3 of 2017 to advance this work stream.

Pillar	Indicator(s)	Milestones	Measurement method	Progress report (November 2016 – April 2017)
				• Most field work and modeling progress towards this goal will be made in the dry *rabi* cropping seasons of 2017/17 and 2017/19 following the implementation of experiments.
		• Contributions to climate services products developed by other CSRD partners to support specific decisions	• Number of climate services products developed by other CSRD partners that the CSRD South Asia and Bangladesh group contributed to	**Achieved:** • CSRD South Asia and Bangladesh is actively supporting ADB and ESRI to develop a portal and repository of shapefiles and datasets that can be publically accessed to support climate services decision making. Eight spatial datasets have been shared so far, **Progress:** • Further collaborative efforts as requested by ADB will be delivered
	2.3. Number of people benefitting from CSRD activities.	• Quantification of people and agricultural land area benefitting from CSRD activities	• Number of people (disaggregated by gender) participating in research activities and/or applying technologies or management practices as a result of CSRD research products • Number of people trained as a result of the CSRD partnership • Number of hectares upon which farmers participating in research activities and/or applied technologies or management practices as a result of CSRD's research products	**In Progress:** • Most progress towards these indicators will be reported on in late 2017 onwards following the project's inception phase and when formal collaboration with BMD is permitted detailed above.
Pillar 3: Build capacities and platforms	**3.1.** Number of new capabilities to operate, deliver, or utilize climate services that are demonstrated.	• At least 150 DAE agents trained as trainers to extend use of CSRD DSTs to DAE sub assistant agricultural officers (SAAOs).	• Training inventories and pre- and post-training test scores	**In Progress:** • Discussions with DAE are ongoing with respect to implementation of these work plans. Clarification of work plans will be articulated in the soon-to-be completed sub-grant with DAE. BMD will participate in trainings and IRI will contribute heavily to curricula development • Most training will take place in 2018/19
		• At least 350 SAAOs subsequently trained in interpreting and communicating meteorological information effectively to farmers.	• Training inventories and pre- and post-training test scores	**In Progress:** • Discussions with DAE are ongoing with respect to implementation of these work plans. Clarification of work plans will be articulated in the soon-to-be completed sub-grant with DAE. • Most training will take place in 2018/19

Pillar	Indicator(s)	Milestones	Measurement method	Progress report (November 2016 – April 2017)
	3.2. Number of efforts aimed at better understanding existing activities, new opportunities, and any limitations of climate services to achieve scale, replication or sustainability.	• Farmer decision making surveys	• Decision tree and/or choice experiment surveys deployed with farmers in CSRD field sites • Decision tree and/or choice experiment surveys data made publically available on DATAVERSE	**In Progress:** • Surveys will be deployed in Q2-Q3 of 2017, and are under discussion with CSRD partners.
		• PANI business model study	• Geographically explicit business model study (quantitative and qualitative) articulating the conditions under which irrigation scheduling services are most feasible deployed in CSRD field sites	**In Progress:** • Literature review completed, with business model study is being designed with CSRD partners to be deployed in Q2 of 2017.
		• Number of people (disaggregated by gender) or in CSRD partner organizations contributing towards, operating, or using climate services to improve agricultural decision making	• Participant observation, listing, and validation of collaborators at BMD, DAE, ICIMOD, IRI and UPF, and BARI contributing towards, operating, or using climate services to improve agricultural decision making	**In Progress:** • Data to be reported upon in the 2017 CSRD annual report after formalization of sub-grant agreements.
Pillar 4: Build knowledge	**4.1.** Number of captured and shared lessons learned (e.g., case studies) pertaining to the policy, practice, and research of climate services development, adoption, and maintenance.	1. **Report:** Initial report on crop specific climate thresholds and farmer decision making framework for key food and income staples identifying ways to incorporate meteorological information.	• Availability of short report/case study/success story	**Achieved:** • In initial progress narrative report on crop-specific weather constraints and farmers' decision making processes with respect to crop management and weather in in Bangladesh in final stages of completion
		2. **Report:** Farmer decision making survey analysis. Information used to further refine packaging of climactic information presented by BMD and DAE.	• Availability of short report/case study/success story	**In progress:** • Surveys to be deployed in Q2-Q3 of 2017. • Short report completed Q2 of 2018
		3. **Report:** Potential for incorporation of maps and decision tools into existing decision support platforms	• Availability of short report/case study/success story	**In progress:** • Report to be developed as part of IRI sub-grant anticipated in May of 2017, with report to be completed in Q1 of 2019.

