Rio Project

GOOD PRACTICES AND INNOVATIONS IN IMPLEMENTING RIO CONVENTIONS IN BANGLADESH

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FOREWORD

The three Rio Conventions on biodiversity, climate change and desertification and land degradation contribute to the sustainable development goals. Each instrument is intrinsically linked, and is operating in the same ecosystems and addressing interdependent issues of environment at global and national levels. Bangladesh signed and ratified the Rio Conventions during 1992-1996. The commitments made under the Conventions for sustaining environmental growth of the country has turned into the tools of balancing environment and development.

The Good Practices and Innovations in Implementing Rio Conventions in Bangladesh has accumulated success cases of conservational approaches, collaborative management between human and nature, community-based adaptation and mitigation practices and community resilience from all corners of the country. The report identified most successful practices relating to biodiversity, climate change, desertification and land degradation accomplished over the years and collated fourteen good practices and innovations mechanisms that are closely connected to adaptation and mitigation of environmental degradations.

The good practices, compiled in this report, is therefore a compilation of innovative researches, outcomes from interventions and utilization of capacities of stakeholders involved to mainstream the UN Convention on Biological Diversity (UNCBD), UN Framework Convention on Climate Change (UNFCCC) and UN Convention to Combat Desertification (UNCCD). I am pleased to announce that the Report on Good Practices and Innovations of Rio Conventions in Bangladesh is ready for dissemination and implementation. I hope that this report will be useful for decision makers, development partners, academics and project managers as a quick reference to successes of Rio Conventions, and also to design and develop new interventions. This report is encouraged for a wider use. The report is available in the website (www.doe.gov.bd) and library of Department of Environment (DoE).

I am thankful and grateful to Global Environment Facility (GEF) and United Nations Development Programme (UNDP) for their kind support. I would thank Mr Md Ziaul Haque, Director, DoE and National Project Director, and Rio project team for a successful completion of this important document.

Dr Sultan Ahmed
Director General
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ACKNOWLEDGEMENT

The Good Practices and Innovations in Implementing Rio Conventions in Bangladesh has involved a series of consultation, workshop and selection that were undertaken by the National Capacity Development for Implementing Rio Conventions through Environmental Governance Project. The project is being implemented by the Department of Environment (DoE), Ministry of Environment, Forest and Climate Change (MoEFCC). Numbers of key government officials, national experts and project focal were involved in preparing this important document. At the outset, I would like to express my gratitude to the Secretary, MOEFCC, Mr. Abdullah Al Mohsin Chowdhury for his effective leadership. My thankfulness is also due to Mr. Md. Raisul Alam Mondal, Secretary, Ministry of Fisheries and Livestock for his wise guidance in preparing the enriched report.

I would like to convey my sincere gratitude to Dr. Sultan Ahmed, Director General, DoE for his guidance and support in the early and middle stages of preparation. My deep sense of appreciation to the former Additional Secretary of Ministry of Public Administration, Mr. Aftab Uddin Khan for his valuable contributions in identifying and selecting the good practices and innovations in Bangladesh. I must also thank the Global Environmental Facility and the United Nations Development Programme, Bangladesh for their financial and technical assistance.

Finally, I would like to gratefully acknowledge the contributions of all Conveners and Members of Project Steering Committee, Project Implementation Committee, Technical Expert Group for providing guidance and suggestions in preparing the final version of the Good Practices and Innovations in Implementing Rio Conventions in Bangladesh. My gratefulness extends to the National Consultants and Rio project team for relentless efforts in documenting and finalizing the publication.

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CONTENT

1 BACKGROUND

'National Capacity Development for Implementing Rio Conventions through Environmental Governance Project (Rio Project)' is being implemented by Department of Environment (DoE), in collaboration with UNDP and GEF with a view to strengthen the capacities of the Government of Bangladesh to implementing and comply with the obligations of Rio Conventions effectively, as to the Parties of these Conventions. The Rio Convention includes the UN Convention on Biological Diversity (UNCBD), the UN Framework Convention on Climate Change (UNFCCC) and the UN Convention to Combat Desertification (UNCCD).

Based on the results and experiences of a set of 'Learning by Doing' activities, this emphasizes a long-term approach to institutionalize capacities in fulfilling Rio Conventions obligations while integrating Rio Convention into the country's national development framework. Specifically, the main purpose of the Rio Project is to strengthen institutional and technical capacities and skills for implementation of the Rio Conventions, which would also enhance Bangladesh's human resource capacity by working with the leading national training institutions.

The document, prepared under this project, identifies the 'Good Practices and innovations' implemented in Bangladesh related to the Biological Diversity, Land Degradation, and Desertification and Climate Change. To identify the good practices, this report reviewed previous practices, measures, and innovation initiated and implemented by local communities, public agencies and development partners with an ultimate objective of providing some policy guidance for mainstreaming those practices to the country's national development framework. The key expected outcome is to present good practices and innovative approaches of Rio Conventions at the national level aiming to replicate, sustain and mainstream into national development policies, programmes and activities. Adoption of good practices will reduce both time and cost of project implementation and research. The case-specific success stories will also be used as supporting documents of the training materials.

Besides, this document provides some evidence-based success cases for implementing the Rio Conventions in Bangladesh that extends the scope of replication given in a similar setting at the local level.

2 METHODOLOGY

A methodology was adopted in the process of accessing good practices. This included a review of accomplished project reports, case studies and relevant literature, key informant interviews, and expert consultations. In the beginning, a conceptual framework for selection of the good practices was presented in a National Consultation Workshop on Rio Conventions. Having feedback from the workshops the team went through a process of Key Informant Interviews (KII) with renowned experts.

While assessing good practices on biodiversity conservation, climate change and land degradation, the guideline of World Overview of Conservation Approaches and Technologies and UNCBD Good Practice Guidelines have been closely reviewed. In identifying the good practices in Sustainable Land Management (SLM) three major criteria are also considered, namely land productivity, livelihoods, and ecosystem. Based on the above criteria, inherent potentials of the practice or intervention for recovery, restoration, and sustainability of biodiversity were actively considered.

Through guidelines review and expert's consultation, four (04) key criteria e.g. scalability, replicability, adaptability, and sustainability are considered for identifying/selecting good practices on UNCBD, UNCCD and UNFCCC projects/ programmes in Bangladesh:

- Scalability: in most of the cases it should have the inherent potentiality to scale up.
- Replicable: in other contexts, or geographical area so that it can reach more people over time.
- Adaptability: to local needs, existing policies, and local institutions, so that any organization can pick up the concept and fabricate it to the local conditions since the concept of replication will work if it is accepted by local communities.
- Sustainability: in the end, the good practice should undeniably meet the "sustainability" criteria of i.e. environmental friendliness, economic and financially viable, technical appropriateness, social and cultural acceptance and building of viable institutions.

A total of 27 good practices have initially been identified considering productivity, livelihoods and ecosystem (Annex I). These practices have also been screened through the lens of scalability, replicability, adaptability and sustainability. Finally, 14 Good Practices and innovations reflecting successful implementations of UNCBD, UNFCCC, and UNCCD in Bangladesh have been selected, which are presented below.

Selected Good Practices and Innovations	Links to the Rio Conventions
1. Co-management of the Protected Areas 2. Innovative Village Common Forests Management 3. Community Based Eco-System Restoration 4. Community Based Swamp Forest Restoration Initiative 5. Community Based Fish Sanctuary	United Nations Convention on Biological Diversity **(UNCBD)**
1. Climate Resilient Agriculture and Food Security: The Role of Floating Agriculture 2. Community based Afforestation and Reforestation 3. Community Based Ecosystem Conservation and Adaptation in Ecologically Critical Areas of Bangladesh 4. Adaptation Technology: Saline Tolerant Rice Varieties 5. Irrigation and Renewable Energy Development: Solar Powered Pumps	United Nations Framework Convention on Climate Change **(UNFCCC)**
1. Mulching to Address Soil Degradation 2. Drip Irrigation for Efficient Water Use 3. Rain Water Harvesting for Natural Resources 4. Composting for Soil Health	United Nations Convention to Combat Desertification **(UNCCD)**

3 GOOD PRACTICES AND INNOVATIONS

United Nations Convention on Biological Diversity (UNCBD): Good Practices and Innovations within Bangladesh Perspective

This chapter gives a systematic account of the selected good practices on the conservation of biological diversities that are resulted from successfully implemented projects in Bangladesh. 08 good practices and innovations have initially been identified considering productivity, livelihoods and ecosystem. Table 1 summarizes justification for selecting five practices considering selection criteria and UNCBD obligations.

Table 1: Selection Criteria of Good Practices and Innovations relating to UNCBD

Good Practice	Scalability	Replicability	Adaptability	Sustainability	Links with CBD Obligations
Co-management of Protected Areas (PAs)	Adopted community managed ecosystem approach taking forest resource users and co-management committee with multiple stakeholders into consideration. To reduce pressure on the biodiversity it has taken into consideration of alternative livelihood options and management ownership by local stakeholders.	Initiated in 2003 in five pilot forest protected areas now extended into 18 PAs. It has got the legal status in Bangladesh Wildlife Preservation Act 2012	Involvement of resource users in decision making, provision of endowment fund and capacity for alternative livelihood had made the system locally adaptable	Along with environmental management it has become viable through local level co-management governance, alternative livelihood options and value chain development of local products are positive trend towards sustainability	Serves the CBD objectives on conservation of biodiversity and sustainable use of its components. Meets directly the demands of the CBD Articles 8- 11. Covers Thematic Areas: Forest Biodiversity; and Cross-cutting Issues on: Tourism and Biodiversity, and Ecosystem Approach

Table 1: Selection Criteria of Good Practices and Innovations relating to UNCBD

Good Practice	Scalability	Replicability	Adaptability	Sustainability	Links with CBD Obligations
Innovative Village Common Forests (VCFs) Management in the CHTs	A traditional practice in the CHT, as it is managed by communities through traditional rules. Restoration of ecosystem through enrichment plantation and management of mini watersheds have made it innovative. Provision of endowment fund for alternative livelihood and creation of drinking water source through restoration of mini watersheds are inherent potentials of the system	VCFs do not exist in all villages in the CHT. Innovative management will help in extending it to most of the villages.	It is compatible to the CHT situation. Provision of endowment fund and capacity development for alternative livelihood had made the system locally more adaptable and adoptable.	Capitalization traditional social institution and provision of alternative livelihood are strong pillars of sustainability of the practice.	Serves the CBD objectives on conservation of biodiversity and sustainable use its components. Meets directly the demands of the CBD Articles 8-11, especially 8(j). Covers Thematic Areas: Forest Biodiversity, Mountain Biodiversity; and Cross-cutting Issues on: Tourism and Biodiversity, and Biological and Cultural Diversity
Community Based Ecosystem Restoration in CHTs	In community-based resource management approach community is involved in the decision making and management process. Community based, adoption of ecosystem approach, provision of endowment fund for alternative livelihood are inherent potentials of the practice.	In addition to initial target Arannayk Foundation had to extend in five more villages being requested by Chairman, Regional Hill Council. USF land in the CHT can be afforested by this practice.	Similar ecological conditions and social structures in the CHT have made it compatible throughout the region. Provision of endowment fund and alternative livelihood, easy access to drinking water have made the practice adaptable across the CHT.	Capitalization of traditional social institution and provision of alternative livelihood are strong pillars of sustainability of the practice.	Serves the CBD objectives on conservation of biodiversity and sustainable use its components. Meets directly the demands of the CBD Articles 8- 11 covers Thematic Areas: Forest Biodiversity, Mountain Biodiversity; and Cross-cutting Issues on: Climate Change and Biodiversity

Table 1: Selection Criteria of Good Practices and Innovations relating to UNCBD

Good Practice	Scalability	Replicability	Adaptability	Sustainability	Links with CBD Obligations
Community Based Swamp Forest Restoration Initiative in Sunamganj District	Community based management, adoption of ecosystem approach where community is involved in decision making and management process, provision of endowment fund for alternative livelihood are potentials to replicate the practice.	The programme was started in 2009. Based on successful outcome of the first initiative in two areas, the program has been extended to four other areas of the District in 2014.	Similar ecological situations, involvement of local communities, provisions for alternative income generation activities have made the practice adaptable in similar socio-ecological conditions.	Management of degraded swamp forests by community-based organizations (CBOs), capacity development of the CBOs in developing their management plans and alternative livelihood support are the major pillars of sustainability of this intervention.	Serves the CBD objectives on conservation of biodiversity and sustainable use its components. Meets directly the demands of the CBD Articles 8- 11 covers Thematic Areas: Forest Biodiversity, and Inland Waters Biodiversity; and Cross-cutting Issues on: Climate Change and Biodiversity
Community Based Fish Sanctuary	Participation of resource users and develop their sense of ownership on the resources of aquatic eco-systems (e.g. water bodies) establishes an effective management approach; and all the people who depend for their livelihoods (income and food) on those systems are inherent force of scaling up the practice.	Since 1960 fish sanctuaries have been established in Bangladesh. Under CBFM-2 project during 2001 – 2006 total 157 sanctuaries were established. Presently a total of 534 fish sanctuaries are reported to exist in Bangladesh (DoF Annual Report, 2015).	Involvement of resource users through formation of CBOs, provision for alternative livelihood for fishers during the period of ban on fishing, setting of rules and limits on the use made the practice adaptable to similar social and ecological conditions.	Fish diversity, restoration of some declining species, fish yield, fish consumption increased through establishing fish sanctuaries. Formation of CBOs has empowered the poor and community people in resource management. These are good indicator of sustainability of the practice.	Serves the CBD objectives on conservation of biodiversity and sustainable use its components. Meets directly the demands of the CBD Articles 8- 11 covers Thematic Area: Inland Waters Biodiversity; and Cross-cutting Issues on: Climate Change and Biodiversity.

GOOD PRACTICE 1:
CO-MANAGEMENT OF THE PROTECTED AREAS (PAs)

Background

Protected Area (PA) in Bangladesh is declared within the reserve forests under the provision of Bangladesh Wild Life (Preservation) Act, 1974 and since 2012 under the provision of the Wildlife (Conservation & Security) Act 2012, to enhance and ensure protection under different qualification (Wildlife Sanctuary, National Park, Eco-park, Botanical Garden and Safari Park).

Co-management concept emerges during the late 20th century and is in practice with a degree of success in the forest management of the Asia and the Pacific region. Community engagement and collaboration in forest resource management are increasing throughout the world (Petheram, et. al, 2004). Co-management of the Protected Areas has been increasingly acknowledged globally (Borrini-Feyerabend et al., 2004); and in Southeast Asia (Erdman et al., 2004).

Participation of the community in forest management in Bangladesh has been initiated in the early 1980s. Gradual development during the last couple of decades shaping up the Co-management for the Protected Areas. The national biodiversity strategy and action plan have included Co-management of Protected Areas in Bangladesh (GoB, 2005). The Wildlife (Conservation and Security) Act, 2012 has provisioned community participation in Protected Area management. During mid-1990s Bangladesh Forestry Sector Master Plan (1995-2015) suggested Co-management of the Protected Areas. Co-management for forest ecosystem in Bangladesh has been initiated by the Nishorgo Support Project (NSP 2003-2008) in five pilot forest protected areas (i.e., Lawachara National Park, Satchari National Park, Rema-Kalenga Wildlife Sanctuary, Chunati Wildlife Sanctuary and Teknaf Wildlife Sanctuary) through an initiative called Nishorgo Support Project (NSP), with active support from the USAID. USAID continued support to the Co-management of the protected Areas through the Integrated Protected Area Co-management (2008-2013) and Climate-Resilient Ecosystems and Livelihoods (2012-2018) project.

Key Features

The Co-management is a governance structure engaging government, non-government, local people, commercial entity and other stakeholders; to share the responsibilities, benefits and decision-making powers; enhance the capacity of local people, equity, the efficiency of decision-making and improve resource management outcomes (Carlsson and Berkes, 2005). Coexistence of the community with nature, not protectionism and community lead conservation with support from the government best characterizes the community-based conservation (Western & Wright 1994). Skilled management of Protected Area (National

Park) addresses integrated conservation in the wider landscape; merging local and scientific knowledge increasingly serving local needs and concerns (Hoole, 2008). Sustainable Protected Area management requires appropriate institutional arrangements and legal support (Thomas and Middleton, 2003).

Co-management involves sharing responsibilities between key stakeholders - resource users and government, and commonly involves devolving a greater share of management responsibilities from government to empower local communities. This management approach makes resource users as the 'custodian' to the resources while providing more scope to the community people in the process of governing the resources. Such an approach limits the role of government agencies from their authoritative governance mechanism to democratic governance mechanism. This is just not sharing of responsibilities but reshaping/ restructuring of governing public commons.

Major Interventions and Accomplishments

Co-management received the support of the local people in Bangladesh; enhanced biodiversity conservation and ecosystem services of the Protected Area (Mukul, et al., 2015). The Government has notified Co-management approach for managing Protected Areas through a gazette that guides the formation of Committees (Ahmad, Sharma and Merrill, 2011). Nishorgo (2003-2008) and IPAC (2008-2013) projects have developed a consistent approach over a longer period for sustainable natural resources management. These projects formed Co-management Council and Committees for several PAs engaging stakeholders and successfully influenced government to issue gazette (FD 2015). Climate Resilient Ecosystem and Livelihoods (CREL 2012-2018) project has worked for Co-management Organizations to strengthen their capacity. This project advocated and facilitated MoEF&CC to support the Co-management Organizations with the legislative framework. Consequently, the Forest Protected Area Co-Management Organizations has been instituted by the legal basis of the Protected Area Management Rules, 2017.

Co-management principles have been defined and implementation guidelines have been outlined in the Protected Area Management Rules, 2017. The Rules provide structure, formation, the scope of work, responsibilities, and duties of the Co-management Committee (CMC). Directives are there in the Rules to engage women, ethnic communities, and the forest resources dependent people in managing Protected Area. Out of 39 Protected Area declared till 2017, a total 21 Protected Area has so far come under Co-management Committees (CMC). The capacity of these Co-management Committees has been increasing, they are able to carry out the organizational activities like conducting meetings, keeping records, communicating with the relevant offices and stakeholders; however, not yet fully capacitate to reform the committee by themselves. The voices of the poor are raised, however not profound yet to influence the management decisions. The PA Rules, 2017 provided directives to make CMC president from the resource-dependent people. The PA Rules also provisioned revenue sharing with the community.

Forest department through development projects during the last couple of decades provided local communities access to different alternative income generating options and livelihood support to reduce pressure on adjacent forest Protected Areas. Support include but not limited to training and microcredit for nursery raising, poultry, and cattle rearing, small enterprise development, training for ecotourism guide, buffer zone management, improved cooking stove for domestic use, etc. In certain cases, local community members were also engaged in forest patrolling. These initiatives, although very limited in terms of support and beneficiaries, substantially reduce the local dependency on forests and illegal forest activities like illegal logging. Ecosystem approach has been adopted taking forest resource users into consideration.

