

**CLIMATE CHANGE ADAPTATION IN WATER MANAGEMENT FOR FOOD SECURITY: RECENT DEVELOPMENTS IN BANGLADESH**

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**1. SITUATION ANALYSIS**

**1.1 Water Resources**

The life and living of the millions of people of Bangladesh have been revolving around the waters of the country's rivers including the great Ganges, the Brahmaputra and the Meghna which are all trans boundary rivers. These three rivers drain a total catchment area of about 1.72 million Sq. km through Bangladesh into the Bay of Bengal. Out of this large catchment area, only 7% lies in Bangladesh. Some 93% of the total annual runoff that Bangladesh drains to the Bay, enters the country from the up-streams so that Bangladesh has very little control over the behaviors of these water flows. Between 22-30% of the country becomes flooded every year, which is considered normal. Major floods used to strike with longer periods. But in recent years, as climate change intensifies, more frequently and devastatingly such floods are occurring. In case of severe floods, up to two-thirds of the country gets under water with varying depths. The last 25 years have seen six devastating floods in 1987, 1988, 1998, 2004 and two in 2007. The hilly regions in the east and north-east have an altogether different hydrological system as these become victims to flash floods. Floods bring with them river erosion and loss of land and homesteads of the poor people who live on or by the river banks. Hundreds of hectares of agricultural land get lost due to river erosion every year. The displaced people migrate to the cities in search of livelihood but are forced by circumstances to live in the slums and create problems for urban congestion and strain on urban services.

In the dry season (November through May), Bangladesh faces water scarcity which severely constrains agricultural and other economic activities. In the face of increasing interventions and abstractions of dry season flows of the rivers in the upstream areas across the border, the water availabilities in most of the rivers of Bangladesh reduce drastically. The cases of the Farakka Barrage across the Ganges, the Gazaldoba barrage across the Teesta, Mohananda and several more barrages/diversion structures across trans boundary rivers diverting their precious dry season flows may be cited as examples. The acute shortage of dry season flows in the rivers of Bangladesh has caused adverse impacts on all forms of development activities as well as serious degradation of environment and bio-diversity risking extinction of many fauna and flora populations and the Sundarbans mangrove forests. Bangladesh has a water sharing treaty with its upstream neighbor India in respect of only one river, i.e. the Ganges. There are 53 other common rivers for which Bangladesh has been waiting for decades for long-term/permanent water sharing treaties with India. Negotiations on this issue however remain at a low key.

In view of the severe constraint of water availability in the rivers during dry reasons (when there is virtually no rains from the sky), people are increasingly pumping out

groundwater for irrigating the crop fields for food production. But an alarming phenomenon is occurring with respect to the quality of ground water. The ground water in most parts of the country has been found to be contaminated with arsenic beyond acceptable limits. Arsenic contaminated ground water has already started to creep into the food chain particularly in cases of leafy vegetables. On the other hand, thousands of people across the country are suffering from different kinds of skin disease, kidney and liver diseases as well as cancers as a result of continuous ingestion of arsenic contaminated water pumped by hand tube wells. Many deaths have also been reported due to arsenic poisoning resulting from ground water drinking. The people and the government of Bangladesh, alarmed by the situation have decided to reduce dependence on groundwater and increase the use of surface water. In the dry season, Bangladesh, therefore, needs to be assured of its legitimate share of the dry season flows in all the trans boundary rivers. There is no other alternative available to Bangladesh because there is no prospect of in-country large scale storage of monsoon water for use during dry season because of its flat topography.

The difference between total annual water resources and internally renewable water resources is significant in Bangladesh. This difference results in a situation where bulks of the water resources are not within the control of this country. Therefore, in case of Bangladesh, high per-capita water availability is misleading and higher values do not necessarily indicate a lack of water stress when it is needed the most.