Pillar	Indicator(s)	Milestones	Measurement method	Progress report (November 2016 – April 2017)
		(CARFT, LCAT, CPT, etc.).		
		4. Report: Business model appropriateness and results of PANI calibration experiments.	• Availability of short report/case study/success story	**In progress:** • Business case study completed by the end of 2017. • Remaining Report to be developed based on field experiments conducted in Q4 2017–Q2 of 2018. Report completed Q3 of 2018
		5. Graphical report (Maps): Use of historical gridded climatic data to evaluate the past frequency of occurrence of the climactic conditions conducive to wheat blast outbreak	• Availability of short report/case study/success story	**Achieved:** Initial modelling, short report and availability of preliminary back-casting and forecasting models for MoT disease risk complete. **In progress:** • A written summary of the graphical report is under development and is available upon request
		6. Report: Assessment of potential to integrate meteorological services into precision nutrient management tools and frameworks completed (New algorithms completed)	• Availability of short report/case study/success story	**In progress:** • Report to be completed after additional seasons of field experiments, by Q2 of 2019.
		7. Report: BMD and DAE forecast and climate services assessment report	• Availability of short report/case study/success story	**In progress:** • Report to be completed after additional seasons of field experiments, by Q4 of 2017 following review and incorporation of DAE and BMD commentary (report is part of the anticipated IRI sub-contract)
		8. Success story or Case study: 10 CSRD case studies and success stories completed	• Availability of short report/case study/success story	**Achieved:** • Two success stories communicating CSRD's work in light of the CSRD pillars completed. **In progress:** • Eight more success stories communicating CSRD's work in light of the CSRD pillars to be completed (2 success stories or case studies) each to be completed by October end, 2017, April end, 2018, October end, 2018, April end, 2019.
		9. Scientific paper: Farmer decision making structures: What role is there for climate information in Bangladesh?	• Paper drafted and submitted to open-access, per review journal	**In progress:** • Anticipated submission before the end of 2018

Pillar	Indicator(s)	Milestones	Measurement method	Progress report (November 2016 – April 2017)
		10. Scientific paper: Review of opportunities and constraints for agricultural climate services in Bangladesh	• Paper drafted and submitted to open-access, per review journal	**In progress:** • Anticipated submission before the end of 2018
		11. Scientific paper: Incorporating forecast information into irrigation scheduling services in Bangladesh	• Paper drafted and submitted to open-access, per review journal	**In progress:** • Anticipated submission before Q2 of 2019
		12. Scientific paper: Towards early warning systems for MoT in South Asia	• Paper drafted and submitted to open-access, per review journal (BARI, BMD, DAE, UPF)	**In progress:** • Anticipated submission before Q2 of 2019
		13. Scientific paper: Feasibility assessment of drought forecasting for agricultural climate services: A comparison of resolution scales (led by ICIMOD with BARC)	• Paper drafted and submitted to open-access, per review journal	**In progress:** • Anticipated submission before Q2 of 2019

USAID
FROM THE AMERICAN PEOPLE

From weather forecasts to the field:
New partnerships reduce drought risks in South Asia

New partnerships for agricultural climate services in South Asia will reduce drought risks for resource-poor smallholder farmers.

Photo: FAISAL MUEEN QAMER/ CSRD AND ICIMOD

"The program will enhance capacity of agricultural extension staff making use of climate advisories to translate climate knowledge to farmers."

– ***Fisal Mueen Qumar, Remote Sensing Specialist, ICIMOD***

This story is made possible through support provided by the United States Agency for International Development (USAID). The contents and opinions expressed herein are those of the project and do not necessarily reflect the views of the USAID or the United States Government.

Researchers in South Asia are using science to tackle one of the region's greatest threats to resource-poor smallholder farmers: drought. Millions of farmers across Afghanistan, Bangladesh, Nepal and Pakistan lack access to irrigation and rely on increasingly unpredictable rainfall to grow the crops that sustain their families. Increasing farmers' access to drought forecasts – especially before the crop seasons begins – is powerful way to help farmers reduce farm production risks by using drought resistant crop and varieties.

The USAID supported Climate Services for Resilient Development (CSRD) is a new partnership that connects climate science, data, decision support tools, and training to agricultural decision-makers in developing countries. CSRD is led by the International Maize and Wheat Improvement Center (CIMMYT) in South Asia, and has embarked on a new partnership with the USAID and National Aeronautics and Space Administration (NASA) supported SERVIR-Hindu Kush Himalaya (HKH) program led by the International Center for Integrated Mountain Development (ICIMOD). The SERVIR-HKH leverages the NASA's satellite and earth observation science to predict drought risks across the region. With the support of CSRD, drought risk forecasts are being translated into easy to understand messages in the form of crop choice and management advisories for farmers.

Fisal Mueen Qumar, Remote Sensing Specialist with ICIMOD commented that "The products generated through this service will be utilized by both national meteorological agencies and institutions involved in designing locally relevant climate services. CSRD support will enable filed validation and capacity building activities and operationalize these products in decision making process"

CSRD collaboration with SERVIR-HKH is kicking off in May of 2017. Scientists will first build the computing facilities needed to make pre-season drought predictions in both Bangladesh, in partnership with the Bangladesh Agricultural Research Council. Subsequent work will test different types of drought forecasting for their accuracy before translating them into formats that farmers can apply to reduce drought risks and increase food production and security.