Gainful partnership with community and multi-stakeholder engagement successfully regenerated denuded reserve forests (Ali, Uddin, and Chowdhury, 2015). Forest resource-dependent communities and Forest Department in Bangladesh are practicing Co-management and Social Forestry which reveals its efficacy in the protection of dwindling forest resources (Ali, Uddin, and Chowdhury, 2015). Uddin and Alam (2015), in "An Ecological and Economic Analysis of Different Forest Management Institutions in Bangladesh" compared attributes of forest health of traditionally managed forests and co-managed forests. More tree species and significantly higher basal area of larger size in Co-managed forests compared to traditionally managed reserve indicate higher disturbances in traditionally managed forests and domination of more mature forest in Co-managed forests (Uddin and Alam, 2015).

Alignment to CBD Obligations

This practice serves the CBD objectives on the conservation of biodiversity and sustainable use of its components. It meets directly the demands of the CBD Articles 8- 11 and covers Thematic Areas: Forest Biodiversity; and Cross-cutting Issues on Tourism and Biodiversity and Ecosystem Approach.

Limitations

Scholars raised few drawbacks of Co-management like vagueness and rigidity, the sluggish pace of engaging communities, and one-sided authority and dubious forest conservation acceptance by local people. The people of Bangladesh lack awareness on forestry practices and approaches, forestry linkage with economic efficiency, income growth and protection of the environment; limits our forestry achievement far behind international standard (Jalil, 2011). Farmers involvement in forestry provided only limited livelihoods (Kibria, et al., 2013). Resource-dependent communities yet to develop a sense of belongingness with government attitude (Ahammad, et al. 2014). Historically, people were conservation oriented. However, since the British regime took over forest excluding people, community believed the government owned the forest, therefore it is the government's responsibility to raise and conserve the forest. The people were tempted to use forest resources as and when to get the opportunity. The Forest Department maintained the exclusionary policy until 1990. Nonetheless, initiated Social Forestry during the early 1980s.

The complex institutional structure of the Co-management Organizations and limited mainstreaming of the approach into the Forest Department, political influence, uncertain financial flows, and dependency on the project remain challenges of Co-management in Bangladesh. The Co-management as it is practiced in Bangladesh offers only limited benefit to the community; not sustainable due to project orientation though enhances conservation and forest cover (Koli, 2010). The Forest Officials create beneficiary groups and engage them for forest and forest land protection, however, do not ensure their benefits (Khan, 1998). Lack of effective engagement of the community, the rural development potential of forest management is not realized (FAO, 2005).

Support from the Forest Department for Co-management is not unanimous; local power structure is complex, and the motivation of the local communities varies (IPAC, 2012). The aspiration of the Officers of the Forest Department on Co-management is mixed; some of them understand, support and promote while some others perceive wrongly and again some others are against Co-management approach. Powerful actors influence decisions to suit their interest.

Concluding Remarks

Protected Areas are to be managed properly with active community participation and benefit sharing to realize potentials (Borrini-Feyerabend, 2004). In the Bangladesh context, serious challenges remain due to high population and complex socio-political dynamics (Hassan, 2013). However, poor resource users are gradually gaining competence and raising voice; supported for alternate income generation, resulted in limited success in reducing illegal logging and hunting. Co-management has been initiated to some of the Protected Area, which is essentially natural forests. However, since forest resources have already been depleted, co-management is not providing desired dividends.

The Protected Area Management Rules 2017 confirmed sharing of revenue with the Co-management Committee. However financial flow will have to be operationalized. Investments will be necessary to generate revenue through nature responsible tourism in many Protected Areas. Koli (2010) argued, the orientation of the co-management in Bangladesh enhances conservation and forest cover; however, are not sustainable and limited livelihood options and political space are insufficient to significantly reduce forest resources dependence. The Co-management approach may become successful overcoming weaknesses and threats ensuring community participation including women and landless; promoting tourism capitalizing indigenous culture and integrating poverty mitigation tactic, confirming answerability and clearness, and decentralization of management; (Tamima, 2015).

GOOD PRACTICE 2:
INNOVATIVE VILLAGE COMMON FORESTS (VCFs) MANAGEMENT IN THE CHITTAGONG HILL TRACTS (CHT)

Background

Village Common Forests (VCFs) are common property resources of the villages in the CHTs. These are called Community Conserved Areas. VCFs are generally small, averaging from 20 to 120 ha in size and consisting of naturally grown or regenerated vegetation. It is an innovative practice as it is common resource management by the community through traditional community rules, but not common in all community villages. The VCFs play an important role in conserving forest resources and are usually very rich in biodiversity, harboring rare plant and animal species that are not usually found in state-owned reserves or unclassified forests due to continued deforestation and land degradation. The VCF system is still in use; in many cases, VCF is the only remaining natural forests in the surrounding areas. VCFs are owned and managed by the communities through hereditary practiced community norms and customs. Generally, the villagers cannot individually extract any timber from this natural forest. Non-wood products can be harvested by community members.

A recent study on the plant diversity of Ampu Para Village Common Forest (VCF), managed by the Murang Community at Bandarban Hill District, Bangladesh, recorded 148 plant species belonging to 128 genera under 61 families (Basak et. al, 2014)

Key Features

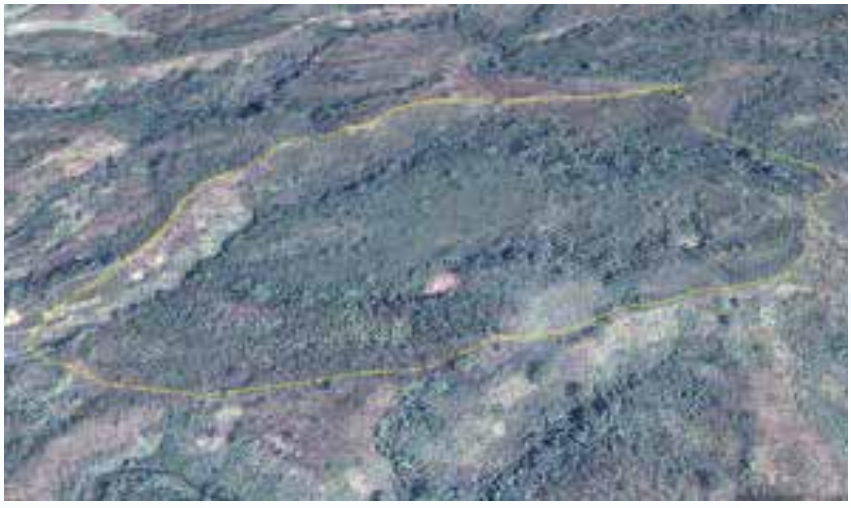
Village common forest is community managed forest management practiced in the hill tract districts. VCF management follows norms and practices for harvesting forest resources in a sustainable way that, in turn, ensures the protection of biodiversity and natural environments of the community forest areas. Indigenous communities are the key protectors of these rich bio-cultural systems that have survived many centuries as a model of sustainable human-forest interaction. The communities have established their own rules and norm on forest resource use. Generally, the villagers cannot individually extract any timber from this natural forest. The community will extract timber and /or bamboo for community use, such as the construction of a school, pagoda, and church. Member of the village only can harvest timber/ bamboo for private use only with prior permission of the community. Non-wood products can be harvested by community members. Generally, a management committee headed by the village head (karbari) manages VCFs. The common perception of the community is that they will protect and preserve their common forests as they remain in the village. Participation is spontaneous and there is the near-universal observance of VCF rules. VCF vegetation protects the surrounded mini watershed and ensures water supply in the streams.

Habitat degradation in the surrounding ecosystems, the increase of pressure on resources from increased population and lack of formal recognition of VCFs are causing degradation and shrinkage of VCFs in many parts of the CHTs.

Major Interventions and Accomplishments

Considering traditional conservation management of natural resources, the Arannayk Foundation in 2009 undertook an initiative to contribute to the conservation of the VCFs. It undertook three projects involving three partner NGOs to deal with seven degraded or threatened VCFs – three in the Chimbuk Range of Bandarban district namely Kaprupara VCF (81 ha), Korangpara VCF (24 ha) and Empupara VCF (24 ha) involving Humanitarian Foundation and another three VCFs in Rowangchari Upazila of Bandarban namely Tulachari Para VCF (101 ha), Rowangchari Sadar Para VCF (24 ha) and Roninin Para VCF (101 ha) involving Tahzingdong and the Itchari VCF (42 ha) in Khagrachari Sadar Upazila of Khagrachari district involving BIRAM. In 2011, Arannayk Foundation launched another project for the conservation of the Komolchari VCF (127 ha) in Khagrachari Sadar Upazila of Khagrachari involving Proshika as its implementing partner. Interventions of the project activities included awareness raising of the VCF communities; participatory assessment of forest conditions and establishment of a management plan for each VCF; restoration of forest cover and biodiversity in the deforested and degraded areas of the VCFs through reforestation and enrichment planting; strengthening management capacities of the VCF management committees; and alternative livelihood development of the VCF community members (jhum farmers).

Fruit tree seedlings/grafts were also planted in the homestead to ensure nutritional security of the households as well as to prevent soil erosion. To reduce their fuelwood demand improved cooking stoves were provided. In addition, 20 home solar systems were set for the families having school going children. As a result, 50% of household-based biomass and the resulting CO2 have been reduced in the villages and improved the women health condition as the improved cooking stoves emit less smoke.

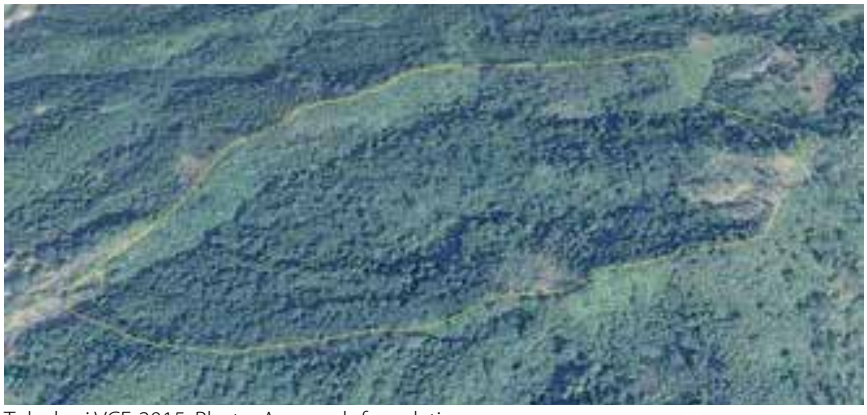


Tulachari VCF, 2010, Photo: Arannyoh foundation

Arannayk Foundation encouraged the VCF communities to undertake participatory savings scheme and provided complementary grants to help them for alternative income generation activities. Partner NGOs organized various AIGA skills development training for the VCF members considering the feasibility and profitability of the AIGAs and interests of the VCF members. The major intervention of the project was to reduce their forest dependence through building capacity for alternative livelihoods such as agriculture, livestock, small-scale business, and nursery. It was found that within six years, they could increase their income by about 40% which helped to reduce their dependence on forests by about 48%. The interventions worked extremely well. VCF established a management plan for their VCF; planted native trees species in the denuded and degraded areas of the VCF including bamboos at the foothills; strengthened monitoring and protection measures; and established a revolving loan fund. As a result, the health of the forests (vegetation cover, biodiversity, the growth of trees and bamboos) improved and flow of water in the springs and canals in the village during the dry season increased significantly. The forest-dependent households adopted various alternative income generating activities and many of them converted their shifting cultivation plots to fruit orchards or multi-story agroforestry gardens.

With financial support from the AF, the Tulachari VCF community in Bandarban district established a Gravitational Flow System (GFS) of water collection from the VCF that brought water to their doorstep and reduced drudgery of women for water collection. The GFS involves the collection of water by constructing a check dam in an up-hill position in the forest and channeling the water to a reservoir in the village through the pipeline using the natural force of gravity. Water from the reservoir is dispensed either directly through taps installed with it or to the households through the pipeline using gravitational force. The community has realized the importance of the natural forest and its relationship with fresh water. They reforested the degraded areas of their VCF through enrichment planting, using local tree species. As a result, the degraded Tulachari forest has now regained a healthier condition. The community members now look after the VCF including proper management of the GFS.

For the above-mentioned work in Tulachari Energy Globe World Award, 2016 was given to Tahzingdong in the Earth Category.



Tulachari VCF, 2015, Photo: Arannyoh foundation

Alignment to CBD Obligations

This practice serves the CBD objectives on the conservation of biodiversity and sustainable use of its components. It meets directly the demands of the CBD Articles 8- 11, especially 8(j), and covers Thematic Areas: Forest and Mountain Biodiversity; and Cross-cutting Issues on Tourism and Biodiversity, and Ecosystem Approach, and Biological and Cultural Diversity.

Limitations

VCFs are limited in size and areas. Increasing population in the villages are exerting pressure on common land for developing homesteads and other land use as well as on the forest resources. There is no legal entitlement of VCF lands. VCFs are not recognized as conservation sites. Endogenous development initiatives by the local government like union council may give rise of power conflicts between representatives of the traditional institute and local government institute leaders/ representatives.

Concluding Remarks

VCFs should be recognized as conservation sites and be given legal status. There are about 4,800 villages/paras in the CHTs where there are scopes for development of VCFs. The Village Common Forests in the CHT should be supported and extended to all recorded Village Common Forests; Agro-forestry shall be promoted into the denuded CHT hills through groups under a Karbari; they should follow the management plan like schedules of trees recommended for the slope, hilltop or valley must be followed; government should support the community for development of the agroforestry, provide support for livelihood till the Agro-forestry starts providing outputs (Ahmed, 2017; Personal Communication). Promote eco-tourism in the VCF villages. VCFs network could be developed under the auspices of Regional and Hill District Councils. These practices should be incorporated into the training curricula of public training institutions and trainee should be encouraged to visit such places. Organize the awareness campaign to encourage people to get involved in the protection and conservation of forests including mini-watersheds.

GOOD PRACTICE 3:
COMMUNITY BASED ECO-SYSTEM RESTORATION IN THE CHITTAGONG HILL TRACTS (CHT)

Background

Chittagong Hill Tracts (CHT) accounts for 10% of the total area of Bangladesh. Around 75% of the total area of CHT is hilly and was once covered with dense forests but now most of it is denuded or degraded due to overexploitation and unsustainable management. Except for 25% area under reserved forests, most of the remaining forest lands are classified as Un-Classed State Forests (USF), which is usually controlled and governed by the of civil administration The USF is particularly highly degraded due to several reasons. These areas in the CHTs have plantation potentials and can be revitalized through conservation and restoration of existing degraded forest ecosystems and enrichment plantations involving communities. In this backdrop, Arannyak Foundation in partnership with non-government organization called Anando, implemented a community-based ecosystem restoration project titled 'Restoration of Hilly Biodiversity through Community-based Bio-resource Management for restoration of hilly biodiversity' in six villages (Voirafa Bridge Para, and GonaPara of Merung Union and Jorabridge, Tarabunia, Shoknachara, Kangerimachara and Rashamonikarbari para of Kobakhali Union) under Dighinala Upazila of Khagrachari District during 2009 – 2014 to develop effective strategies for community based conservation of the USF.

Key Features

The project in Dighinala titled "Restoration of Hilly Biodiversity through Community Based Bio-Resource Management at Dighinala, Khagrachari" started piloting in two villages in Merung Union, where 35 indigenous households were living since 1997 being rehabilitated there by the CHT Development Board after the CHT Peace Accord. Each household had 2.25 acres (0.91 ha) of hilly land, received under the resettlement project, which became denuded and fertility-degraded due to repeated jhum (slash and burn) cultivation with a very short fallow period. Arannayk's partner NGO Aanando trained and guided the project participants to bring their homesteads, fallow hills and stream banks underproductive and sustainable use using well defined land-use models for specific site conditions.

Timber trees such Champa (Michelia champaca), Chapalish (Artocarpus chama), Garjan (Dipterocarpus turbinatus) and Bahera (Terminslia bellerica) were planted on the upper part of the hill; fruit trees with thick trunks such as Mango, Litchi, Indian Olive (Elaeocarpus floribundus) and Wood-Apple (Aegle marmelos) on the middle part; short-stature fruit trees such as Orange, Lemon and Papaya intercropped with pineapple, vegetables or root crops on the gently sloped lower part of the hill and bamboo on stream banks. In the homesteads and valley lands, they established multi-tier orchards (MTO) and a model of productive living fence consisting of two lemon trees and six pineapple plants in between two Mahogany (Switenia macrophylla),

Neem (Azadirachta indica), Indian Olive, Champa or Jackfruit trees in every three meters in a row along the boundary line of the homestead. They planted papaya and different vegetables in all available spaces of their homesteads. The project involved 235 participants and brought 230 hills (about 250 ha) under reforestation and sustainable management. Multi-Tier Orchard (MTO) model of land-use had brought success in their project. This is a specialized production system (agroforestry) where trees and crops are grown together in the same parcel of land for multiple benefits such as diversified production, natural resource conservation (biodiversity, soil fertility) and other ecosystem services (shade, erosion control, carbon sequestration, etc.).

The project used 3-5 layers of trees, shrubs and herbs in an MTO depending on the location. Generally, the ground layer consists of various vegetables or pineapple, the second layer consists of orange or lemon and the third layer is with fruit trees/grafts like Litchi or Mango.

Fourth and fifth layers are with timber trees like chapalish, champa, garjan, dhakijam, amloki, haritoki, bohera etc. Stream (Chara, jhiri) banks have been planted with muli and baijja bamboo. The project also included alternative income generation activities that have enhanced household income of the project participants. To foster community initiatives for sustainable management of the natural resources and alternative livelihood development, Anando organized and developed the households into a cooperative and helped them establish a revolving loan fund by introducing a monthly savings program and providing them a small grant of BDT 245,000.

Under their savings scheme, each member started contributing BDT 100 per month and the management committee of the cooperative started giving small loans of up to BDT 10,000 at a minimal interest rate of 3% to their members for undertaking AIGAs. By June 2012, their RLF stood at BDT 575,077 due to its rapid circulation. The beneficiary households invested in cattle and pig rearing, poultry rearing, vegetable cultivation, leasing land for rice cultivation and various small businesses.

AF also undertook a similar project in Wagga, Rangamati, titled 'Community-based Conservation of Forest Resources and Enhancing Rural Livelihood in Rangamati of CHT' is being implemented by a Rangamati-based local NGO, Hill Flower. The project was initiated in June 2009 in five villages of Wagga Union, where shifting cultivation and collection of forest resources (timber, fuelwood) from the USF lands, including stones from the hill slopes and creeks, were the main occupation of 127 households (indigenous communities). The forests were highly degraded, and the streams used to become dry during January-May. Similar interventions of RFL, AIGs, and restoration initiatives were undertaken.