The water sector development projects of Bangladesh have mainly focused on flood control and drainage; irrigations; riverbank erosion control; delta development and land reclamations. The projects involved construction of infrastructure facilities like small and medium sized barrages, cross-dams, regulators, sluices, canals, embankments and sea-dykes along the coast and rivers. The Dhaka city protection embankment in this respect has been partially completed. Over the last 12 years, the Government of Bangladesh has spent about US\$1.5 billion as investment for development of flood control, irrigation and drainage. A comprehensive water sector assessment was done under the Flood Action Plan (FAP) in the late 1980s early 1990s. But these studies have, by and large, remained unutilized in policy making or action on the ground.

The National Water Policy, 1999 is a forward looking document that has taken into consideration all the important aspects for improving the water resources management and protection of environment comprising of water rights, water pricing guidelines, decentralized water management and the role of women in water management. Although climate change does not feature in it, the more recent policy documents indicate the major implication of climate change for the water sector.

A National Water Management Plan, drafted during 1999-2000, was finally adopted by the government in management issues, specifying 83 programs under 8 clusters to be implemented around the country. But all these programs were rather conceptual with no definitive project proposal and hence remained largely neglected. The challenge remains in implementing both the policy and the plan, particularly under advance conditions of changing climate.

In the wake of climate change and sea-level rise, a major issue now relates to how the flood control and irrigation polders and coastal embankments, which were built in earlier decades are to be repaired, rehabilitated, renovated or even reconstructed to successfully withstand storm surges and coastal flooding. Broadly speaking these

needed to be strengthened and their heights raised appropriately. But this is a very expensive undertaking. One tentative estimate puts the figure at US\$10 billion, which the government cannot afford. Again the land reclamation/accretion programs in the coastal belt need to be more scientifically pursued at a faster pace to offset the adversities of sea-level rise. But this also requires huge investments.

Bangladesh shares the waters of 54 trans boundary/common rivers with India. The Indo-Bangladesh Joint Rivers Commission (JRC) deals with sharing and management of trans-boundary river waters, which is a very politically sensitive issue as it involves negotiations with India. The lessons and experiences of the last four decades points to fact that for positive forward movement of the negotiations for meaningful and mutually acceptable water sharing treaties in the JRC, India, the regional powerhouse, will have to take pains to be seen to be 'just' and 'fair' to its smaller neighbor.

## **1.2 Food Security and Sustainable Agriculture**

Agriculture including crop cultivation, livestock and poultry rearing and fishery, despite its relative decline in terms of contribution to GDP, remains the mainstay of the economy of Bangladesh. It provides employment to just under one half of the local labor force, supplies raw materials to some of the major agro-processing industries and earns foreign exchange from its exports. Agriculture however, is at the cross-roads as water scarcity, land degradation, salinity ingress and the climate change impacts are threatening its sustainability.

A formidable challenge before the country relates to the housing, food security, access to clean water and energy and other services for a population of more than 150 million living in a country of 147,570 sq.km. Unplanned land use in setting-up of development projects, private, industrial and service activities, human settlements, grabbing of wetlands and other common resources by unscrupulous persons and unplanned rapid urbanization is a major problem facing the country. The country is also losing on an average close to 1% of agricultural land per annum to other uses. More agricultural land will be lost in future due to increased salinity ingress and river erosion as a consequence of climate change. This is a serious concern relating to food security in future. Bangladesh needs to rethink its priorities relating to sustainable use of land as it approaches 2050 when the population is expected to be more than 300 million from the present 150 million.

Due to withdrawal of dry season Ganges flows by India, large swathes of land in the Ganges basin in Bangladesh has become desertified where it used to be lush green before. The land has become unfit for agriculture and the rivers have turned into narrow drains with innumerable large-small shoals and inlets cropping up in the flow path of the rivers.

Major achievements have been registered by Bangladesh in various agricultural sub-sectors. Despite a large and growing population, national self-sufficiency has now been achieved in food grain production. Rice production has been intensified through High Yielding Variety (HYV) and other technology infusion. Production of vegetables, fruits and spices has also registered notable expansion. Crop diversification was introduced in the country with the addition of maize and wheat as major crops. The horticulture and nutrition development initiative established horticulture nurseries around the country and set-up 12 training and research centers. Recently flowers are being produced widely as a cash crop. Integrated Pest Management (IPM) was introduced throughout the country

through the establishment of “Farmers Field Schools (FFS)” in all Upazila (Sub-districts) to reduce harvest and post-harvest losses and better management crop diversification and crop production. GIS based agricultural planning has been introduced in the country based on specific agro-ecological zones. The country has developed and released rice varieties which include those of shorter duration maturity (escaping seasonal drought and thus obviating the need for supplementary irrigation and saving energy), tolerant up to two weeks of flood water submergence, and tolerant to moderate salinity. The agriculture extension service which diffuses the new technologies to farmers and advises them is the largest public sector service provider in the country with its delivery agents in practically every village of the country.