USAID
FROM THE AMERICAN PEOPLE

Shout it out!

Bangladesh to boost farmer-friendly climate advisories

Bangladesh sets its sights on expanding climate services to benefit millions of farmers.

Photo: DEPARTMENT OF AGRICULTURAL EXTENSION

"CSRD will help the Department of Agricultural Extension (DAE) to develop the next generation of 'agro-meteorologically literate' extension agents in Bangladesh."

-- Dr. Aziz Mazharul, DAE

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Bangladesh is South Asia's most population and poverty dense country. Home to over 160 million people, farmers in Bangladesh grapple with unreliable precipitation, droughts, floods, high temperatures and humidity, all of which can reduce farm productivity. Bangladesh's Meteorological Department (BMD) has worked since 1978 to provide timely weather forecasts, and is now setting their sights on forecasts and custom-designed advisories for farming communities across the country. Communicating these forecasts through simple to understand messages and advisories can prepare smallholder farm families for adverse weather, ultimately reducing production risks.

The USAID supported Climate Services for Resilient Development (CSRD) is a new partnership that connects climate science, data, decision support tools, and training to agricultural decision makers in developing countries. CSRD is led by the International Maize and Wheat Improvement Center (CIMMYT) in the South Asian region, and is working to increase the precision of BMD's forecasts and to develop new communications tools and systems with Bangladesh's Department of Agricultural Extension (DAE) to spread climate advisories to farmers.

DAE has over 14,000 field extension agents poised to boost farmers' access to climate advisories. A widely used method to spread awareness among in rural areas is the use of musical jingles communicating information to farmers using loudspeakers that are moved about on bicycle carts or trucks. Partnering with CSRD, this and other media communication technologies will be tested and scaled-out so farmers can receive BMD's weather forecasts for farm management.

"It is essential to communicate weather related crop production threats efficiently to farmers in a timely manner to reduce risks," commented Dr. Aziz Mazharul, Deputy Director of Planning and Implementation & Information and Communication Technologies at DAE. "CSRD activities which will integrate agriculturally relevant meteorological information into easy-to-use and demand-driven decision support platforms to improve climate advisory services and farmer crop management"

The CSRD partnership in Bangladesh kicked-off in 2016 and will work though 2019 to expand climate services to smallholder farming communities.

Annex 5. Letter from USAID to the Secretary of Defense encouraging collaboration with CSRD

USAID | BANGLADESH
FROM THE AMERICAN PEOPLE

March 22, 2017

Mr. Akhtar Hussain Bhuiya
Secretary In Charge
Ministry of Defence, Ganabhaban Complex, Sher-E-Bangla Nagar
Dhaka-1207, Bangladesh

Subject: Climate Services for Resilient Development (CSRD) project partnership supported by USAID

Dear Mr. Bhuiya,

The Climate Services for Resilient Development (CSRD) Partnership is an international partnership convened by the U.S. government and chaired by the U.S. Agency for International Development. It was launched in 2015 with the participation of H.E. Mohammad Ziauddin, Ambassador of Bangladesh to the United States.

CSRD is committed to working with partners and countries around the world to increase resilience to climate variability and change. CSRD's core commitment is to foster climate information services that enable decision makers to create solutions to significant problems across timescales and in a variety of sectors, including agriculture, water, health, and disaster risk management. CSRD supports user-centric, collaborative information solutions that effectively harness the power of data, technology, and innovation to anticipate and manage risks. CSRD aims to build local capacity to sustain the development and application of scalable and replicable climate services, starting in three focus countries: Bangladesh, Colombia, and Ethiopia. CSRD contributes to the vision of the Global Framework for Climate Services. More information on this partnership can be found at cs4rd.org.

In Bangladesh, USAID has partnered with the International Maize and Wheat Improvement Center (CIMMYT) to support CSRD's implementation in coordination with the Bangladesh Meteorological Department (BMD). CIMMYT's proposed work plan for CSRD in Bangladesh is informed by July 2016 consultations with the BMD, specifically agro-meteorology consultations. CIMMYT will help achieve several objectives in Bangladesh and the South Asia region including:

1. The development and refinement of impact-based national-scale decision tool platforms to support the BMD's Sector 3 agro-meteorology track.

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www.usaid.gov/bd

2. The collaborative development and refinement of South Asian regional-scale decision support tools, services, and products.
3. Furthering progress of the CSRD South Asia and Bangladesh working groups on climate information services.

Through the CSRD partnership, we propose to continue working together to increase Bangladesh's resilience to climate variability and change. We kindly ask your Ministry to support the CSRD partnership by permitting CIMMYT to engage BMD on a working basis such that activities can begin quickly and efficiently with guidance from CIMMYT. This would ensure CSRD's rapid progress and would enable an on-schedule completion of work. If necessary, a mutual letter of agreement between CIMMYT and BMD could be developed to permit the project to move forward quickly.

Thank you in advance for your collaboration, and please do not hesitate to contact us with questions.

Sincerely,

Matt Curtis
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CC:

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