Major Interventions and Accomplishments

Over a period from 2009 to2015, the 235 beneficiary households of Dighinala project planted 59,245 trees in their homesteads, 113,427 trees in the hills and 27,250 bamboo seedlings on stream and river banks. The areas planted during 2009-2013 have regained vegetation cover and water flows in the streams of those areas have improved significantly. The average annual income of the households in those areas has increased from BDT 60,000 to BDT 84,000. The household's annual income is found in increasing trend due to increased production and harvests of fruits and bamboos. Re-vegetation of the denuded hills has increased water flow in the hilly springs (jhiris) and canals (Chara), It has also assured the re-occurrence of birds and other wild animals such as barking deer, wild boar, and jungle fowl.

Based on the successful outcomes of the pilot initiative in two villages, Anando extended the program to two more adjacent villages within the Union involving 100 households in 2013 and another 100 households in four villages of the adjacent Pabakhali Union in 2015. In the extended areas, AF did not give any grant to form RLF, but the groups established the Fund with their monthly savings schemes. Through training and input supports, all the 200 new households enriched their hills and homesteads with trees and other agroforestry crops.

The success of community-based forest restoration activities in Khagrachari inspired project participants at Wagga, Rangamati, who enriched biodiversity of 80 ha degraded forests through planting local endangered tree species. Appreciating the approach and outcomes of the project, the Chairman of the Regional Hill Council requested AF to expand the area of the project to at least five more adjacent villages. Accordingly, AF extended the activities of the project to five more villages of Wagga Union of Kaptai, Rangamati, from July 2015 (AF, 2016).

Alignment to CBD Obligations

This is an eco-restoration process of biodiversity conservation, which serves the CBD objectives on the conservation of biodiversity and sustainable use of its components. It meets directly the demands of the CBD Articles 8-11 and covers Thematic Areas: Forest Biodiversity, Mountain Biodiversity; and Cross-cutting Issues on Climate Change and Biodiversity, and Ecosystem Approach.

Limitations

Land tenure and land title in the Chittagong Hill Tracts are the major limitations of the project. Development initiatives by the national or local government bodies ignoring the marginal project people may develop local unrest and frustration of the community members. Greed for land by local elites and land grabbers and allotment by the government without concerning the project people are also threatening to such community based eco-restoration projects. Local government institutions like Regional Councils and Hill District Councils, Chittagong Hill Tracts Development Board seem to be least concerned with such initiatives. Lack of technical knowledge and management skills are also an important limiting factor.

Concluding Remarks

About 705,000 ha of land, mostly the USF lands, are in degraded condition. These lands could be brought under community management system to enhance forest coverage and their sustainable management. However, it requires special attention to land tenure and land zoning. Strengthening forest extension network and extending institutional support both in kind and cash will encourage people in promoting such community restoration and conservation initiatives. These practices should be incorporated into the training curricula of public training institutions and trainee should be encouraged to visit such places. Organizing awareness campaign to encourage people to get involved in the protection and conservation of forests including mini-watersheds.

GOOD PRACTICE 4:
COMMUNITY BASED SWAMP FOREST RESTORATION

Background

Freshwater swamp forests exist in haor areas of Sylhet, Moulvibazar and Sunamgonj districts. FD (2015) reports 23,000 ha under freshwater swamp forests, which is 0.16% of total land area of the country and 1.44% of the FD managed forest land. The swamp forests are locally called 'Hijol-Koroch Bagh' as Hijal (Barringtonia acutangula) and Koroch (Pongamia pinnata) are the dominant tree species of these forests. Reed swamp forest (nal-khagra bon) is adapted to lands intermediate in height between the haor basin and homestead lands (Kanda), typically on ridges out in the haors and river and stream banks. The grasses Phragmites karka (nol) and Saccharum spontaneum (khag, aisha) predominate. Haors is home of a number of bird species, both resident and migratory birds, and other wildlife fauna.

The swamp forests play a crucial role in protecting the homesteads of people from erosion caused by wave action of water, aside from their other ecosystems services such as shelter to numerous species of local and migratory birds and feed and breeding ground for fishes. But due to lack of proper management and protection measures, most of the swamp forests are in highly degraded condition. A study revealed that 63% of the swamp forests were 'Khas' lands (state-owned land under administrative control of the Deputy Commissioner of the district), 30% 'Ejmali (owned collectively by the heirs of a common ancestor), 2% individually owned private and 5% were of partly Khas and partly Ejmali lands. Most of the forests in the Khas lands are either degraded or completely deforested mainly due to inappropriate leasing system of water bodies. The leaseholders harvest fish as well as trees for maximizing profit within the leasing period and because of this, after the leasing period, one can hardly find any swamp forest in the wetland. Community's fuelwood dependency is another major cause of swamp forest degradation.

In 2009, Arannayk Foundation undertook a pilot project in two Upazilas of Sunamganj district in partnership with the Center for Natural Resource Studies (CNRS) to develop effective strategies for restoring and conserving the denuded and degraded swamp forests involving local communities. The piloting sites were Rahimapur Bagh (44 ha) in Jamalganj Upazila and Gobindapur Bagh (22 ha) in Sunamganj Sadar Upazila of Sunamganj district.

Key Features

The Rahimapaur Bagh was a khash land. CNRS mobilized the poor households of seven villages in the vicinity of this degraded forest to form community-based organizations (CBO) and, by motivating the Deputy Commissioner of Sunamganj, arranged a 10-year lease of the targeted lands in favor of them (CBOs). On the other hand, the Gobindapur Bagh was an Ejmali land and CNRS arranged a similar lease (for 10 years) of this forest from the authorized representative of the owners of the Ejmali land to a similar CBO formed at Gobindapur. With the help of Arannayk Foundation and CNRS, the CBOs developed a sustainable management plan for each forest. To develop institutional and management technical capacities of the project participants,

CNRS provided training on organizational and leadership development to the CBO leaders and training on swamp forest management to the general participants. To promote alternative income generating activities, CNRS also provided training on vegetable/homestead gardening to the CBO members.

Climate Resilient Ecosystem and Livelihoods (2012-2018) CREL, have worked with VCGs under DoE initiatives to plant and encourage regeneration of native swamp thicket-forest vegetation on khas land. CREL, DoE implemented project supported Village Conservation Groups (VCG) with livelihoods and provided training and encouraged to manage the Swamp patches in the Hakaluki Haor. The VCG members reforested with swamp species, protected and managed those patches established in Khash land.

Major Interventions and Accomplishments

By 2014, Rahimapur and Gobindapur forests were successfully restored and are being conserved by local communities. The project participants planted around 45,000 Hijal and Koroch trees in 24 hectares of degraded areas of the two forests. The forests became densely covered with trees. The project participants also planted 12,560 saplings of fruit, timber, and fuelwood yielding trees in their homesteads to reduce their dependency on the swamp forests.

Based on the success of the first initiative, Arannayk Foundation started expanding the program in four other swamp forests (with a total area of 82 hectares) – two in Biswamvarpur and two in Taherpur Upazila from April 2015 using the same approach and the same implementing partner. CNRS organized the poorest and highly forest-dependent people of the villages nearest to the selected forests into four groups. In 2015 the concerned CBOs planted around 50,600 Hijal and Koroch trees in 50 hectares in the four new sites. Results from the interventions indicate that restoration of the swamp forest ecosystem is possible involving local people.

CREL project was successful in influencing the Ministry of land and the local administration and obtained formal recognition of swamp conservation areas; in 2015 the ministry recognized 24 plots (110 ha) of land as swamp forest protection areas.

Alignment to CBD Obligations

This practice serves the CBD objectives on the conservation of biodiversity and sustainable use of its components. Meets directly the demands of the CBD Articles 8- 11 covers Thematic Areas: Forest Biodiversity, and Inland Waters Biodiversity; and Cross-cutting Issues on Climate Change and Biodiversity, and Ecosystem Approach.

Limitations

Hijal-koroch bans are considered as production and protection units in haors, but their conservation perspectives are not recognized in policy documents. CBOs are officially not recognized as legal institutions. Moreover, socio-political conflicts among local elites and CBO members is a major limiting factor. Prior to restoration programme through CBOs, the local elites used to enjoy lease for Khas swamp forests for decades. They used to enjoy both fish resources and benefits from the trees. This community programme has made control over their easy access to these resources, which the elites do not like. Another limitation is the continuity of leasing of Izmali swamp forest as heirs of owners may change their views in future.

Concluding Remarks

These forest thickets should be recognized officially as priority conservation areas. Their conservation, restoration, and sustainable management should be incorporated into sector development plans and should be mainstreamed. Swamp forest restoration initiatives should be incorporated into the training curricula of public training institutions and trainee should be encouraged to visit such places. Awareness campaign to get involved in the protection and conservation of natural resources should be promoted.

GOOD PRACTICE 5:
COMMUNITY BASED FISH SANCTUARY

Background

The establishment and management of fish sanctuaries appear to be easier than most other management interventions and they are popular with fishing communities. Depending on the purpose, the sanctuary may be seasonal/ temporary or permanent. One factor is the lifecycle of the main species that to be protected; fish species that attain maturity within a year or even spawn twice a year need only a few months refuge in the dry season and then they are capable of repopulating in seasonally flooded land. The refuges for these species need only be seasonal to ensure that they survive to reproduce; this is mainly for the small floodplain resident species. On the other hand, fish species such as major and minor carps that require several years to mature to breeding age need a permanent refuge so that they can live and grow there until reaching to breeding age/ size and can then spawn either within the same sanctuary or in a seasonal sanctuary in suitable habitat.

Since 1960, fish sanctuaries have been established in Bangladesh by the government through different development projects, but these have not been sustainable. As soon as the projects were over, the sanctuaries ceased to exist. However, during the last decade fish sanctuaries have been established as part of testing community participation in management regimes through different projects such as MACH, CBFM- 2, FFP of the Department of Fisheries (DoF) and other government-financed projects. In most cases, sanctuaries have been established in part of the water bodies leased to the community organization for fisheries management. Presently a total of 534 (DoF Annual Report, 2015) fish sanctuaries are reported to exist in water bodies in Bangladesh.

However, Baikka Beel permanent wetland sanctuary in Hail Haor and 12 wetland sanctuary in the Hakaluki Haor is declared by the Ministry of Land which CBOs are managing and protecting.

Key Features

The community-based organization called Resource Management Organizations (RMO) constituted with representatives from all professions including fishers, farmers, landless, women, and local elites (teacher, businessmen, service holder), living around these water bodies are responsible for managing the sanctuaries. The RMOs are registered with the Social Welfare Department to give them legal status. RMO manages fishing in one or more nearby water bodies leased to it plus floodplain areas (private land that is seasonally flooded).

The RMO is responsible for paying lease values, maintaining or restoring the wetland status of the jolmohals, establishing and managing any sanctuaries including preventing poaching, and ensuring that its rules regarding fishing are observed. Typically, the RMOs allow fishing by the users of the resource and the families living in and around the water bodies during the monsoon. Also allowed fishing on payment of gear-based

fees or on the payment as per fishing contract in the post-monsoon and dry season. RMOs for the permanent sanctuary, however, protects any extraction from the sanctuary

Major Interventions and Accomplishments

Community-based fisheries sanctuary has tremendous success stories. Resulted from the 4th Fisheries, MACH (Management of Aquatic Ecosystems through Community Husbandry) Project and CBFMS, there are around hundreds of community-based fish sanctuaries in various sizes throughout the country. The MACH project has, since 1999, established 56 distinct sanctuaries in three large wetland systems. CREL Project successfully influenced the MOL to increase the Baikka beel sanctuary to help protect the core area and resources, particularly during the dry season, when these refuge areas became critical to the survival of fish and other fauna, Baikka Beel permanent wetland sanctuary in Hail Haor has been enhanced formally by adding 17 plots of public land.

Community-based fisheries sanctuary

Restoration of wetland habitats and conservation measures such as sanctuaries and closed seasons have increased fish catch per hectare. In Hakaluki Haor fish catches in sample areas increased from 171 kg/ha in 2013-14 to 277 kg/ha in 2015-16 suggesting positive impacts from the beels protected as sanctuaries and swamp forest regeneration within the haor. Waterbird surveys confirmed the continued success of Baikka

Beel sanctuary – within three years of its original establishment and protection by Baragangina RMO, water birds returned in numbers to the sanctuary and it continues to host a high species diversity and population of wintering waterbirds, which reached a peak of over 10,000 in 2014 and 2017. In Hakaluki Haor waterbird numbers remain internationally important, recovering from a low of about 20,000 in 2014 and 2015 to 58,000 in 2017 and 45,000 in 2018 (USAID, 2018). This wildlife is attracting human visitors also, offering the RMO and community an opportunity to get additional income from eco-tourism.

Alignment to CBD Obligations

Practicing of fish sanctuary fulfills the CBD objectives on the conservation of biodiversity and sustainable use its components. It meets the demands of the CBD Articles 8-11 and covers thematic area: inland waters biodiversity, climate change, and biodiversity, and ecosystem approach.

Limitations

The effectiveness of sanctuaries depends on several key factors such as the identification of the type of sanctuary needed, selection of water body, appropriateness, and compliance with the rules introduced. RMOs do not have any legal footings. Normally the Upazila level administration has no direct linkages with the community and typically they do not know the requirements or constraints of the community. Sometimes RMO governance is influenced by local elites represented in the RMO and socio-political pressure from existing ruling parties.

There is no policy of the government for declaring wetland sanctuaries and no instrument to help MOL to declare and guide the management of the permanent wetland sanctuaries.

Concluding Remarks

To develop RMOs as a sustainable community-based institution it is necessary to bring them under a legal framework. The success stories of fish sanctuary management should be incorporated into the training curricula of public training institutions and trainee should be encouraged to visit such places. Awareness campaign to encourage people to get involved in the protection and conservation of natural resources should be promoted.

United Nations Framework Convention on Climate Change (UNFCCC): Good Practices and Innovations Bangladesh Perspective

This chapter includes selected good practices on the climate change adaptation. The good practices resulted from the implementation of various projects and programmes implementation in Bangladesh. The selection criteria included scalability, replicability, adaptability and sustainability and the UNFCCC obligations. A total of 09 practices have initially been identified considering productivity, livelihoods and ecosystem. Table 2 summarizes justification for selecting five practices.

Table 2: Selection Criteria of Good Practices and Innovations relating to UNFCCC

Practices	Key Characteristics				Link with FCCC obligation
	Scalability	Replicability	Adaptability	Sustainability	
Climate Resilient Agriculture (floating agriculture)	It ensures the availability of food production considering the broader contexts of submerged lands due to increased rainfall, flooding, sea level rise and water logging. This traditional knowledge-based approach is scalable easily with necessary technical and financial support.	Providing the socio-economic, environmental and cultural benefits, this practice has higher replicability in similar geographical context. The practice is already replicated in 42 Upazilas in 10 districts.	This agriculture is suitable to grow in wetland /waterlogged areas of the country which is a significant adaptation measure to climate change impacts and vulnerabilities, which will ensure and promote the food security.	Traditional community knowledge of floating agriculture is strengthened by scientific and technological inputs from different development partners and public agencies. Such technological inputs over the years has up scaled the technology with longer and stronger beds and enable crop rotation and cultivation of diversified vegetables to meet future needs in waterlogged areas.	Adaptation: focused on agricultural, food security, and sustainable development.
Community based Afforestation and Reforestation	• Besides the afforestation and reforestation, this practice provided means of restoration of ecology and biodiversity, conservation and sharing benefits of natural resources involving community participation • This practice further enhanced the capacity and coordination between local and national administrative stakeholders.	This practice enhanced national and local adaptive capacity to deal with climate change impacts and vulnerabilities and paved avenues for further up scaling and replication in other coastal sites and other ecosystems like haors, or low-lying floodplains in Bangladesh	This practice evident that different adaptation measures to reduce and manage the climate change impacts and vulnerabilities from cyclones, storm surges and tidal erosions and which can contribute in mitigation of global climate change as carbon sinks	This practice has taken efforts to reduce forest degradation and to increase forest coverage through participatory planning/ monitoring with community involvement, which contributed in building the long-term resilience of communities in coastal and hilly areas to climate change	Mitigation, Adaptation and loss and damage

Practices	Key Characteristics				Link with FCCC obligation
	Scalability	Replicability	Adaptability	Sustainability	
Adaptation Technology (Salinity Tolerant Rice Varieties)	Climatic stress tolerant and high yielding rice varieties ensures sustainable rice production, in turn, food security in salinity prone areas of Bangladesh	Salinity tolerant rice varieties are tested cultivated in some places of coastal districts and can be replicated all coastal districts in Bangladesh.	Farmer communities of the coastal zones adopted the practice of saline tolerant rice varieties in place of traditional rice varieties. As the newly developed rice varieties are high yielding, thus scaled up the food production.	It promotes science-led agriculture technology systems and encourage research and adoption of modern agricultural practices for development of drought, submergence and saline prone agriculture	Adaptation, technology development and transfer.
Irrigation and Renewable Energy Development (Solar Powered Pumps)	The marginalized farmers are getting opportunities to access the clean energy for irrigation and, which also contributing to reduce the GHGs emissions and to enhance community resilience to deal with adverse impacts of climate change, including changing rainfall patterns	Taking into account the difficulties related to access to electricity and diesel, the solar powered irrigation pumps in Bangladesh paved a new opportunity for sustainable alternative energy sources for irrigation. Currently 613 solar powered irrigation are already in operation with target to install 1,500 solar pumps by 2018 and 50,000 by 2025	Different feasibility studies on the application of solar energy in agricultural sector reveal that the photovoltaic systems would be the suitable options for agricultural taking into account the maintenance and environmental impacts (no maintenance cost and zero negative impacts to environment)	Solar powered irrigation is being considering as reliable, cost effective and environmentally sustainable energy for irrigation services, also contributing to GHG emission reduction by replacing diesel run pumps with the solar powered pumps. Farmers prefer to operate the solar powered pump for long run.	Adaptation and promoting food production and ensuring food security. Mitigation with reducing burning fossil foul through using clean energy

GOOD PRACTICE 1:
CLIMATE RESILIENT AGRICULTURE AND FOOD SECURITY: THE ROLE OF FLOATING AGRICULTURE

Background

The community-based practices of floating agriculture, especially in the waterlogged areas in Bangladesh, have been recognized locally and globally as a compatible adaptation measure to climate change impacts and vulnerabilities. In the context of a prolonged waterlogged condition, soilless floating platforms (beds) formed by locally available materials such as water hyacinth and other aquatic weeds are used to produce seasonal cash crops and vegetables. The practice of the floating agriculture was started initially by the framers in southwestern coastal areas that become waterlogged due to drainage congestion and changing of croplands into wetlands. These practices of floating agriculture further have been promoted by NGOs, development partners, and public agencies and replicated in different ecosystems, particularly in other wetland /waterlogged areas of the country as a significant adaptation measure to climate change impacts and vulnerabilities. Both government and non-government organizations are promoting this technology through training and cross visits (MoEF, 2009).