Most firms of Bangladesh are tiny by any standard, 88% of them operating on no more than a hectare or so. Yet the credit for the achievement of self sufficiency in food grain goes to the hard work of these marginal and small farmers of the country, who are very open to adopting newer technologies and building resilience to the vulnerabilities of climatic events such as floods, cyclones, droughts, etc. by adapting quickly to new farming options.

Bangladesh has one of the largest fresh water fishery sectors of the world, Yet continuous and increasing volume of fishing has caused depletion in the national stock and loss of indigenous varieties of fish. Over the years, fish has become dearer in cost and at times unaffordable to the poor and even the middle-income groups. Shrinking wetland, reduction of natural flows in rivers and indiscriminate human interventions in the flow paths of rivers/canals/creeks. This decline has however encouraged large scale adoption of pond based fish culture, but the natural decline that has happened so far is yet to be recouped.

The livestock sub-sector is highly promising but has shown little dynamism since late 1990s, although the dairy and poultry looked like taking off at one time. There is scope for small scale dairy in various parts of the country. On the other hand, the poultry industry, which had a vigorous growth only a few years ago, is now reeling under the threats and effects of avian influenza and other diseases.

Soil degradation is posing a serious problem in Bangladesh. Estimates by Bangladesh Agricultural Research Council (BARC) of 2000 indicate that soil related problems may become a major constraint to agricultural growth. Organic matter depletion is observed in 7.5 million hectares of land. Declining soil fertility, soil erosion and salinisation affect respectively 5.6-8.7 million hectares, 5.3 million hectares and 3.05 million hectares of land. It is estimated that Bangladesh soil loses annually some 2 million metric tons of nutrients. Unless compensated through balanced application of nutrients every year the fertility of land is going to decline and so will its productivity. As per one estimate, about one percent of crop GDP will be lost every year. Sustainable land management (efforts for which is ongoing now) is therefore, a major challenge for now and also in the future.

Climate change is going to create major problems in Bangladesh’s agriculture and food security. This calls for large scale investments in technological innovation or adaptation in water management, infrastructure development, cropping system and varietal improvement and development, modeling of climate change and its impact (natural as well as socio-economic) and will affect human and institutional capacity building. A Govt of Bangladesh (GoB) and UNDP joint study of 2009-10 on Investment and Financial Flow (I&FF) required for adaptation in the agriculture sector (crops, fisheries, livestock

and forestry) has estimated that the country will need over and above the Annual Development Program (ADP) allocation for the sector, a total of US\$69.67 billion up to 2030, with 2011 values as the base line. Of this amount, 30% will be for infrastructure, 17% for market development, 15% for irrigation and water management and the rest for other purposes, and all these are related to adaptation.

On climate change, Bangladesh has prepared several planning documents, the latest being the 'Bangladesh Climate Change Strategy and Action Plan' (BCCSAP). The BCCSAP is now reflected broadly in the country's Sixth Five Years Plan (2011-16). Agriculture Ministry is a beneficiary of the disbursements from the GoB's Bangladesh Climate Change Trust Fund (BCCTF), which is being used mainly for adaptation programs.

The government has set up a major research fund for innovative research in agriculture. The present amount stands at about US\$70 million.

### **1.3 Climate Change**

The Global Climate Risk Index (GCRI) 2010, covering the period 1990-2008, assesses Bangladesh as the most vulnerable country to extreme climate events and it further estimates that, on an average 8,241 people died each year in Bangladesh, while the cost of damage was US\$1.2 billion per year and loss of GDP was 1.81% during the period. A British firm called Maplecroft, specializing in risk analysis, finds in its Climate Change Vulnerability Index (CCVI) Report 2011 that Bangladesh is among the 30 most vulnerable countries to climate change out of 193 nations.

Bangladesh's contribution to Global carbon emissions is negligible at per capita/annum of 0.3 tons compared to the global average of 1.6 -2.0 tons for the developing countries and about 20 tons in USA. Bangladesh is a victim of climate change caused by the industrialized countries. Bangladesh for long, been a country frequently visited by different types of natural disasters which left marked impacts. But such events like floods, droughts, cyclones and storm surges, tornadoes, sea level rise, salinity intrusion are now occurring almost routinely as climate change is intensifying. Available estimates suggest that a 1.0 meter sea-level rise will inundate 15-20% of Bangladesh in the coastal region. The existing coastal embankments cannot stop the sea water intrusion into rivers and increased salinity further inland, rendering the affected land unfit for agriculture or for any other economic use. Also, livelihoods, water security, health security and even human security will be severely threatened. The impacts may cause the displacement of up to 30 million people by the mid-21<sup>st</sup> century. The rehabilitation of such a large number of people will be a gigantic task. Given the extreme scarcity of land and limited adaptive capacity, social tensions may arise in the country. Obviously, interventional support will be needed in terms of acceptance of out-migration of climate change induced displaced people from Bangladesh and transfer of resources and technologies to enable Bangladesh to undertake appropriate adaptive and rehabilitative activities.

Women are found to be the more vulnerable to the impacts of climate change than men, particularly because they are more involved with natural resource management. This calls for greater efforts in capacity building of women for climate resilience and community –based adaptive activity.

## 2. RELATED POLICY DEVELOPMENTS

Bangladesh in its submission to the 'Bali Action Plan' made it explicit that development and poverty reduction are the priorities for the country and it opposes any action that may jeopardize the attainment of secure access to food, water, energy and livelihoods.

Bangladesh remains highly proactive in facing the adversities of Climate Change. It is one of the first countries to develop a Nationally Appropriate Plan of Action (NAPA) in 2005 for addressing climate change through a Consultative process among GOs, NGOs, Civil society, academia, professional bodies, private sector, research organizations, think tanks and development partners. The NAPA was updated in 2009. And, as the first country in the world, Bangladesh has adopted a Bangladesh Climate Change Strategy and Action Plan (BCC SAP) in July 2009. It is built around six broad thematic areas or pillars: (i) food security, social protection and health, (ii) comprehensive disaster management, (iii) infrastructures, (iv) research and knowledge management, (v) mitigation and low carbon development, and (vi) capacity building and institutional strengthening. The BCCSAP includes 44 listed programs of action.

The objective of BCCSAP is to increase the country's resilience to climate change, reduce or eliminate the risks that climate change pose to national development and expedite development of the country following a low-carbon path. It postulates that climate resilient development would be pursued through an integrated approach to socio-economic development and management of climate change issues.

The government has already invested US\$10 billion over the last 3 decades to make the country climate resilient and less vulnerable to disasters. Recently the government has created a US\$300 million Bangladesh Climate Change Trust Fund (BCCTF) with its own resources and is going ahead with adaptation activities by GOs and NGOs. Another Fund, namely Bangladesh Climate Change Resilience Fund (BCCRF) has been established by the government with contribution from development partners. So far US\$125 million has been received in BCCRF and another US\$113 million has been pledged. Managed by a committee headed by the Ministry of Environment and Forest, Projects have started to be implemented with allocations from this fund. However, both funds are too little to address the massive cost of adaptation infrastructures needed for protection against sea level rise, floods and storm surges.

As part of low carbon development, both the private sector and the government are investing substantially providing solar home systems, biogas stoves and are now undertaking solar mini-grids and wind energy as pilot projects. However, financing of these expensive technologies still remain a major challenge.

Beginning in 1998, Bangladesh developed a National Comprehensive Disaster Management Program (CDMP) for disaster planning, coordination preparedness and response, The program has brought in a paradigm shift in Bangladesh's disaster management culture by moving away from the earlier response mechanism of primarily relief and rehabilitation to disaster planning, preparedness, early warning dissemination, emergency response and rehabilitation by building capacities at all levels-national, sub-national and grassroots.