Over the years this community based floating agriculture practice has been evolved as one of the innovative climate adaptive technology, also become a scalable, replicable, compatible and sustainable adaptation measures considering the broader contexts of submerged lands due to increased rainfall, flooding and sea level rise.

Key Features

The floating platforms or beds are constructed usually in the monsoon using the floating mats of water hyacinth and other aquatic vegetation available in the wetlands. A good mixture of organic manure (cow dung and other materials) make the beds fertile. The floats/rafts are dragged to the edges of wetlands and the organic matter is used to cultivate winter vegetables after the harvest. The technology is entirely green in nature, besides the residues generated from the beds are environment-friendly and helps to control invasive hyacinth and aquatic weeds in wetlands.

Traditional community knowledge of floating agriculture is further strengthened by scientific and technological inputs from different NGOs, development partners, and public agencies. Such technological inputs over the years have upscaled the technology with longer and stronger beds and enable crop rotation and cultivation of diversified vegetables. Hence, floating agriculture provides a unique opportunity for the local farmers for food and nutrition security. The capacity of the community enhances through the practice to grow and sustain agricultural practices in the subsequent floods and waterlogging conditions. Floating agriculture increases employment opportunity and income of vulnerable farmer's community. This environmentally sustainable, economically viable, and socially compatible practice provides socio-economic, environmental and cultural

benefits. This practice has been replicated in different regions. In particular, women are involved with this practice offering their nursing with traditional knowledge to grow crops and vegetables in floating beds.

Floating Platforms or Beds

Major Interventions and Accomplishments

Floating agriculture is found in Gopalganj, Madaripur, Barisal, Pirojpur and Jhalokathi, Gaibandha and some other districts of Bangladesh including Haor areas. From 2000 onwards a number of NGOs include inter alia CARE, IUCN Bangladesh, Action Aid, Bangladesh, Practical Action, Bangladesh, Gono Unnayan Kendro, has been supporting communities to promote, upscale and replicate the technology to similar ecological context. Department of Agricultural Extension (DAE) has been promoting the floating agriculture since 2011. DAE is implementing a project titled 'Expansion of the Production of Floating Vegetables and Spices as a means of Adaptation to Climate Change in those Areas Prone to Flood and Waterlogging' The project is funded Bangladesh Climate Change Trust Fund and is being implemented in 42 Upazilas (sub-districts) in 10 districts in figure 1.

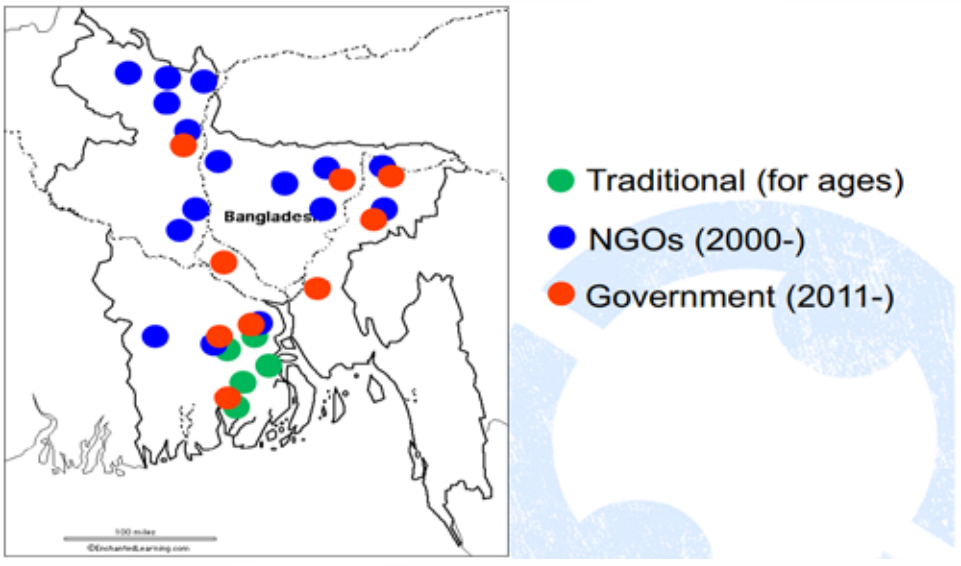


Figure 1: Areas of the floating agriculture practices in Bangladesh

The floating agriculture practices have been highlighted in national policy and strategies on climate change and are included in the sector strategy and policy. Bangladesh NAPA (National Adaptation Program of Action) 2005 considered the implementation of floating agriculture as an adaptation strategy to flood and water-logged conditions with a view to ensuring climate resilient agriculture and food security (MoEF 2005). Bangladesh Climate Change Strategy and Action Plan, (BCCSAP) 2009 underscores the importance of developing community-level adaptation, livelihood diversification, better access to basic services and social protection (e.g., safety nets, insurance) and scaling up and to develop climate change resilient cropping systems (MoEF, 2009).

Among the sector, specific policies, the National Organic Agriculture Policy in 2016 recognized the floating agriculture stating that 'activities related to vegetable farming/ vegetable gardening in the floating method will be encouraged (Sec 3.4.5.)'. The National Agriculture Policy in 2013 suggested promoting effective initiatives to establish self-reliant and sustainable agriculture that is adaptable to climate change and responsive to farmers' need' (Sec. 2.1., National Agriculture Policy 2013). The draft National Agricultural Extension Policy suggested for 'identification/development of area-specific production technologies (i.e., mulching, water management, polytunnels, raised beds, floating beds, rainwater reservoirs etc.)' [Sec. 54 ((iv), National Agriculture Policy 2013].

The floating agriculture practice as an adaptation measures have got recognition from different international organizations include UNFCCC, FAO, ADB and UNEP. The Technology Executive Committee (TEC) of UNFCCC, in its policy brief identified floating gardens in Bangladesh as an example of a successful technological innovation, which has been replicated through community-based adaptation processes. News Centre of UNEP, mentioned, "*floating gardens help lift Bangladeshis out of poverty and stave off worst impacts of climate change*". Asian Development Bank (ADB) recognized floating agriculture as one of the potential technologies for climate change adaptation. Food and Agriculture Organization (FAO) declared Floating Garden Agriculture in Bangladesh as Globally Important Agricultural Heritage System (GIAHS) in 2015 Through this declaration, this system has become one of the 38 GIAHSs around the world. The area of the heritage site is 2500 hectares and is in the 3 south central districts of Bangladesh, namely Gopalganj, Pirojpur and Barisal. IPCC, 5th Assessment Report (AR5, Chapter 14-Adaptation Needs and Options) recognized the floating gardens as

adaptation technology. The practices of floating garden are also found in some other countries and literature review finds floating agriculture practices in Dal Lake of Kashmir in India, Inle Lake in Myanmar and Xochimilco in Mexico (Irfanullah, 2014).

Alignment to FCCC Obligations

This practice directly links with thematic sector of UNFCCC which is adaptation with a focus on agricultural, food security, and sustainable development.

Limitations

Lack of integrated ecosystem approach: These practices are producing crops and vegetables, however, there can be a holistic approach to produce crops/vegetables taking into account the water and fisheries management. There are sectoral policies and institutional mandates for sectoral resource management and there is lack of sectoral coordination and integration. The policy documents also are not providing guidance for integrated ecosystem management. At the same time, local institutions still to act to facilitate these community practices.

Still missing the good governance, which can promote the interests of landless people and can also exclude the powerful elites. Its noteworthy that landless people do not have rightful access to open water bodies or in the water-logged areas. They should be allowed to practicing this technology in the open water bodies through ensuring the good governance. So, policy and institutional mainstreaming is needed to promote such community compatible practices, which is globally recognized now.

Replication efforts by the government institutions is still limited and need to scale up taking into consideration of climate change impacts and vulnerabilities providing technical and financial supports to community.

Concluding Remarks

Traditional knowledge and community practices of floating agriculture need a holistic approach of integrated ecological management to ensure the food and nutrition security of flood/waterlogging affected people considering the climate change impacts and vulnerabilities. GoB has taken some policy approaches to promote these practices, however, there is a need for specific policy guidance to promote this community practice, which is now globally recognized climate change adaptation measure.

GOOD PRACTICE 2:
COMMUNITY BASED AFFORESTATION AND REFORESTATION: MITIGATION AND ADAPTATION APPROACHES TO CLIMATE CHANGE

Background

The coastal areas of Bangladesh are predominantly prone to many hazards like a tropical cyclone, storm surge, river bank erosion, and salinity intrusion. IPCC reports and the relevant literature revealed that the frequency and intensity of extreme weather events have been increased due to climate change impacts. The existing and potential climate change impacts and vulnerabilities in Bangladesh identified by GoB in NAPA, 2005 and BCCSAP, 2009 include sea level rise, increased salinity, higher precipitation during monsoon, very low rainfall in winter, increase in frequency and intensity of tropical cyclone and storm surges, coastal embankment erosion, drainage congestions and declining coastal ecosystem. (MoEF, 2009).

To reduce vulnerabilities of the coastal communities the government of Bangladesh, in collaboration with UNDP and GEF's financial support, have implemented 'Community Based Adaptation to Climate Change through Coastal Afforestation' Project in four coastal districts, namely Borguna, Noakhali, Bhola, Chittagong. The project promoted the community-based afforestation and reforestation and evidenced its effectiveness to address the community vulnerabilities in the changing climate. NAPA prepared in 2005 identified coastal afforestation as one of the prioritized projects having both adaptation and mitigation approaches. As prioritized in NAPA, Department of Forest also implemented a project titled 'Climate Resilient Participatory Afforestation and Reforestation Project (CRPARP)' financially supported by BCCRF.

Key Features

Community-based afforestation programs introduced the ecosystem-based adaptation to climate change with community participation. Community participation generated awareness, engaged them in the decision-making processes and ensured their benefits. These projects and programs provided some means of restoration of ecology and biodiversity, conservation and wise use of natural resources with community participation in the management process; enhanced the capacity and coordination among the relevant management stakeholders including local to national agencies which influenced to adopt some policy approaches to community-based afforestation as adaptation option.

Afforestation and reforestation contribute to mitigation and revealed reduction of vulnerabilities from cyclones, storm surges, and tidal erosions. These projects provided many adaptation measures to reduce and manage the climate change impacts and vulnerabilities and helped to develop rural development strategies, especially as they pertain to coastal regions, which ultimately builds the societal resilience to the impacts and vulnerabilities of climate change. These projects enhanced national and local adaptive capacity to deal with climate change impacts and vulnerabilities and paved avenues for further upscaling and replication in other coastal sites and other ecosystems like haors, or low-lying floodplains in Bangladesh.

These projects and programs are providing opportunities of enhancing the community resilience, livelihood diversification, protecting people from frequent and intensified cyclones and storm surges, dealing with slow onset processes like changing ecology and land degradation. Contributing to sequestrate carbon and thus reducing GHG emission, reduce forest degradation and increase forest coverage[1].

Major Interventions and Accomplishments

Bangladesh submitted Intendent Nationally Determined Contribution (INDC) to UNFCCC in 2015, which is now Nationally Determined Contribution (NDC) as to the Party of the Paris Agreement, 2015. INDC, identified some sectors for possible conditional action-based contributions, include land use, land use change and forestry, which intends to contribute for mitigation of global climate change through reforestation and afforestation programmes. 7th Five Year Plan provided guidance for afforestation and reforestation activities in the coastal zone with a view to strengthening the adaptation and mitigation measures for climate change impacts ensuring the community participation, including women. This plan prioritized coastal afforestation strip plantation to capture atmospheric carbon within vegetation and to explore international financing for such programmes.

Some other strategies and plans including National Conservation Strategy (2016-2031), Perspective Plan of Bangladesh, 2010-21, National Sustainable Development Strategy (NSDS) 2010-21, National Social Security Strategy (NSSS) of Bangladesh, 2015, have provided some guidance on afforestation and reforestation as climate change adaptation and mitigation measure. Coastal Zone Policy, 2005, recognized the climate change impacts and vulnerabilities in the coastal zone and provided some policy guidance for afforestation and reforestation programmes (Sec. 4.3). The Disaster Management Policy, 2015 providing guidance for building green belt in the coastal zone through afforestation and reforestation for reducing impacts of tidal surges, cyclonic storms, and tidal erosion and from salinity (Sec.3.1). National Women Development Policy, 2011, to encourage women in farming, fisheries, cattle raring and afforestation and give them equal opportunity. Also, the Forest, Act, 1928 (Sec, 3 & 28A.1), Social Forestry Rules, 2004 and the Forest Policy, 1994 provided guidance for afforestation and reforestation.

The projects and programs related to afforestation and reforestation demonstrated the effectiveness of reducing the impacts of tidal surges, cyclonic storms, and tidal erosion and the protection of community livelihoods from related slow onset processes of climate change. These projects and programs provided a governance structure for collaborative forest management ensuring the coordination and integration among the relevant public agencies, local governments, NGOs, and communities. These projects also provided governance structures for effective co-management and benefit-sharing for coastal greenbelt plantations and community-based early warning and preparedness planning for extreme climate events. According to the majority of the expert, the community-based afforestation and reforestation are highly scalable.

1 See- http://crparp-bfd.org/about-crparp/project-locations/

Alignment to FCCC Obligations

The objectives and activities of community-based afforestation and reforestation directly met the thematic sector of climate change convention and Paris Agreement: mitigation, adaptation and loss and damage.

Limitations

Lack of integrated and coordinated management approaches for community-based reforestation and afforestation programs and projects to promote community involvement and ecosystem-based adaptation measures for adaptation and mitigation to climate change. Limited policy guidance for collaborative management, community participation and profit sharing specifically from the benefits of REDD+ programmes.

Concluding Remarks

Needed more integrated and coordinated management approaches with specific institutional and legal frameworks for afforestation and reforestation programmes to facilitate community and ecosystem-based adaptation for reducing vulnerabilities and promoting and protecting livelihoods, collaborative management, and benefit sharing.

GOOD PRACTICE 3:
COMMUNITY BASED ECOSYSTEM CONSERVATION AND ADAPTATION IN ECOLOGICALLY CRITICAL AREAS OF BANGLADESH

Background

The ecosystems and all the living beings are currently threatened because of multiple anthropogenic causes like pollution, alteration of natural systems, over-exploitation, rapid urbanization, and climate change. The anomaly in seasonal pattern, changes in rainfall pattern and water regime, and the frequency and intensity of hazards have already started to affect agricultural production.

The Bangladesh Environment Conservation Act, 1995 authorizes the Ministry of Environment and Forests to declare Ecologically Critical Area (ECA). DoE implemented "Coastal and Wetland Biodiversity Management Project (CWBMP)" in ECA funded by UNDP-GEF and the "Community-based Adaptation in Ecologically Critical Area" (CBA-ECA) Project (2011–2015) funded by the Bangladesh Climate Change Trust, the Embassy of the Kingdom of the Netherlands in Dhaka and the UNDP. The later project continued to nurture communities for sustainable management of the ECA by enhancing awareness, revitalizing community groups established under the CWBMP, enhancing the capacity of the communities, especially women on alternative income-generating activities. The project further focused on enhancing the resilience of the people living around ECA through organizing and engaging them in biodiversity conservation and habitat restoration. The CBA-ECA Project has been implemented in three important ECAs: i) Hakaluki Haor spread over Kulaura, Juri and Baralekha Upazila are under Moulvibazar district and Golapganj and Fenchuganj Upazila under Sylhet district, ii) Cox's Bazar-Teknaf Peninsula ECA covering four upazillas, and Sonadia Island ECA.

Key Features

This community-based approach to conserving biodiversity of the ECA are engaging communities for preparing disaggregated tasks and action plans for biodiversity conservation and climate change risk reduction, capacity building and livelihood diversification of the community; implementation of priority actions on biodiversity conservation and climate change adaptation, adaptation measures for community protection against climate change, monitoring and enforcement awareness raising, and media campaign.

Courtyard meetings, plantation programme, folk dramas, rallies, school awareness programmes, and nationally and internationally important day observance, etc. increased the awareness and sensitized participants. The CBA-ECA project promoted an institutional arrangement for the management of ECAs. The lower tier of this framework is the grassroots level community organizations, the Village Conservation Groups (VCG)—central to the ECA. The uniqueness of the CBA-ECA Project is to facilitate innovative funding mechanisms; the Micro Capital Grant (MCG) was given to the community to enable them to reduce dependency on natural resources.

MCG received by all 68 VCGs, introduced as a revolving fund used through social banking policy among the community members.

Biodiversity conservation is the core of the CBA-ECA Project. Conservation measures included swamp forest protection and plantation, aquatic sanctuary establishment, mangrove protection and plantation, sand dune plantation, rocky inter-tidal zone and mudflats protection, bird conservation, turtle conservation, and extension of Integrated Pest Management (IPM) among the communities. Community guards have been deployed for patrolling. Local administrations with the Department of Environment and the VCGs have undertaken legal enforcement to stop illegal harvesting of ECA resources.

Major Interventions and Accomplishments

For addressing climate change mitigation, physical interventions like solar based irrigation and desalination plants in the project areas have been established. Solar based irrigation plants also established in Hakaluki Haor. Submergible greenbelts, embankments with tree plantation on either side that go underwater in monsoon have been created as a climate change adaptation measure in the Hakaluki Haor. The project has constructed four watchtowers, popularly known as Paribesh Tower, to encourage ecotourism and to establish better surveillance of ECA resources.

A total of 68 Village Conservation Groups were nurtured, with an aim to achieve better management of ECA resources and enhance the resilience of the community. 10 Village Conservation Centre (VCC) buildings have been constructed where a biodiversity museum has been established. (Department of Environment, 2015). The building space is used to hold meetings, training and to share their ideas of sustainable use of ECA. The building also provides some earnings.

The CBA-ECA Project undertook many conservation initiatives at the ecosystem and the species levels, ranging from mangrove restoration and sea turtle conservation on the coast to swamp protection and aquatic sanctuaries in the haor. To build community resilience through adaptation and mitigation, special initiatives were undertaken by providing a wide range of technological support like improved cooking stoves, solar home systems, solar irrigation and desalination plants, and submersible green belts. Women's empowerment enhanced through alternative income generation activities, and capacity and skill development training.

The success of community conservation initiatives supported by CREL and previous projects, such as swamp forest restoration and guarding, turtle hatcheries, and livelihoods development changed the MoL's understanding about the maturity of these groups for future representation in the Upazila ECA committees and, their capacity to independently carry out conservation. USAID funded CREL project facilitated DoE and MoEFCC to pursue and influence the ministry of Finance and the legislative division and consequently the ECA management Rules 2016 has been enacted. The Rules details formation and functions of VCGs, Union ECA coordination Committee, Upazila ECA committee, District ECA Committees, and National ECA Committees. A central ECA fund was established with MoF support. Community-based management of the ECA is legally supported in Bangladesh

Alignment to FCCC Obligations

The successful implementations of community-based ecosystem conservation and adaptation in ecologically critical areas of Bangladesh fulfilled the essentials of adaptation and mitigation through sustainable forest management and GHG emissions and capture.