A large number of cyclone shelters were built and a large contingent of volunteers was trained to help the people in harm's way evacuate as a cyclone approaches and also

help them find access to immediate relief. As a result Bangladesh became a world leader in cyclone response preparedness and action. Hence while 348,000 and 138,000 people died as consequence of the devastating cyclones of 1970 and 1991 respectively, only 3,800 died as a consequence of the mega cyclones Sidr (2007) and Aila (2009).

Bangladesh has an elaborate Standing Order on Disaster (SOD), which outlines committee formation at all levels from central to village and codifies what to do in the event of natural disaster. Over the past decade, integration of disaster risk reduction with disaster risk management has been institutionalized. The disaster management system is now able to evacuate even millions of coastal people within a couple of days in the face of impending storm-surge disaster, thus reducing the death toll to a smaller number.

Some salient institutions and capacity building instruments created under CDMP-I include among other: climate change cell in the Department of Environment, National Risk Reduction Action Plan, Corporate Plan of Ministry of Food and Disaster Management, Strategic Risk Reduction Plans, Local Disaster Risk Reduction Plans, Standing Order on Disasters, Disaster Impact Risk Assessment including coping mechanisms among others. The country has launched CDMP-II in 2011, which has integrated climate risk management (CRM) in the Disaster Risk Reduction (CDRR) process.

The Government has so far improved 456 cyclone shelters, built 230 new ones and is going to build another 2700 new multipurpose cyclone shelters in the next 10 years in the coastal belt. The newly built cyclone shelters also double as government/non-government primary schools and also as community centers for training and recreation. These shelters are being provided with solar lighting, rainwater harvesting, separate rooms for pregnant women, bathrooms, doors and windows, first aid boxes and 2 to 4 tube wells, which were absent in the earlier cyclone shelters. All cyclone shelters are 3 storied with one floor for keeping animals when a cyclone strikes and have provisions for vertical extension in their foundation. More new cyclone shelters are now in the offing.

The CDMP-II will also help farmers gain access to crop varieties resistant to climate change impacts. Thus CDMP-II would seek to respond to predicted climate change impacts with tangible local level actions that support adaptation.

Bangladesh has remained at the forefront of meeting its international obligations. As part of its commitment, it has prepared the following instruments:

- National Biodiversity Strategy and Action Plan (NBSAP)
- Initial National Communication (INC) on climate change
- Second National Communication (SNC) climate change
- National Capacity Self Assessment (NCSA)
- National Bio-diversity Strategy and Action Plan (NBSAP)
- National Plan for Combating Desertification.

Under the Montreal Protocol technical support, Bangladesh has made significant progress in phasing out Ozone Depleting Substance (ODS) which contribute to global warming. Bangladesh embarked on a series of 16 initiatives since 1994 for complete phase-out of ODS from the country. As of 1<sup>st</sup> January 2010, Bangladesh has achieved 100% phase-out of CFCs from the refrigeration and air-conditioning service sectors. Bangladesh has also achieved 100% phase-out by 1<sup>st</sup> January 2010 of carbon tetrachloride which was used as a

cleaning solvent in the ready-made garment industries. Therefore, ODS is nearly phased out from the country and Bangladesh is expected to meet the MDG target on time.

The country has made significant progress in the areas of increasing literacy rates both for girls and boys and greater enrolment of girls in primary schools and secondary schools. The literacy rate for 7 years and above was 44.3% with the adult literacy rate 35.3%. Primary level enrolment has reached 94.7% in 2010 against MDG target of 100% by 2015. The school dropout rate has also significantly decreased. It is expected that by 2015 all primary age children will be enrolled in schools.

In the Health and Population sector, Life expectancy at birth has increased in Bangladesh from 46.2 in mid-70s to 68 years currently, which is due to improvement and availability of vaccines against diseases and affordable medicine.

The total fertility rate (TFC) has fallen from 7 live births in the mid-70s to 2.3 births per woman in 2011 as the contraceptive prevalence rate increased from 8% in the early 1970s to 40% in early 90s to 60% by 2011. The population growth rate which was of 1.42% in 2001 is down to 1.3% according to 2011 population census which is a noteworthy achievement. The male-female ratio is also quite stable at 105:100. But the problem of population growth continues.

### **3. SCIENTIFIC INNOVATION**

#### **3.1 Flood forecasting and warning**

Bangladesh recognizing the fact that the climate change would induce more severe floods, droughts, cyclones more frequently has been making all out efforts to improve its Flood Forecasting and Warning system as well as cyclone warning system. In terms of giving advance warning on floods, Bangladesh Water Development Board (BWDB) with the application of more modern techniques is frantically trying to decrease the lead time of warning from 72 hours to 24 hours for the major river floods, and at least 6 hours for the flash flood prone areas. This endeavor would come to fruition if only the upper riparian country/countries extend meaningful assistance by providing real time rainfall and river water level data of the upstream hydrometric stations on the trans boundary rivers.

Bangladesh all alone can do no further in this matter without the active support of the upper riparian countries particularly India. But inside the country efforts are underway to improve the dissemination techniques to make the warnings reach more people more early, in languages which can be easily comprehended.

#### **3.2 Drought Forecasting:**

Bangladesh has no mechanism of drought forecasting in place. Relevant research organizations are trying to evolve appropriate drought forecasting systems in the country but in this case too, the active assistance of the upper riparian countries will be an essential prerequisite.

#### **3.3 Infrastructures:**

All the communication, housing and settlement and water sector infrastructures are now being designed and implemented under the flood proofing concept so that they are not



inundated by increased flood heights. The plinth levels of dwelling houses are being raised gradually. The roads, rail-way tracks are being further raised to put them above the inundation depths. The heights of old flood protection embankments as well as sea dykes and appurtenant structures are being gradually but slowly raised. But paucity of funds is a major constraint in this respect.

All dwelling houses are going to be progressively equipped with rain water harvesting systems. More small scale water conservation undertakings are also in the offing. The relevant departments like BWDB, Roads and Railway Departments as well as the Housing sector are making sure that the designs of all their future projects cater to the changed circumstances to be forced by climate change. Some of these projects are being funded by the climate change trust fund as well as climate change resilience fund. River erosion control projects of BWDB are being designed to be more robust and effective.

In order to effectively deal with the climate change impacts BWDB's char development and settlement project would play an important role. The Estuary Development Project of this Board would not only offset the negative impacts of sea level rise but shall also help accrete more new land along the Coast in the south. 18 scientifically designed cross-dams would be undertaken at the initial stage under this project. Water Resources Planning Organization (WARPO) is going to update and revise the National Water Management Plan to face the impacts of Climate Change. BWDB has also embarked upon an ambitious program of Capital Dredging in the main rivers as well as some other important medium rivers to improve the drainage system of the country.

### **3.4 Agricultural Practices**

#### **a) Irrigation Management:**

The continued trend of more frequent and intense droughts and variations in rainfall due to climate change are having significant impacts on agriculture. So people and the relevant departments are encouraging more and more innovative techniques to facilitate round the year irrigation. Traditional practices such as pond excavation, retention of rainwater in mini pond or in 12'x12'x3' size pit at any corner of the land is providing supplemental irrigation in many places. Private and government supported shallow and deep tubewells are also facilitating irrigation with subsidy in fuel and electricity. Rubber dams are being implemented in increasing numbers in some small rivers for supplying irrigation water. Farmers are practicing moisture conservation through 'mulching' by straw, water hyacinth, rice husk, polythene etc. Some are following AWD (Alternate Wetting and Drying) method for rice cultivation. Alternative adaptation practices such as multiple cropping systems and homestead gardening etc. are also been encouraged.

#### **b) Fertilizer Management:**

Climate change is inducing change in the country's fertilizer management. Increase of atmospheric carbon dioxide reduces the nitrogen uptake by plants or crops. To cope with the situation use of USG (Urea Super Granule) in wetland rice cultivation is a popular method now. Use of organic matter or organic manure is being popularized to increase water holding capacity of the soil.