Limitations

The ECA committees at all tiers and the central ECA fund as directed by the Rules has not yet been formed. Shorter duration project activities are not conducive to make a longer-term sustainable change in the arena of natural resource management. The complexity of geographical spread of an ECA into the different administrative unit and the overlapping mandates of the related line ministries and agencies and lack of coordination, in general, remain as limitations. The absence of DoE offices near the ECAs limits the function to patronize the community participated approach in the ECA.

Concluding Remarks

Management of ECA through community participation has been practiced in several ECAs for more than a decade. Learnings from the implemented projects and to meet the needs the ECA Rules 2016 has been enacted. The challenge now for DoE is to activate the different tiers of ECA committees formed under the Rules, given that the ECAs encompass several types of ecosystems, with each ecosystem having a set of overlapping agencies and authorities over their condition and management. It is necessary to immediately form the central ECA fund. Longer term programme approach is necessary for the management of the ECA engaging the communities as directed by the Rules.

GOOD PRACTICE 4: ADAPTATION TECHNOLOGY: SALINITY TOLERANT RICE VARIETIES

Background

The agriculture sector of Bangladesh is extremely vulnerable to climate variability and climate change impacts. Already, the higher temperatures and changing rainfall patterns, frequent flooding, drought, and rising salinity in coastal areas are causing affecting crop yields and crop production. IPCC reported that the production of rice and wheat in Bangladesh could decline 8 percent and 32 percent respectively by 2050 against the base year of 1990, which will cause serious food insecurity and increase in poverty of 15% by 2030. Such impacts are already evident in different eco-sensitive zones like coastal, drought and flood-prone areas of Bangladesh and in response to these impacts and vulnerabilities, Bangladesh has taken context-specific adaptation measures along with technological innovation.

Meantime many global, as well as national policy and strategy paper, highlighted the significance of technological innovation, especially in the agriculture sector. The Technology Needs Assessment (TNA) Report 2012 of the government of Bangladesh identified the need for developing inter alia salinity and drought tolerant rice varieties, and short maturing rice varieties. Technology Executive Committee (TEC) of the UNFCCC, also has identified some adaptation technologies in the agriculture sector, which also include the development of resilient crop-varieties.

Considering the urgency of building climate resilient agriculture in Bangladesh, relevant public agencies, research institutions, and NGOs, in collaboration with development partners, have already developed climatic stress-tolerant rice varieties and their cropping practices. Among them, the salinity tolerant rice variety got notable acceptance to the coastal farmers. This case study provides an overview of key aspects and effectiveness of these saline tolerant rice varieties as an adaptation technology in Bangladesh.

Key Features

Climate change impacts and vulnerabilities, specifically like sea level rise, cyclone and storm surge have been contributing to aggravate salinity intrusion in coastal areas of Bangladesh and decreasing agricultural production by the unavailability of fresh water and soil degradation. In response to the salinity intrusion, Bangladesh has developed some salt-tolerant rice varieties, to adapt to the impacts resulting from salinity intrusion caused by climate and non-climate factors. The scientists of Bangladesh used the gene-marker technology to develop some salt-tolerant rice varieties in Bangladesh, which is recognized nationally and internationally as adaptation technology. The following map (figure 2) provides an overview of salinity concentration on groundwater in Bangladesh.

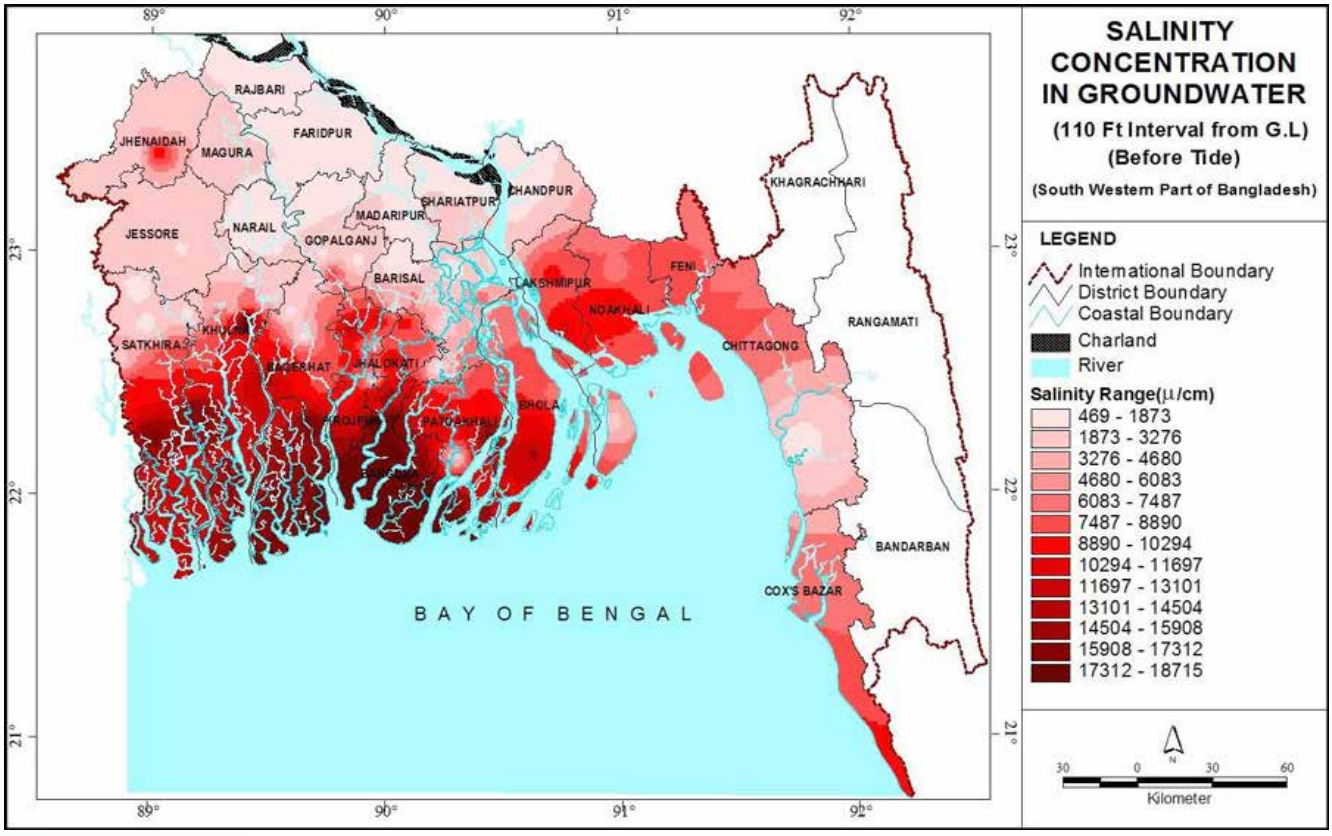


Figure 2: Salinity Concentration on Groundwater in Bangladesh

Development of climatic stress tolerant, high yielding rice varieties, to ensure sustainable rice production, in turn, food security is one of the mandates of the Bangladesh Rice Research Institute (BRRI) and Bangladesh Institute for Nuclear Agriculture (BINA). So far 11 salinity tolerant rice varieties have been developed, 9 of which are BRRI varieties and 2 from BINA. Some of the varieties were developed in collaboration with the International Rice Research Institute (IRRI) under its Stress-Tolerant Rice for Africa and South Asia (STRASA) project. Three of the BRRI varieties: BRRI dhan 47, BRRI dhan55 and BRRI dhan 61 are suitable for Boro season. BRRI dhan 55 can also be cultivated in Aus season. Rest of the varieties are for Aman season. The newly developed varieties yield better, in some cases, double the local varieties[2].

BINA dhan 8 and 10 are popular salt-tolerant varieties in Bangladesh. Both varieties are for Boro season and are higher salinity tolerant than the other varieties of this kind. In non-saline lands production higher. BINA dhan10, released in 2012, can withstand stormy weather. Under the saline condition, BINA dhan 8 and 10 can yield, on an average, 5 and 5.5 t/ha respectively, and if cultivated in non-saline lands they can produce as high as 7.5 t/ha and 8.5 t/ha. Among the BRRI varieties of salt-stress tolerant rice, 'BRRI dhan 47 is widely adopted in most of the environments of coastal Bangladesh in the dry season, followed by BRRI dhan 61 and the short-duration varieties, BRRI dhan53 and BRRI dhan54, which also are moderately tolerant of SF (Stagnant Flood) are suitable in most sites during the wet season'. STRASA-USAID-IRRI project, provided four salt-tolerant rice varieties to 162,237 farmers in collaboration with Agricultural Extension Department (DAE), NGOs and local private seed producers in southern districts. The following table 3 provides relevant information on Salt-tolerant rice varieties in Bangladesh.

2 See- http://www.knowledgebank-brri.org/brri-rice-varieties-en.php

Table 3: Salt-tolerant Rice Varieties in Bangladesh

Variety	Season	Salinity tolerance (in dS/m)		Yield in saline condition (t/ha)	Remarks	Developed by	Year Released
		Seedling Stage	Maturity				
BRRI *dhan* 40	T. Aman	8	8	4.5	Double yield than the local varieties	BRRI	2003
BRRI *dhan* 41	T. Aman	8	8	4-4.5	-	BRRI	2003
BRRI *dhan* 47	Boro	12-14	6	6	Better yield than BRRI 28 and Boro varieties	BRRI & IRRI	2007
BRRI *dhan* 53	T. Aman	8-10	8-10	5	-	BRRI & IRRI	2010
BRRI *dhan* 54	T. Aman	8-10	8-10	5.5	Double yield than the local varieties	BRRI & IRRI	2010
BRRI *dhan* 55	Boro & Aus	8-10 (Up to 3 weeks)	-	7 (Boro) 5 (Aus)	-	BRRI & IRRI	2011
BRRI *dhan* 61	Boro	12-14 (Up to 3 weeks)	8	3.8-7.4 (depending on the degree of salinity)	1.5t/ha Better yield than BRRI 28	BRRI & IRRI	2013
BRRI *dhan* 73	T. Aman	12	8	2.1-6.1 (depending on the degree of salinity)	-	BRRI	2015
BRRI *dhan* 78	T. Aman	6-9	6-9	4.5-5.5 (depending on the degree of salinity)	-	IRRI and BRRI	2016
BINA *dhan* 8	Boro	8-10	10-12	5	-	BINA & IRRI	2010
BINA *dhan* 10	Boro	10-12	12-14	5.5	Remains erect (no loading) even in stormy weather and no shattering.	BINA & IRRI	2012

Major Interventions and Accomplishments

As of now BRRI and BINA have developed 11 salinity tolerant rice varieties which have shown promises in fighting salinity intrusion and food productivity. Currently, BRRI is implementing several research projects for developing salinity and other stress-tolerant crop varieties in Bangladesh. It has a project titled 'Tracking Climate Resilient Rice Varieties Development by BRRI and its Economic Performances at the farm Level in Bangladesh'. Bangladesh Agricultural University (BAU) is also implementing a research project titled 'Resistant Breeding for Salinity Stress Tolerance in Rice.

NAPA, prepared in 2005, provided the project ideas on 'promotion of research on drought, flood, and saline tolerant varieties of crops to facilitate adaptation in future' and promoting adaptation to coastal crop agriculture to combat increased salinity (Project. 10 &11). BCCSAP, prepared in 2009 based on NAPA processes, recognized the ongoing research works of BRRI, BARI and other research centers under NARS to develop cultivars adapted to likely future climatic conditions and also identified the urgent need to develop the research capacity of

these institutes and scientists, and to provide better research facilities (BCCSAP, 2009-Theme: 1., Programme:1). INDC, submitted to UNFCCC by Bangladesh in 2015, which is now the NDC for Bangladesh in accordance with the Paris Agreement, 2015, identified the adaptation priority for stress tolerant (salinity, drought, and flood) variety improvement

The 7th Five Year Plan suggested to promote science-led agriculture technology systems and encourage research and adoption of modern agricultural practices for development of drought, submergence, and saline prone agriculture. It also suggested for climate-smart/resilient technologies; introduce salinity, submergence and other stress tolerant varieties especially in the southern regions (Planning Commission, 2016). Coastal Zone Policy 2005 suggested for developing the salt-tolerant crop varieties along with possible measures to resist salinity (Sec 4.4.5). The Agriculture Policy, 2013, National Agricultural Extension Policy, 2012, Integrated Small-scale Irrigation Policy, 2014, National Disaster Management Policy, 2015 provided some guidance for research works on climate change, saline water intrusion and technological developments for sustainable agriculture in Bangladesh. Specific Plan of Action on Disaster and Climate Risk Management in Agriculture for Department of Agricultural Extension, adopted in 2015, which also provides guidance for saline tolerant crops in Bangladesh.

BRRI and BINA in collaboration with IRRI have developed a number of salinity tolerant rice varieties, which have already been proven as an effective adaptation option to saline intrusion in the coastal arable lands and ensuring sustainable food security in Bangladesh through rice production in the coastal regions in the face of climate change. Farmer communities of the coastal zones adopted the practice of saline tolerant rice varieties in place of traditional rice varieties. As the newly developed rice varieties are high yielding, they are scaling up the food production.

Policies and measures relevant to developing salinity tolerant rice varieties, in Bangladesh, are providing necessary guidance. Research works have been going on in the international agencies like IRRI, and national ones, such as BRRI, BINA, BARI and other research institutions, and taking new initiatives for developing more salinity tolerant rice varieties. Relevant institutions of GoB in partnership with the other international and national NGOs and private seed companies are taking actions to disseminate the new varieties to the farmers, through training, distribution of seed and demonstrating the cultivation method. STRASA-USAID-IRRI project is one example of such initiatives.

Alignment to FCCC Obligations

Salinity Tolerant Rice Varieties captured successful imagery of adaptation, technology development and transfer over changing climates that directly relates the climate change Conventions and associated instruments.

Limitations

- Community education and awareness: There is a lack of community education and awareness for the need and use of saline tolerant rice varieties.
- Seeds of saline tolerant crops are rarely available in the market.
- BRRI, BINA, and BARI having limited collaboration with private sectors and international organizations.

Concluding Remarks

Some of saline tolerant rice varieties demonstrate as an effective adaptation option in the coastal zone of Bangladesh, however, further policy guidance along with financial, technical and capacity building support is required to promote cultivation of saline tolerant varieties in a wider scale.

GOOD PRACTICE 5:
IRRIGATION AND RENEWABLE ENERGY DEVELOPMENT: SOLAR POWERED PUMPS

Background

Irrigation can play a vital role in improving yields, reducing vulnerabilities to changing rainfall patterns, and enable multiple cropping practices. However, access to affordable, reliable and environmentally sustainable energy for irrigations is always a challenge. Irrigation in Bangladesh mostly depends on diesel-run pumps mainly due to unavailability of grid electricity in the remote areas. There is also a restriction on using electric power pumps as they consume a significant amount of national grid electricity often leading to a power cut in the urban areas. Daily Sun reported in 2015 that installed 0.27 million electricity-run pumps consumed about 1500MW of electricity during the peak irrigation season. Given the context, solar-powered irrigation is now considered as reliable, and environmentally sustainable energy which contribute to GHG emission reduction.

Solar powered Irrigation Systems (http://idcol.org/home/solar_ir)

The solar-powered irrigation started to play an important role in the agriculture sector of Bangladesh. The marginalized farmers are getting opportunities to access the clean energy for irrigation to enhance community resilience to deal with adverse impacts of climate change. This study identifies solar-powered irrigation to evaluate as a case both for adaptation and mitigation to climate change in Bangladesh.

Key Features

In Bangladesh, about 60% of the cropping lands need irrigation for food production, and mostly pumps are used for irrigation. There are about 1.61 million irrigation pumps used in Bangladesh. Among them, 1.34 million pumps are -run by diesel and 0.27 million run by electricity. GoB provides subsidy around TK 24-26 per liter of diesel, but still, diesel is expensive for the farmers of Bangladesh. Diesel is not readily available in remote areas.

The electricity generation capacity of Bangladesh reached more than 16000 MW by August 2017 and only about 83% of the total population of the country has access to grid electricity (The Financial Express, 2017). The water pumps run by electricity, consume around 1,300MW for irrigating and additionally 1.34 million diesel-run pumps are used for irrigation during the peak growing season, which uses about 900,000 tons of fuels per year, for irrigation of 3.4 million hectares of lands (The Daily Star, 2012).

The electricity access by the farmers of Bangladesh for water pumps is difficult due to include inter alia, demand-supply gap, crumbling electricity transmission, and distribution infrastructure, the high cost of electricity (Figure 3). On the other hand, the farmers of Bangladesh are also facing difficulties with diesel-run pumps due to including the cost of diesel, transportation of diesel to crop fields, high maintenance costs of diesel-run pumps and environmental pollutions. Therefore, considering the difficulties related to access to electricity and diesel the solar-powered irrigation pumps in Bangladesh paved a new opportunity for sustainable alternative energy sources for irrigation.

Different feasibility studies on the application of solar energy in the agricultural sector, reveal that the photovoltaic systems would be the suitable options for agricultural considering the maintenance and environmental impacts (no maintenance cost and there is no environmental impacts). GoB is promoting the solar powered irrigation in Bangladesh through policy measures, programs, and projects. Specifically, GoB owned company named Infrastructure Development Company Limited (IDCOL) implementing different projects under the Solar Irrigation Programme, in collaboration with World Bank, KFW, KOICA, JICA, ADB, USAID, GPOBA, and Bangladesh Climate Change Resilience Fund (BCCRF, which is recently dysfunctional).

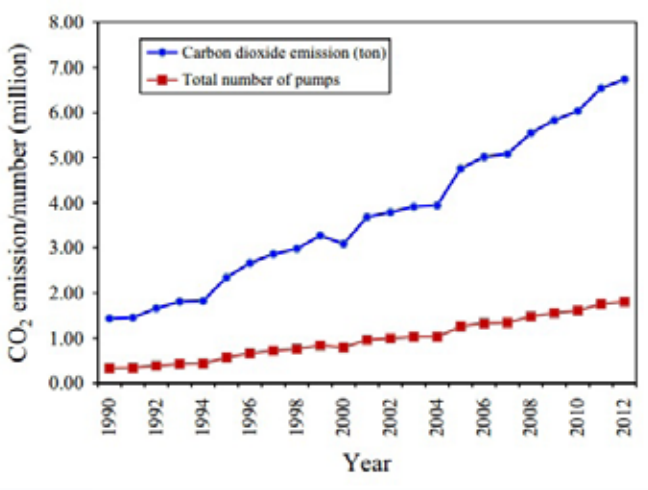


Figure 3: Scenario of Diesel Pump Use and CO_2 Emission in Bangladesh (1990 - 2012) (Uddin, 2017)

IDCOL is implanting its Solar Powered Irrigation Program, which is an innovative, economical and environment-friendly approach to promote the agro-based economy of Bangladesh. The program is aimed at providing access to green energy to the farmers through providing the power with the solar system, particularly to the off-grid rural areas. This program also intends to reduce the use of fossil fuel, which ultimately contribute to the reduction of GHG emission and to global mitigation efforts for tackling climate change. The scenario of diesel pump use and emission has been rising since 1990.