#### **c) Appropriate Crop/Variety selection:**

Cultivation of existing crops may not be possible following current cropping patterns due to the environmental changes induced by climate change. So the relevant research

organizations of the Ministry of Agricultural are innovating and evolving different rice varieties like the following,

- Drought Tolerant: For rice crops Bangladesh Rice Research Institute (BRRI) dhan 42, BRRI dhan 43 and early maturity BRRI dhan 33, BRRI dhan 39. For acute drought prone areas the variety is BINA dhan-7. The newly innovated hybrid Boro paddy (dhan) BRRI Hybrid Dhan-3 with shorter life time and lower production cost is going to be released soon. Farmers are adopting some innovative practices (viz. zero tillage, priming of seeds during sowing, mulching, relay cropping, dry seeding etc.) in the drought prone areas.
- Saline Tolerant: Bangladesh Institute of Nuclear Agriculture Research (BINA) has released two salt tolerant 'Aman' rice varieties (BINA-8, BINA-9). Besides, BINA Tomato-6 will also be a salt tolerant tomato seed variety. BRRI has already released salt tolerant rice variety (Bridhan 47) for the coastal region. Farmers are adopting some innovative practices like 'Floating bed agriculture in many flood prone and salinity / tidal surge areas. Salt tolerant spices like chilli, groundnut, methi, water melon, cucumber are being encouraged to be cultivated in saline zones.
- Flood Tolerant: BRRI has released two flood tolerant varieties (BRRI dhan-51, BRRI dhan-46) can be cultivated just after the flood water recedes till mid-October. Submergence tolerant rice BR-11-sub-1 has been released. The newly innovated hybrid 'Boro' paddy-BRRI Hybrid dhan-3 with shorter lifetime and lower production cost is expected to be released very soon.

Floating vegetable cultivation on water hyacinth mass (heap) may be practiced in low lying areas which for major part of the year remain submerged.

#### **4. CAPACITY BUILDING**

The capacities of the relevant departments and agencies of the government in the Water and Agricultural sectors like, BWDB, WARPO, DAE, BARC, BRRI, BARI etc. though not enough are more or less considerable to cope with the current situations. But the capacities of these implementing agencies as well as research institutions need beefing up to cope with the upcoming critical situations to be induced by the climate change. The Government of Bangladesh (GoB) is well aware of the impending situation due to climate change. The GoB has already formulated its policies, strategies and action plans to cope with the climate change impacts. The government responses at this juncture are quite adequate with respect to public expectations. As for policy support to improve the capacities of the water sector institutions dealing with water management and food security, Bangladesh is a front-runner on this issue. The relevant agencies and institutions in the country mostly have their own training institutions and many of them have linkages with the Universities in areas like Dhaka, Mymensing, Chittagong, Khulna etc. The capacities of such institutions are no doubt required to be further upgraded and strengthened. Bangladesh has linkages with some global climate change networks-but unfortunately do not get the most vitally required data and information that are essential for meaningful flood and drought forecasting as well as cyclone warnings. Bangladesh is a participant to some regional and global programs relating to climate change. The extent of training programs at that level are however inadequate. More than training, Bangladesh needs meaningful cooperation from the global or more specifically from the adjoining South-Asian countries in the field of exchange of real time data on water situations like floods, drought, cyclones etc. Regional collaboration among co-basin countries of the Ganges and the Brahmaputra like China, India, Nepal, Bhutan and

Bangladesh for basin-wide Integrated Water Resources Management (IWRM) of the International rivers for mutual benefit of all is the pressing demand at this time for the welfare of millions of people.