Major Interventions and Accomplishments

IDCOL already has approved 666 solar-powered irrigation pumps and currently, 613 solar powered irrigation are already in operation. IDCOL is working to install remaining pumps will come into operation shortly. To replace diesel-operated pumps in Bangladesh, IDCOL has a target to finance 1,500 solar pumps by 2018 and 50,000 by 2025 (Chowdhury, 2018). While the World Bank, KfW, GPOBA, JICA, USAID, ADB and Bangladesh Climate Change Resilience Fund (BCCRF) are supporting the program taken by IDCOL; Grameen Shakti, Jagorani Energy, ARS Bangladesh, REB, and Electro Solar Power Ltd are working under a collaborative program

of IDCOL to install and maintain the solar irrigation projects in different rural areas. Under this program NGOs, the private sector and public agencies are working with a collaborative approach to promote the solar-powered irrigation pumps in rural areas of Bangladesh.

The relevant projects and programs also influenced GoB to adopt policies and plans related to Solar Powered Irrigation Programs in Bangladesh. BCCSAP was adopted in 2009 and this strategy and action plan adopted the programme on renewable energy development under the thematic area of mitigation and low carbon development (programme-4, theme-5,) with the objective of maximizing the use of renewable energy sources to lower GHG emission and ensuring energy security. This plan also identified the scope for developing renewable energy including solar and suggested for providing incentives, where required to promote renewable energy in Bangladesh (MoEF, 2009). INDC submitted to UNFCCC by GoB in 2015, which now as NDCs as to the Paris Agreement, 2015, specifically identified the need for investment of .60 billion USD, by 2011-2030 for solar irrigations pumps, while renewable energy is identified as a means of meeting conditional and unconditional commitments of NDCs under the Paris Agreements (INDC, 2015)[3].

The 7th Five Year Plan of Bangladesh suggested to expand the farm mechanizations, by increased use of solar power as a source of energy, (Sec 4.2.3.) for improving productivity, reducing the cost of production, and achieving timeliness of crop production operations in a sustainable manner in Bangladesh. Some other strategies and plans including Perspective Plan of Bangladesh 2010-2021, and National Sustainable Development Strategy (NSDS) identified the solar as an important source of sustainable energy and provided suggestions for using of solar energy in off-grid rural areas and in irrigation through subsidizing capital costs (Sec 4.3. & 5.3 of NSDS, 2010-21).

Renewable Energy Policy Bangladesh adopted in 2009 aims to meet 5% of total energy demand through renewable sources by 2015, and 10% of total demand by 2020 and recognized the different sources of renewable energy including the solar as the primary source of renewable energy. Some other policies in Bangladesh include Integrated Small-Scale Irrigation Policy, 2014, National Agriculture Policy, 2013, National Organic Agriculture Policy, 2016 and Agricultural Research Vision 2030 recognized the use of solar energy in off-grid rural areas and for irrigation. Moreover, Sustainable and Renewable Energy Development Authority (SREDA) was established by the Ministry of Power Energy and Mineral Resources (MPEMR), through SREDA Act, 2012 with a view to promote renewable energy in Bangladesh including solar and to assist to identify sources of financing and make necessary arrangement to provide financial incentives to attract and encourage private investment in renewable energy sector.

The projects and programs related to solar-powered irrigation in Bangladesh are involving the farmer's community to install and maintain solar-powered pumps and sharing the benefits of such projects and programs. GoB has taken some policy measures for promoting solar-powered irrigation in Bangladesh and at present GoB provides 40% subsidies and soft loans for promoting renewable energies. The project's interventions resulted with some innovations related to technology and financial management related to solar pumps and enhancing community resilience and adaptive capacity, reducing vulnerabilities and promoting and protecting livelihoods, collaborative management, and benefit sharing.

3 Bangladesh submitted Intendent Nationally Determined Contribution (INDC) to UNFCCC in 2015, which is now Nationally Determined Contribution (NDC) as to the Party of the Paris Agreement, 2015

Alignment to FCCC Obligations

The irrigation and renewable energy development (solar powered pumps) practices meet the obligations in two-fold.

- Adaptation and promoting food production and ensuring food security.
- Mitigation with reducing burning fossil fuel by using clean energy.

Limitations

Solar irrigation systems are expensive for the farmers compared to the traditional system. Power Sector Master Plan, adopted by GoB in 2010 stated that, 'the solar power generation cost at this point in time is more than five times higher than the power generation cost of conventional thermal power generation and in the future, the large-scale introduction of solar power generation cannot be expected unless the cost of solar panels becomes significantly lower or government provides a large number of subsidies. Moreover, the availability of the land for the installation of a solar system is another major problem in Bangladesh.

Policies plans related to solar irrigation systems in Bangladesh do not provide clear guidance for technological and financial support to promote the solar-powered irrigations in Bangladesh, the subsidies and incentives and access to international supports related to financial and technical assistance. Awareness and capacity of farmer's community, public agencies, private sectors, and development community remain a challenge to promote solar-powered irrigation systems in Bangladesh.

Concluding Remarks

The solar-powered irrigation started to play an important role in the agriculture sector which is also contributing to reduce the GHG emissions and to enhance community resilience to deal with adverse impacts of climate change. However, specific policies and plans relevant to subsides and incentives and to access the international supports related to financial and technical assistance are needed for solar-powered irrigation systems in Bangladesh.

United Nations Convention to Combat Desertification (UNCCD): Good Practices and Innovations Bangladesh Perspective

A total of 10 practices have initially been identified from previously implemented projects considering productivity, livelihoods and ecosystem. Following four Good Practices are selected, finally, after screening through the lens of scalability, replicability, adaptability and sustainability:

i) Mulching,
ii) Drip Irrigation,
iii) Rain Water Harvesting (RWH)
iv) Compost production

Causal Loop Diagram (CLD), as indicated in the following figure 4 shows the inter-relationship among for Good Practices of drip irrigation, mulching, RWH and compost production. Good Practices selection criteria have been listed in the following table 4.

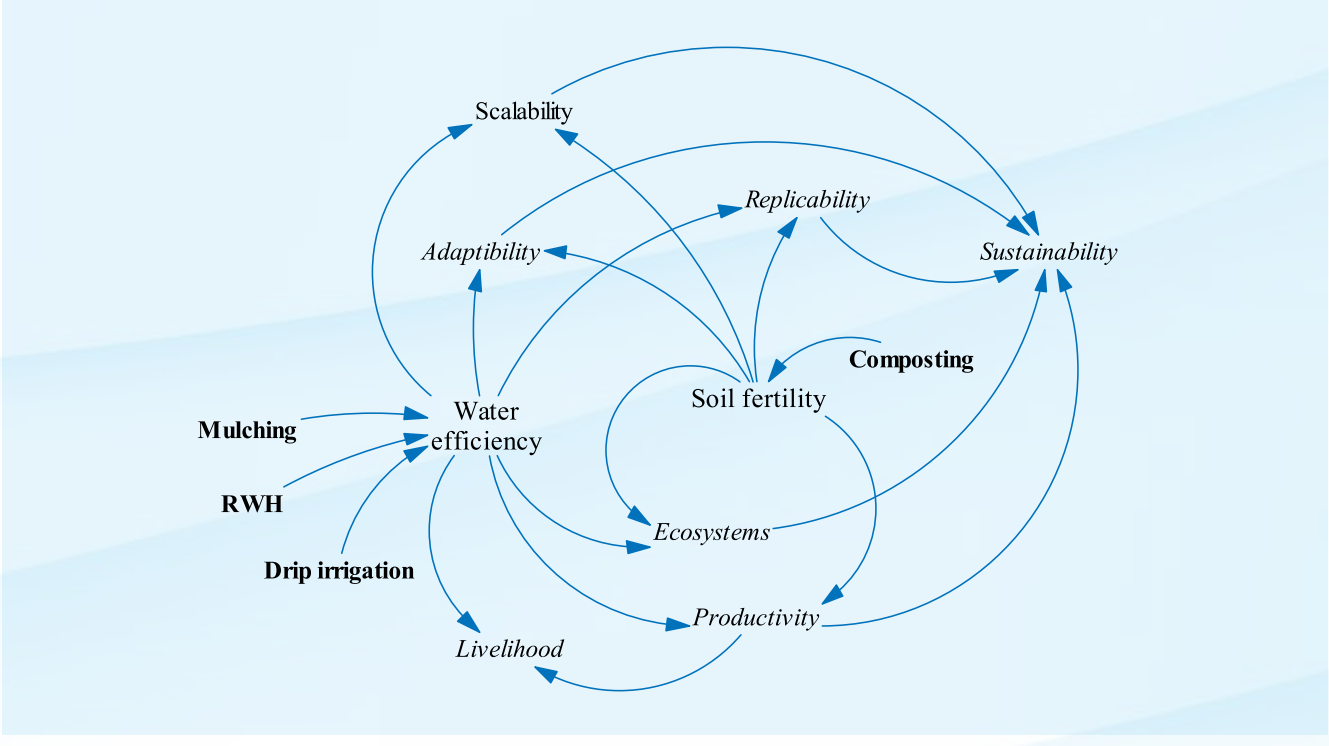


Figure 4: Interrelationship of UNCCD Good Practices of Drip Irrigation, Mulching, RWH and Compost Production.

Table 4: Selection Criteria of Good Practices and Innovations relating to UNCCD

Practice	Scalability	Replicability	Adaptability	Sustainability	Link with CCD obligation
Mulching	It increases productivity. It is scalable due to high affordability for water efficiency.	Mulching is replicable in drier parts of Bangladesh, especially in the Northern Bangladesh.	It is adaptive to changing climate.	Mulching is not a time or space limiting practice. Once adopted, farmers usually continue practicing for long time.	It addresses the General Obligations of the convention, Article#4, Section#2(a), focusing on physical, biological aspects of drought or land degradation.
Drip Irrigation	This water efficient irrigation system can be practiced in small area, as well as in large field.	Drip irrigation is replicable in any area having <5% of slope.	Climatic change will not affect agricultural practice of drip irrigation. It is adaptable in any area of <5% slope.	Drip irrigation is a water efficient practice. With growing shortage of water availability, the practice will gain more acceptance. Thus, it will be sustainable for long time.	It addresses the Obligations of the affected country parties of the convention, Article#5(a), focusing on the effects of drought or land degradation.
RWH	RWH is suitable for micro irrigation. However, larger scale implementation is possible in an area with plenty of rainfall, and having scope of excavating large reservoir.	Replicable in an area of high rainfall. Barind area and the southwest coastal zone of the country is suitable for replicating the practice.	Number of RWH families is growing very fast, indicating its good adaptive capacity. However, long time drought situation may affect the practice.	RWH offers agricultural production in water crisis areas. However, Sustainability of RWH depends upon the availability of rain water.	It addresses the Obligations of the affected country parties of the convention, Article#5(d), focusing on involving communities in mitigating the effects of drought or land degradation.
Composting	Composting is possible in small scale practice, as well as, large scale farming.	Composting is replicable in any places of Bangladesh.	It is adaptable in any changing climate and environmental condition.	It has been and will be practiced by farmers because of its easy technology, easily available materials and application nature in any spatial settings.	It addresses the Obligations of the affected country parties of the convention, Article#5(d), focusing on involving communities in mitigating the effects of drought or land degradation.

GOOD PRACTICE 1:
MULCHING TO ADDRESS SOIL DEGRADATION

Background

Mulching can be defined as the process of covering bare soil, predominantly with organic materials, but also could be with the inorganic ones. It is the process of covering the topsoil with plant material such as leaves, grass, twigs, crop residues, the straw which enhances the activity of soil organisms such as earthworms. Mulching stimulates the microbial activity in soil through improvement of soil agro-physical properties.

Mulching is an age-old technique that was already being applied since last around three centuries when the term 'mulch' was first coined. This technique has been developed over time through innovative approaches of land users. In the parts of Africa, South Asia and Australia mulching are used for increasing crop production.

Key Features

Mulching is applicable in various opportunities depending on the objective, scale, and climate. Basically, mulching is an effective method to reduce soil erosion and increase soil health to ensure more crop production. Mulching can be used in arid and semi-arid climate zones to keep soil moisture and to enhance nutrient contents. Mulching can be suitable for humid and semi-humid climates but not in the arid climate extent.

According to the material used as mulch, the mulching can be categorized into two: Organic, and Inorganic Mulching. These are the basic difference in mulching practice classified. Organic mulches are those that decay and add to the nutrient quality of the soil. Inorganic mulches do not decay but it has its own set of advantages for conserving soil moisture.

Organic Mulching

Organic mulching is the key method of mulching that uses various type of degradable materials extracted from nature. Four types of Organic Mulching are-

Wood Bark Mulching: Small pieces of wood gravels or wood chips are used for mulching.

a) Leaf Mulching: Leaf mulching uses fallen leaves as mulch and is the popular mulch as the materials are easy to collect.
b) Crop residue mulching/ hyacinth mulching: The debris of crops or cereals are used for mulching and has a high decomposition rate which adds nutrient to the soil.
c) Rice straw mulching: Rice straws are used as mulch material to increase soil health and increase production.

Organic Mulching

Inorganic Mulching

Inorganic mulch refers to those types of mulch which are synthetic and are not biodegradable. Manufactured materials, such as paper, metal foil is also used in this method. In response to the demand for this type of material, woven polypropothene mulches are available nowadays.

Mulching reduces risk of production failure due to drought or lack of soil moisture content as well as excessive runoff associated with rainfall variability. It enhances nutrient contents in soil and offers resilience to poor soil conditions due to climate variability. It helps to maintain soil moisture. It also protects soil erosion. Some general benefits of mulching observed in Bangladesh can be listed as-

- Helps to reduce soil moisture loss;
- Helps to control weed germination and growth;
- Insulates soil, protecting roots from extreme summer and winter temperatures;
- Improves soil biology, aeration, structure (aggregation of soil particles), and drainage over time;
- Improves soil fertility as certain mulch types decompose;
- Ensures nutrient supply to soil;
- Enhances crop productivity and reduces risk of production failure; and
- Contributes to food security

Inorganic Mulching

Mulching offers tremendous benefits in enriching soil nutrient content and crop production in the context of climate change induced soil degradation e.g. drought. Table 5 shows the extent of advantages of mulching in climate adaptive agriculture and climate resilient development.

Table 5: Impacts of mulching on climate resilient development and climate adaptive agriculture.

Sector	Aspect	Extent
Development	Preventing/reversing land degradation	+++
	Maintaining and improving food security	++
	Reducing rural poverty	+
	Creating rural employment	++
	Supporting Gender Equity/marginalized groups	+
	Improving crop production	+++
	Preserving biodiversity	+++
	Addressing Climate change (mitigation/ adaptation)	++
	Improving soil resources	+++
Climate Change Adaptation	Resilience to extreme dry conditions	+++
	Resilience to variable rainfall	++
	Resilience to extreme wind and storm	n/a
	Resilience to rising temperature and evaporation rates	+++
	Reducing risk of production failure	++

[Note: +++ Very positive; ++ positive; +slightly positive; +/- neutral; - slightly negative; -- negative]

In Bangladesh, mulching has been used to address various types of land degradation, including but not limited to-

- Water degradation: Drought due to a decrease of average soil moisture content and low precipitation rate which subsequently creates change in the surface water quantity.
- Erosion by water: The topsoil consisting of rich nutrients are susceptible to excess runoff.
- Physical degradation: Soil erosion is a significant factor which threatens the productivity of the soil. This type of degradation can be addressed by mulching.
- Chemical degradation: Fertility decline is associated with physical decline. Loss of balance of Nitrogen, Phosphorus, Potassium, and Carbon.
- Biological degradation: Macro and microorganisms are displaced and are threaten of habitat loss that in turn threatens soil health and crop productivity.

Mulching contributes to increased production and minimizes land degradation. In addition to agricultural production, it offers benefits in the economic, ecological and socio-cultural arena. Impacts of mulching at the community level, watershed or landscape level and national/global level have been shown in the following table 6.

Table 6: Mulching at community, landscape and national level

Benefits	Community level	Landscape level	National
Production	+++ increased crop yields ++ diversification of production +++ Increased nutrient availability	++ reduced risk of crop failure +++ reduced damage to neighboring fields	++ improved food security
Economic	+ increased farm income +++ reduced fertilizer costing	++ stimulate economic growth + diversification and rural employment creation ++Less damage of offsite infrastructure	+++ improved agriculture standard ++ less instability
Ecological	+ increase biodiversity +++ less use of fertilizers +++ increased soil organic matter and soil fertility +++ reduced soil erosion and soil loss ++ increased net soil moisture +++ Improved soil cover ++ biodiversity enhancements ++ reduced velocity of runoff	+ + intact ecosystem +++ reduced ++ degradation and sedimentation + reduced water pollution	+++ increased resilience to climate change + enhanced biodiversity +++ reduced degradation and desertification incidence and intensity ++ enhanced biodiversity
Socio-cultural	++ community capacity building ++ improved knowledge ++ accepting alternate strategies	++ increased awareness of sustainability and adaptability	

[+++ Very positive; ++ positive; +slightly positive; +/- neutral; - slightly negative; -- negative]

Major Interventions and Accomplishments

Mulching has been promoted in Bangladesh during the last couple of decades through many projects. Food and Agriculture Organization of the United Nations (FAO) provided technical support in many instances. Many of the USAID and UNDP supported projects promoted mulching in various projects. National NGOs including BRAC implemented projects promoted mulching. By now (2019) the mulching practice is widely used in different parts of Bangladesh as reported by the professionals and researchers.

Depending on the objective of the mulching in any agriculture practice, this method has been used on crop lands, grazing lands and forest as well (Table 7).

Table 7: Applicability of mulching. i) in various land degradation, and ii) in different land uses.

Land Degradation	Land Use	Scale
Erosion by water	Wet Land	High
Erosion by wind	Crop land	Moderate
Chemical degradation	Grazing land	Low
Physical Degradation	Forest	Insignificant
Biological Degradation	Mixed land use	
Water Degradation	Other	

Alignment to CCD Obligations

Mulching practice addresses the general obligations of the Convention, Article#4, Section#2(a), focusing on physical, biological aspects of drought or land degradation.