**With respect to capacity building** of the different institutions and communities inside the country the following items may be highlighted,

- Integrated Water Resources Management (IWRM) to improve the productivity of water, dry season water supply augmentation, salinity control, flood management, river erosion control, drainage improvement etc.
- There is a need to launch a vigorous campaign to intensify mass awareness to resist illegal occupations of river banks, river beds, drainage channels/paths etc and illegal interventions over the water flows.
- Better maintenance of the existing water sector infrastructures like flood embankments, sea dykes, drainage channels, and appurtenant hydraulic structures like sluices, regulators etc.
- Effective water conservation measures for more efficient rainwater harvesting.
- Physical Modeling Capabilities of the River Research Institute (RRI) of BWDB.
- Close monitoring of Ground water resources in terms of both quality and quantity including the issue of sea level fluctuations.
- Measures and Techniques to reduce wastage of water during different uses.
- Improvement of collection and dissemination of weather-related information by improving weather station net works to strengthen monitoring of extreme events and their impacts on food production and availability.
- Restoration of wetland and increasing water storage capacity and connectivity of river system.
- Disaster and Climate Risk Management in Agricultural sector including network strengthening; strengthening Farmers Field Schools, facilitate DRR and CCA issues coordination and management, adaptation to disaster and climate change risk reduction option.
- Sharing information on management of climate change and related science, data, tools and methodologies with regional and global networks.
- Establishment of Drought monitoring and management centers including formulation of Drought forecasting methodologies.
- Development of meteorological services for determining suitable sowing dates for local crops and also altering the timing of planting dates to adapt in changing growing conditions.
- Information and knowledge Management including development of reference data base system.
- Disaster management, Emergency Relief and Social Safety Net measures.

## **5. ECONOMICS OF ADAPTATION TO CLIMATE CHANGE IN BANGLADESH**

A study on the Economics of Adaptation to climate change in Bangladesh was conducted by the World Bank together with UK, Netherlands and Switzerland in 2009-2010.

The study mentions that investments in the past 50 years have increased the resilience of Bangladesh to climate induced hazards, particularly in the disaster management and agriculture sectors. Despite the resilience, climate related disasters continue to bring large economic losses, which reduce economic growth and slows the progress in poverty reduction.

The government has undertaken the implementation of 62 projects of different categories and dimensions with funds from the Bangladesh Climate Change Trust Fund (BCCTF). These projects concern Food security, Social protection and Health, Disaster management, Infrastructures, Research and Knowledge management etc. to be funded from BCCTF which has only US\$300 million as of now. This is too meager a fund considering the massive needs.

The World Bank (WB) study mentioned before concludes by putting emphasis on sequencing adaptation action as a necessity in the face of uncertainties, addressing current climate related risks, research and knowledge building for improving future actions, sound development policies for an adaptation agenda, adjustment of design standards for resilient infrastructures, development of climate resilient cultivars and cropping, and strengthening regional cooperation for management of the water resources of the Ganges, Brahmaputra and Meghna basins amongst other things.

## **6. GAPS AND CONSTRAINTS**

Bangladesh has no responsibility at all to climate change, but it is one of the most vulnerable countries, being at the forefront of threats of increasing sea level rise, salinity ingress, storm surges, cyclones, floods, loss of habitat, destabilization of agriculture etc. Without international support for countering the effects of climate change, largely through adaptation actions, Bangladesh is not in a position to fight it alone. Regional support in terms of co-operative basin wide management of the international river water resources traversing through this country is totally absent. Despite utmost efforts for last several decades by Bangladesh for such cooperation, virtually nothing has materialized. The cooperation amongst the South-Asian regional countries for preparation and dissemination of meaningful flood and drought forecasting in the Ganges, Brahmaputra, Meghna river basin areas to save the life and living of millions of downtrodden people still remains a far cry. All efforts of Bangladesh to conclude long-term water sharing treaties on all 54 common/transboundary rivers with India over the decades are going in vain. This is the gaping and glaring gap.

As for constraints, the absence of communication network amongst the South-Asian countries for free flow of all types of climate change related data and paucity of adequate funds minimally required to implement the adaptation measures are the two major constraints amongst many others. Bangladesh is seeking to combat climate change impact with its own meager resources to the feasible extent. But the funds this country can afford for this purpose are too little compared to the huge needs. Bangladesh, therefore, has been reiterating that all financial support from the global community provided for climate change management activities must be new and additional to the official Development Assistance (ODA). It must be over and above the normal ODA for Bangladesh. Least Developed countries including Bangladesh are now facing a scenario of declining ODA. This scenario needs to change and the developed countries should abide by their own commitment to sustainable and equitable development world-wide.

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