Limitations

Mulching is an efficient method to manage soil moisture. However, there are some limiting factors in using the technique. Generally, mulching may show drawback in production and ecology. Nonetheless, both limitations can be managed by respective overcoming measures as indicated in Table 8.

Table 8: Limiting factors of mulching and identified overcome procedures.

	Constraints	How to overcome
Production	Poor and less effective mulching material reduce the quality. Over use of high degradation value materials can hurt the production. Some organisms can proliferate too much in the moist and protected conditions of the mulch layer. Slugs and snails can multiply very quickly under a mulch layer. Ants or termites which may cause damage to the crops. When crop residues are used for mulching, in some cases there is an increased risk of sustaining pests and diseases.	Proper knowledge and understanding is necessary for applying mulch to avoid over proliferation of ants or slugs.
Ecological	When carbon rich materials such as straw or stalks are used for mulching, nitrogen from the soil may be used by microorganisms for decomposing the material. Thus, nitrogen may be temporary not available for plant growth.	Mulch materials should be balanced in blend and different mulch materials should be combined to avoid loss of nitrogen.

[+++ Very positive; ++ positive; +slightly positive; +/- neutral; - slightly negative; -- negative]

Concluding Remarks

Mulching has been practiced throughout Bangladesh. Its adoption rate is very high. Farmers are aware of the positive effects of this practice. Supporting rural farmers for practicing mulching can help to restore soil health and crop production.

For local and small-scale cultivation, farmers use debris. In case of high scale practice, mulch materials must be available in the market. Inorganic mulching products like plastic sheets should be accessible for local farmers. The understanding of nutrient deposition through mulching is the knowledge that should be shared and maintained for the betterment of the practice. Proper training should be offered to local farmers for better application. Better linkage to market is necessary and assistance of agriculture practitioners is needed to adopt more mulching practice in all scale and types of farming since it will help communities to sustain proper soil balance and soil health. In most cases, farmers practice mulching using their indigenous knowledge. Conveying them scientific aspects of mulching will help to adopt a more efficient mulching.

GOOD PRACTICE 2:
DRIP IRRIGATION FOR EFFICIENT IRRIGATION IN WATER SCARCE AREAS

Background

Drip irrigation is a watering system that delivers a slow-moving supply of water at a gradual rate directly to the soil consisting of networks of porous pipes, tubing valves, and emitters involving dripping water onto the soil at very low rates (2-20 litres/hour) from a system of small diameter plastic pipes fitted with outlets called emitters or drippers. It is also referred to as micro-irrigation or trickle irrigation. This technique of irrigation can be executed in areas of arid or semi-arid climate with seasonal droughts. It has been practiced in areas with scarce freshwater resources. It ensures efficient uses of water.

Drip irrigation has been practicing for thousands of years. The ancient practice of agriculture found a suitable and manageable way to bury pots near the plants. These water pots had small holes in them that would allow captured harvested water to discharge slowly near the plants. By the late 1960s, many farmers in both North and South America as well as in Australia shifted to the new drip irrigation technology.

However, Drip irrigation system is a relatively new technology in Bangladesh, is being used for growing vegetable crops. It has created interest because of low water requirement and a possible increase in production. The system has proved its superiority over other conventional methods of irrigation. Drip irrigation is mainly applied in China, Vietnam, Bangladesh, India, North & South America, Australia, and South Africa. In Bangladesh farmers of the water scarce and saline water dominated areas respectively in Barind and southwest coastal zone are practicing drip irrigation.

Key Features

Drip irrigation on Flat Land

Drip irrigation uses pipes and has a minimum gap from the water pores and soil which makes it a highly efficient technique to irrigate. The efficiency is 90% or more. This method is good to use in dryland areas or in dry season where or when water sources are scarce. Generally, only high-value crops are considered for this type of irrigation, because of the high capital costs of installing a drip system. A typical drip irrigation system consists of five components: i) Pump unit; ii) Control head; iii) Main and sub-main lines; iv) Laterals; and v) Emitters or drippers. The pump unit takes water from the water source or tank and provides the right pressure of water flow for delivery into the pipe system. The control head consists of valves to regulate the discharge and pressure. It can have filters to clear the water.

Some control head units contain a fertilizer or nutrient tank. These slowly add a measured dose fertilizer into the water during irrigation. This is one of the major advantages of drip irrigation over other methods. Mainlines, and laterals supply water from the control head into the fields. Lateral pipes are usually 13-32 mm diameter.

Medium to high level of knowledge is required for establishing a drip irrigation system. The practice demands training for installing at any scale. Moderate level of labor is required to introduce drip irrigation. However, once the preparation is taken to apply the technique and installed suitably the process needs minimum labor attention.

Drip Irrigation in Banana field in Madhupur upazila in Tangail District

Drip irrigation reduces the risk of product failure due to water shortage and provides proper irrigation to the soil and roots which in term helps crops to get water with efficiency. It enhances aquifer recharge. It enables farmers to grow crops under low precipitation rate and in the area with drought scenarios.

Level of the extent of advantages of drip irrigation in climate resilient development and in climate adaptation has been mentioned in Table 9.

Table 9: Impacts of drip irrigation on climate resilient development and climate adaptive agriculture

Sector	Aspect	Extent
Development	Preventing/reserving land degradation	++
	Maintaining and improving food security	+++
	Reducing rural poverty	+
	Creating rural employment	++
	Supporting Gender Equity/marginalized groups	+
	Improving crop production	+++
	Addressing Climate change (mitigation/ adaptation)	+++
	Improving soil resources	++
	Improving of water resources	+++
	Improving water productivity	+++
Climate Change Adaptation	Resilience to extreme dry conditions	+++
	Resilience to variable rainfall	++
	Resilience to rising temperature and evaporation rates	+++
	Reducing risk of production failure	+++

[+++ Very positive; ++ positive; +slightly positive; +/- neutral; - slightly negative; -- negative]

Major Interventions and Accomplishments

Drip irrigation has been used in different parts of Bangladesh. However, drip irrigation is extensively used in Barind area and southwest coastal zone of Bangladesh. By now (2019) this practice is widely used in different parts of Bangladesh as reported by the professionals and researchers.

With the growing demand for food production and reduced availability of water resources, Drip irrigation is highly preferred to address water scarcity. Water degradation and Chemical degradation are addressed efficiently by using this technique (Table 10). The state of low quality and quantity of surface and groundwater supply (due to drought and or minimum rainfall) are addressed through this innovative irrigation practice. The pollutions which are associated with the cultivation can be reduced through this practice. The fertilizer deteriorates water quality on a significant level and very little runoff is associated with drip irrigation. Physical degradation of soil remains minimum by using drip irrigation.

This method is basically used on croplands or grazing lands on a controlled scale or specific area under control of the mechanics. This helps to specifically target roots and crops to utilize water on a high extent. Lands with insignificant water availability in the northern part of Bangladesh and rainfed agriculture in the southwest coastal zone is in the top of drip irrigation practice. It is also practiced in stable land (up to 2% slope) in CHT. On moderate slopes (5-8% slope), the gravity can be used to the favor of the method.

Table 10: Applicability of Drip Irrigation in various land degradation, land uses and slopes.

Land Degradation		Land Use		Slopes %		Scale	
	Erosion by water		Wet Land		Very steep (>60)		High
	Erosion by wind		Crop land		Steep (30-60)		Moderate
	Chemical degradation		Grazing land		Hilly (16-30)		Low
	Physical Degradation		Forest		Rolling (8-16)		Insignificant
	Biological Degradation		Mixed land use		Moderate (5-8)		
	Water Degradation		Other		Gentle (2-5)		
					Flat (0-2)		

Impacts of drip irrigation at community level, watershed or landscape level and national/global level have been shown in Table 11.

Table 11: Drip irrigation at community, landscape and national level

Benefits	Land Users/ Community level	Watershed/ landscape level	National/global level
Production	+++ Increased crop yields ++ diversification of production +++ Enhanced water availability	++ reduces risk of crop failure +++access to sustainable water use	++ improved food security +++ improved water security
Economic	++ increased farm income +++ access to effective irrigation method ++can reduce the costing of irrigation in the long run.	++ stimulate economic growth ++ diversification and rural employment creation ++Less damage to offsite infrastructure	+++ improved livelihood ++ less instability

Benefits	Land Users/ Community level	Watershed/ landscape level	National/global level
Ecological	++ less use of fertilizers +++ improved water availability +++ improved water infiltration +++reduced runoff ++reduce soil erosion and soil loss +++ can be used for rehabilitation of highly degraded land	+++ reduce use of groundwater ++ Reduced fertilizer use +++ increased water efficiency and reliable water flow in dry season ++ ground water recharge ++ reduce ground water pollution ++ reduced degradation of sediments	+++ increased resilience to climate change and natural disasters +++ reduced degradation incident and intensity.
Socio-cultural	+++ community capacity building ++ improved knowledge ++ accepting new technologies +++ less pressure on water resources for irrigation ++ improved conservation	+ increased awareness of sustainability and adaptability ++ reduced water conflicts ++ national institute strengthening	

[+++ Very positive; ++ positive; +slightly positive; +/- neutral; - slightly negative; -- negative]

Alignment to CCD Obligations

Drip Irrigation contributes to the Section C of General Obligation 9 Article 4, where the government is committed to integrating strategies for poverty eradication into efforts to mitigate the drought. It also addresses Section 1(e) of Article 19, which emphasizes adapting environmentally sound technology and traditional method of agriculture. It addresses the obligations of the affected country parties of the convention, Article#5(a), focusing on the effects of drought or land degradation.

Limitations

The key drawback of Drip irrigation is its high cost in comparison to other practices. Medium to large scale implementation is very costly. However, this limitation can be addressed by arranging affordable and readily available materials. The adoption rate remains medium to low. Farmers adopting the technique might have to deal with high prices. The technique recommended must be economic and would offer higher benefit to attract local communities to adapt to drip irrigation. Clear land and water tenure and property rights are necessary to motivate land users to invest in drip irrigation. The technique should be manageable at all level, otherwise, the whole practice might end up resulting loss to the farmers.

Concluding Remarks

Drip irrigation is a highly efficient mode of irrigation in scare water situation, but a more expensive than other modes of irrigation. Efforts should be made to open the knowledge of drip irrigation to minor to large scale crop production systems to ensure this sustainable water use practice. In some cases, farmers, despite having the proper motivation, lack the supervision of market access to find the basic and proper material to start with the process. The market should offer a good supply of materials to start with the practice and help the farmers to have low pricing products to install drip kits.

GOOD PRACTICE 3:
RAIN WATER HARVESTING (RWH) FOR TAPPING NATURAL RESOURCES

Background

Rainwater is an option, which has been adopted in many areas of the world where conventional water supply systems are not available or have failed to meet the needs and expectations of the people. It is a technique of water collection, which has been used since ancient times. Rain Water Harvesting (RWH) is the collection and storing of rainwater to make it available for domestic or agricultural uses in dry areas where moisture deficit is the primary limiting factor. Agricultural production in dry areas, which is usually delivered by subsistence farmers, depends on unreliable rainfall. Rainwater harvesting is an opportunity to improve the productivity of small-scale farming and enhance food security and economic development. Rainwater harvesting is an ancient practice and has been developed in areas where rainfall is not enough to support crop production or is too variable to guarantee a harvest, or where drinking water sources are scarce. Around 80% of cropland worldwide is rain fed. Many different cultures have used this technology for agricultural purposes.

It is practiced in many countries, including but not limited to Bangladesh. Brazil, China, Argentina, Thailand, United States, Myanmar, India, Pakistan, South Africa, New Zealand, Sri Lanka, and the United Kingdom. In Bangladesh, it is mainly practiced in Barind region and southwest coastal zone of Bangladesh. However, the main reason of RWH in North Bengal, especially, in the Barind region is agriculture, but in the southwest part, it is mostly used for domestic uses and small-scale homestead agriculture.

Key Features

The basic approach to rainwater harvesting is to have three basic components; rainfall, catchment area and a structured method of diverting water to a storage or recharge facility. Various developments of the method can be seen but for thinking in the light of Bangladesh below are some techniques to mention (Biswas and Mandal, 2014). Rainwater harvesting is suitable for different purpose and goals with the basic applicability of collecting and utilizing water to ensure proper management of the resource. It enables users to collect, store and use water with targets that makes it highly productive method to use. Rainwater harvesting system reduces the risk of product failure due to water shortage associated with variable rainfall, drought or other extreme events. In areas where rainfall patterns are interrupted, and water is scarce this technique can aid to build up resilience to rainfall variability due to climate change.

In Situ Rainwater Harvesting

In situ rainwater harvesting systems are based on changing soil and water management techniques, with the aim to improve infiltration, water holding capacity and fertility of the soil and to counter soil erosion. Capture and storage areas are within a small distance. It is not considered as a direct rainwater harvesting method since this technique allows rainwater to store where it falls. Runoff is not allowed, and evaporation loss minimized. It can also be used as a water source for livestock or domestic purposes if it recharges shallow groundwater aquifers or other water flows or small ponds.

Ex Situ Rainwater Harvesting

With this method, water is not collected in the same area. The water is stored in natural or artificial reservoirs of various dimensions, such as; wells, ponds for irrigation purposes or for domestic use. The capture surface has little or no infiltration capacity. Depending on the catchment areas surrounding the crop land the technique can be differentiated by micro-catchments and macro-catchments.

Rooftop Rainwater Harvesting

In rooftop rainwater harvesting, the roof becomes the catchments, and the rainwater is collected from the roof of the house/building. It can either be stored in a tank or diverted to an artificial recharge system. This method is less expensive and very effective and if implemented properly helps in augmenting the ground water level of the area. Rainwater from the rooftop is carried through down take water pipes or drains to storage/harvesting system. Water from sloping roofs could be caught through gutters and down take the pipe.

Surface Runoff Harvesting

Rainwater flows away as surface runoff which could be captured and used for recharging aquifers by adopting appropriate methods. The surface being impenetrable it can be used as catchment area to store water into a water storing facility. Pond and dams can also be made to collect runoff water depending on the scale of the catchment setup and geological position. If the catchment area offers a big load of runoff then using the large storing facility as the pond is better for proper utilization. In the case of the hilly areas, this method can be used for capturing and storing for domestic and agriculture use as well.

A woman in southwest coastal zone is standing beside a rain water harvesting tank

Rainwater harvesting has a clear and convincing offering of benefits. It helps to solve water scarcity and help in utilizing water for agriculture practices, resulting in an enhanced crop and livestock production, as well as secured water supply for domestic purposes. Rainwater harvesting offers great incentives for development and climate change adaptation. Level of the extent of advantages of Rainwater harvesting has been mentioned in Table 12.

Table 12: Impacts of rain water harvesting on development and climate change adaptation sectors.		
Sector	**Aspect**	**Sector**
Development	Preventing/reserving land degradation	++
	Maintaining and improving food security	++
	Reducing rural poverty	++
	Creating rural employment	++
	Support Gender Equity/marginalized groups	+++
	Improving crop production	++
	Climate change mitigation/ adaptation	+++
	Improving soil resources	++
	Improving water resources	+++
	Improving water productivity	++
Climate change	Resilience to extreme dry conditions	++
	Resilience to variable rainfall	+++
	Resilience to extreme wind and storm	+
	Resilience to rising temperature and evaporation rates	++
	Reducing risk of production failure	++

[Note: +++ Very positive; ++ positive; +slightly positive; +/- neutral; - slightly negative; -- negative]

Major Interventions and Accomplishments

Rainwater Harvesting (RWH) has been used in different parts of Bangladesh. Various development projects over the last decade funded by ADB, USAID and others supported rainwater harvesting. UNICEF patronized such projects. LGED and other government agencies host these projects. National and international NGOs have used this technology in their community support projects. Rain water harvest has been in practice in 37 upazilas in 13 districts of Bangladesh. The areas identified as Rain Water Harvesting (RWH) practicing upazilas have been indicated in Figure 5. Other upazilas of the same districts have also been marked (Table 13). These upazilas have high potential of practicing RWH.

Table 13: RWH Practicing Upazilas		
SL.	**District**	**Upazlia**
1	Bagerhat	Mongla, Morelgang, Rampal, Sarankhola
2	Barisal	Babugonj, Bakerganj, Banaripara, Barisal Sadar, Mehendiganj, Muladi
3	Bhola	Monpura
4	Borguna	Amtali, Patharghata, Taltoli
5	Chandpur	Kochua, Matlab
6	Comilla	Barura, Chandina, Comilla Sadar, Homna, Laksam, Monoharganj, Sadar Dakshin
7	Cox's Bazar	Kutubdia, Moheskhali, Ramu, Teknaf
8	Faridpur	Bhanga, Faridpur Sadar
9	Khulna	Dacope, Dumuria, Paikgacha
10	Netrokona	Purbadhala
11	Pirojpur	Mothbaria
12	Rajshahi	Bagha, Charghat
13	Satkhira	Tala

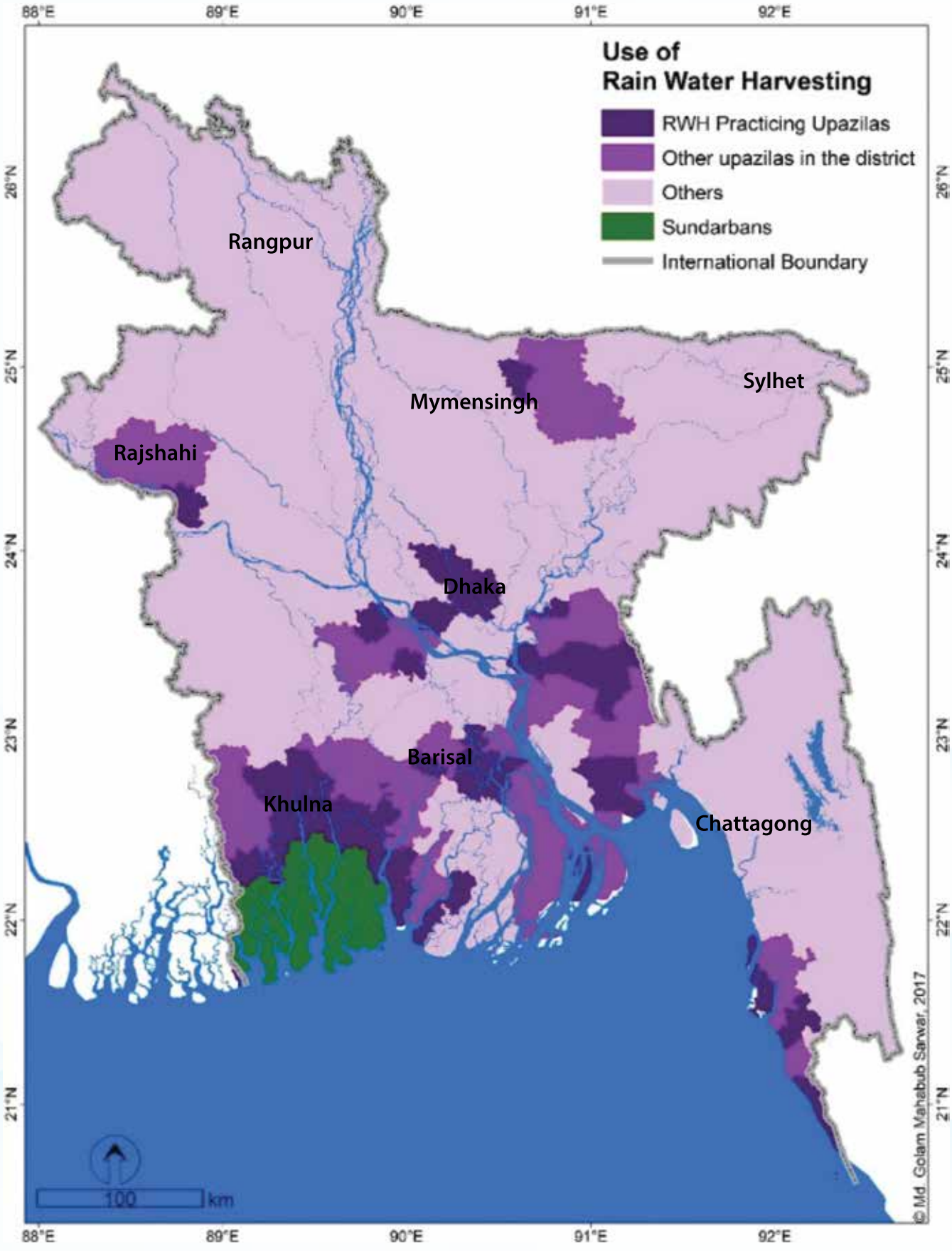


Figure 5: RWH practicing upazilas in Bangladesh

Rainwater harvesting is highly used in drought-prone areas in Northern part of Bangladesh and in Southwest districts of Satkhira, Khulna, Bagerhat, Barguna and Patuakhali districts having with an acute shortage of fresh water. It is also used in the area where groundwater is depleted due to extensive extraction and loss of freshwater resources. In the CHT, RWH is used to cultivate fish in the small and medium charas. This technique can be used in annual croplands with cereals, rice, and vegetable production (Table 14).

Table 14: Applicability of RWH in various land degradation, land uses and slopes

Land Degradation	Land Use	Slopes %	Scale
Erosion by water	Wet Land	Very steep(>60)	High
Erosion by wind	Crop land	Steep(30-60)	Moderate
Chemical degradation	Grazing land	Hilly(16-30)	Low
Physical Degradation	Forest	Rolling(8-16)	Insignificant
Biological Degradation	Mixed land use	Moderate(5-8)	
Water Degradation	Other	Gentle(2-5)	
		Flat(0-2)	

Rainwater harvesting contributes to higher production in a water shortage situation. In addition to agricultural production, it offers various benefits in economic, ecological and socio-cultural sectors. However, it offers more of ecological benefits than those of economic or socio-cultural.

Impacts of RWH at the community, landscape, and national level have been shown in Table 15.

Table 15: Degree of advantages of Rain water harvesting at community, landscape and national level.

Benefits	Community level	Landscape level	National level
Production	++ Increased crop yields ++ diversification of production	++ reduces risk of crop failure +++ access to fresh and clean drinking water	+++ improved food security
Economic	++ increased farm income ++ access to clean free drinking water	++ less damage to offsite infrastructure ++ stimulate economic growth + diversification and rural employment creation	+++ improved livelihood ++ less instability
Ecological	+ Increase biodiversity +++ improved water availability +++ can be used for rehabilitation or highly degraded land ++ Improved water infiltration ++ reduced velocity of runoff ++ reduced soil erosion and soil loss ++ improved water drainage + improved soil cover	++ reduce use of groundwater ++ reduced degradation and sedimentation ++ increased stream flow + ground water recharge + intact ecosystem	+++ increased resilience to climate change and natural disasters ++ reduced degradation and desertification intensity + enhanced biodiversity
Socio-cultural	+++ less pressure on water resources for drinking water or irrigation ++ improved knowledge + accepting new technologies + reduce land conflict	+ increased awareness of sustainability and adaptability ++ reduced water conflicts	+ protecting national heritage

[Note: +++ Very positive; ++ positive; +slightly positive; +/- neutral; - slightly negative; -- negative]

Alignment to CCD Obligations

It addresses the Obligations of the affected country parties of the convention, Article#5(d), focusing on involving communities in mitigating the effects of drought or land degradation. Rainwater harvesting contributes to the section C of General Obligation (Article 4), where the government is committed to integrating strategies for poverty eradication into efforts to mitigate the drought. It also addresses Section 1(e) of Article 19, which emphasizes adapting environmentally sound technology and traditional method of agriculture.

Limitations

The prolonged absence of rain is the main limitation. During the dry season, the amount of rain is minimum. To have a rooftop harvesting, a stable roof is required. A poor rural farmer may not have such a strong house and fail to avail such a system. Following table 16 mentions some limiting factors in practicing RWH. The table also presents the ways to overcome.

Table 16: Limiting factors of rain water harvesting and its overcoming measures

	Constraints	How to overcome
Production	RWH alone does not lead to high yield production	Combine with new soil fertility management
Ecological	Water logging can be problem under poor drainage systems Water can only be harvested when it rains	Water logging system should be considered during design phase
Socio-Cultural	RWH can promote upstream downstream conflicts in terms of water availability. Not accepting RWH for socio cultural reasons.	Clear idea and concepts needs distribution. Ensuring proper land and water use rights. Improved watershed planning. Farmers and community involvement.

[Note: +++ Very positive; ++ positive; +slightly positive; +/- neutral; - slightly negative; -- negative]

Challenges within rain-fed farming in many arid, semiarid, sub-humid and even in humid regions are frustrating due to lack of variable rainfalls. Water for production continues to be a key constraint to agriculture. The absence of clear land and water use rights prevents water harvesting technique from being more widely spread. To establish RWH systems medium to high-level knowledge is required. RWH methods require high labor at the initial phase of the process. However, in the household or domestic purpose setups, small labor is required. In cases where dams and ponds need retention, then the labor is high through the long process of setting up a harvesting system.

Concluding Remarks

RWH is a method that can be used from any part of the country. However, its application is higher in the drier area of the northern part of the country, especially in the Barind region. In addition, the use in agriculture, the method is also used to tap drinking water. Generally, the adoption rate of the technique is low, but getting popular, especially in the southwest coastal zone of Bangladesh, where fresh water is highly scarce. People in that area harvest rainwater for agriculture and drinking purposes. The cost of RWH and amount of labor must be affordable for the community. One of the constraints that are hindering adoption of RWH technique is the lack of proper knowledge and training. The materials and technical support should be of ease and permissible by farmers. The natural environment and the instability of environmental conditions in dry areas in times of climate change is a permanent threat to the livelihood of rural and poor people. As part of integrated agricultural water management, RWH could be used as an adaptation mechanism for climate change and to improve the livelihood of farmers and domestic lifestyle.

GOOD PRACTICE 4:
COMPOSTING FOR SOIL HEALTH

Background

Composting is an ancient technology undertaken in a different level and scale, from household to industrial, from small practice to a commercial venture. The distinction between compost and fertilizer is that compost feeds the soil and fertilizer feeds the plants. Compost is a reliable source of soil nutrient that not only supports crop production but also maintains soil fertility. The health of cultivating soil can be highly improved since the compost offers supplementary nitrogen source that complements fertilizer nitrogen.

Composting is a quite old technique, but recently people's interest has turned towards it. It is not anything except the bioconversion process. Compost is highly appreciated in areas with seasonal droughts or low nutrient factors prevailing the soil. It is mainly used as supplementary to soil richness to ensure good production value in cultivation. This process is, of course, a process of giving it back to nature. It can also be used to control municipal waste management and the technique is highly efficient in doing so.

Key Features

Compost is a soil mixture that consists largely of decomposed organic matter and is used for fertilizing and conditioning land. Composting is nature's process of recycling decomposed organic materials into a rich soil known as compost under aerobic conditions with aerobic microbes. The simplest process of composting requires making a heap of wet organic matter known as green waste (leaves, food waste) and waiting for the materials to break down into humus after a period of weeks or months.

The process of compost production involves stacking various layers of animal manure, sewage sludge, garbage, straw, and leaves. Stacked material was turned occasionally over 6 months or longer, and leachate from the decomposing residues was recycled to maintain adequate moisture in the piles. Current composting practices use essentially the same principles. Bangladesh is familiar with composting for many years. Farmers from the beginning of agriculture practice in this region are using the composting method to utilize organic materials to enrich soil productivity. This method is somewhat native to many extents. Composting mainly applied in Bangladesh, India, Myanmar, Vietnam, Indonesia, New Zealand, North America, Nigeria, and Zimbabwe. In Bangladesh, farmers of all districts use compost.

There are several ways of compost production. However, two methods are mainly used in Bangladesh: Underground/ Pit/ Trench Method and Surface/ Pile/ Heap Method.

Underground/Pit/Trench Method

This method places materials into pits or trench and this method is suitable for dry seasons like summer or winter. Generally, a trench of 3 meter-long, 1.2 m wide and 1.3 meter-deep are prepared for stacking different layers. However, the size of the trench or pit can, of course, vary according to the purpose of the preparation.

This method should be used on high lands above the flood-prone area but near to water source. A shade is suitable for composting. Before the process starts some straws of rice, wheat, or jute may be placed as an absorbing material. A 30 cm thick layer is made using water hyacinth and other waste materials. After settling the absorbing material 200g urea and 200 TSP is placed on the layer surface after which a 2.5 cm thick layer of cow dung or clay is placed. This procedure is continued until the pit fills with composting material. Doing so when the pit reaches a height of 45 cm it is molded with more cow dung and clay material to seal the structure. After 3 months this compost will be ready to be applied on soil.

Surface/ Pile/ Heap Method

This method is useful in areas where precipitation is high. It can be prepared in the rainy season, as well. In the method, a 30 cm thick layer is made with water hyacinth and other waste materials. Fertilizer of 200g urea and 200g TSP is broadcasted on the layer surface after which a 2.5 cm thick layer of cow dung or clay is placed. This process continues until it reaches a height of 1.3 m. After the heap is made a cover should be made over the heap structure using cow dung or any sort of clay materials. After 4 months this will transform into usable compost to apply on the soil.

The quality of compost depends on the moisture content in the heap or pit. After about 7 days, a stick can be used to understand the moisture condition inside the heap. If it shows excessive moisture content then a few holes should be made on the structure in order to aeration to take place. But after 3 to 4 days these holes should be sealed with soil. In order to enhance decomposition, the layers can be inverted with one-month interval. However, worm composting or vermicomposting is getting popular in the country, day by day.

Compost energizes the soil food web, which is made up of microscopic bacteria and fungi, along with earthworms, crickets, and many other life forms. Many fungi form symbiotic, or mutually rewarding, partnerships with plant roots, making it possible for vegetables to feed themselves more efficiently. It reduces pest significantly. Use of pesticides and adding organic materials to the soil improves moisture retention. Compost provides a balanced, slow-release source of nutrients that helps the soil hold nutrients long enough for plants to use them. Composting increases the formation of stable carbon that remains bound in the soil for long periods of time. Applying organic matter to soils is one of the most effective ways to divert CO2 from the atmosphere and convert it into organic carbon in soil. The nitrogen in compost can increase soil productivity, which can lead to increased crop residues and an increased return of carbon to the soil.

Major Interventions and Accomplishments

Compost fertilizer has been promoted in Bangladesh during the last couple of decades through many projects. UNDP provided technical support in many instances. Many of the USAID and UNDP supported projects promoted composting in various projects. National NGOs including BRAC implemented projects promoted composting.

Drought promotes a lack of soil nutrients which in term is a climate variable. This method helps to cope with the backlash and sustain soil production capacity. Utilization of compost manure helps soils to recharge its nutrients and organic matter.

Compost offers tremendous benefits in development and climate change sectors. Level of the extent of advantages of compost production in the development sector and also in climate change adaptation has been mentioned in Table 17.

Table 17: Impacts of composting on development and climate change adaptation sectors

Sector	Aspect	Extent
Development Issues	Preventing/reserving land degradation	+++
	Maintaining and improving food security	+++
	Reducing rural poverty	+
	Creating rural employment	+
	Support Gender Equity/marginalized groups	+
	Improving crop production	+++
	Climate change mitigation/ adaptation	++
	Improving soil resources	+++
	Improving wood/fibre production	++
Climate change adaptation	Resilience to extreme dry conditions	++
	Resilience to variable rainfall	+
	Resilience to extreme wind and storm	na
	Resilience to rising temperature and evaporation rates	+
	Reducing risk of production failure	+++

[Note: +++ Very positive; ++ positive; +slightly positive; +/- neutral; - slightly negative; -- negative]

Compost has been used to address the physical, chemical and biological degradation of soil. Excessive use of topsoil leads to degradation of soil quality (porosity, structure, texture) and nutrient balance, which can be addressed through composting that recharges nutrients of the topsoil. Extensive agriculture practice reduces the chemical nutrients available in the soil. Nitrogen-phosphorus, potassium, carbon, and salts which are crucial for any practice of agriculture and for the soil. The microorganisms or the helping agents are depleted through excessive uses of soil. Degradation of microorganisms of soil can be regained by using compost manure (Table 18).

Depending on the uses and objectives, this method has been used on crop, grazing and forest lands that are free from flooding. Compost production does not specifically have any preferred climate type since the procedure and methods require few techniques and small variables. However, too much humid climate is avoidable. Mostly high lands are suggested and not areas with slopes or inclination.

Table 18: Applicability of composting in various land degradation, land uses and slopes

Land Degradation		Land Use		Slopes %		Scale	
	Erosion by water		Wet Land		Very steep(>60)		High
	Erosion by wind		Crop land		Steep(30-60)		Moderate
	Chemical degradation		Grazing land		Hilly(16-30)		Low
	Physical Degradation		Forest		Rolling(8-16)		Insignificant
	Biological Degradation		Mixed land use		Moderate(5-8)		
	Water Degradation		Urban area		Gentle(2-5)		
					Flat(0-2)		

Land ownership is not crucial for composting in case of small-scale practice but the large scale production requires ownership on land. However, large scale composting will need bigger labor input. Composting contributes to increased production, also offers benefits in economic, ecological and socio-cultural sectors. The impacts of composting at the community, landscape, and national level have been presented in Table 19.

Table 19: Impacts of composting at community, landscape and national level

Benefits	Community level	Landscape level	National level
Production	++ Increased crop yields		++ improved food security
Economic	+ increased farm income +++ Reduced fertilizer costing	++ stimulate economic growth + diversification and rural employment creation	+++ improved agriculture standard ++ less instability
Ecological	+ Increased biodiversity +++ Reduced fertilizers use +++Increased soil organic matter and soil fertility +++reduced soil erosion and soil loss +Increased net soil moisture +++ Improved soil cover	++ Reduced groundwater use +++ Reduced fertilizer use + +Maintained ecosystem + Reduced degradation	+++ increased resilience to climate change + enhanced biodiversity +++ reduced degradation and desertification incidence and intensity ++enhanced biodiversity
Socio-cultural	+ Enhanced community capacity ++ improved knowledge ++ Introduced alternate strategies	++ increased awareness of sustainability and adaptability	

[Note: +++ Very positive; ++ positive; +slightly positive; +/- neutral; - slightly negative; -- negative]

Alignment to CCD Obligations

Composting contributes to the Section C of General Obligation (Article 4), where the government is committed to integrating strategies for poverty eradication into efforts to mitigate the drought. It also addresses Section 1(e) of Article 19, which emphasizes adapting environmentally sound technology and traditional method of agriculture.

It addresses the Obligations of the affected country parties of the convention, Article#5(d), focusing on involving communities in mitigating the effects of drought or land degradation.

Limitations

Composting is an efficient method to increase soil fertility and to manage soil health and moisture. However, there are some limiting factors in using the technique. Composting may show drawback in production and ecology at a negligible level. Nonetheless, both limitations can be managed by respective overcoming measures, as indicated in Table 20.

Table 20: Limiting Factors of Composting and its Overcoming Root

Sector	Limitation	How to overcome
Production	Poor and less effective compost material reduce the quality of composting	Proper waste management is necessary and collection of high composting value materials
Ecological	inadequate pathogen suppression	The process needs integration of mechanisms to avoid pathogen dispersion

Concluding Remarks

Composting is a traditional soil improvement technology practiced almost in every part of the country. Its adoption rate is high, especially in rural cultivation. Farmers are well known with the idea and they implement composting in most agriculture practices. Framers across the country are practicing compost production that offers them an economy mode of applying nutrients to the soil. Compost production is an environmentally friendly practice. The technique is profitable for the cultivation of crops and in return for farmers. The practice creates the opportunity to build and increase capacity rather than just depending on the deteriorating conditions of the soil. Since this knowledge is well established, it will be more pertaining to try to upscale the technique.

This method does not require extensive knowledge or training to execute the practice, however, having basic knowledge is important to have a better result. If the preparation to the pits and heaps can get assistance from market accessibility, it will be more convenient for farmers to incorporate composting in large scales.

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ANNEX I

List of practices and innovations identified primarily using productivity, livelihoods and ecosystem	
Practices	**Relevant Rio Convention**
1. Co-management of Protected Areas (PAs) 2. Community Based Eco-System Restoration in the Chittagong Hill Tracts (CHTs) 3. Village Common Forests (VCFs) Management in the CHTs 4. Conservation through Religious Institutions Involving Local Communities in the CHT 5. Community Based Swamp Forest Restoration Initiative in Sunamganj District 6. Community based Fish Sanctuary 7. Hilsa Fishery Management 8. Poultry Vaccinators Delivering Services to the Doorstep of the Poorest in Bangladesh	UN Convention on Biological Diversity (**UNCBD**)
1. Climate Resilient Agriculture and Food Security: The role of Floating Agriculture 2. Community based Early Warning System to reduce the Disaster Risk Reduction: A case of Flood/Cyclone Warning Systems 3. Community based Afforestation and Reforestation 4. Irrigation and Renewable Energy (Solar) Development 5. Saline Tolerant Crops: Rice and Jute 6. Drought Tolerant Crops: Rice 7. A case of establishing Climate Change Trust Fund (BCTF) 8. Community based Co-management for Wetlands in Bangladesh 9. Co-management of the Protected Areas (PAs) in Bangladesh	UN Framework Convention on Climate Change (**UNFCCC)**
1. Zero tillage farming 2. Slope farming 3. Slash and burn 4. Vermiculture 5. Plantation for erosion protection 6. Orchard farming 7. Mulching 8. Rain Water Harvesting 9. Composting 10. Drip irrigation	UN Convention to Combat Desertification (**UNCCD**)

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