

Exploring the Major Climate-smart Agricultural Practices for Dry Season Crop Production in Salinity Affected Fallow Land in the Coastal Areas of Bangladesh

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

The landmasses of the coastal areas of Bangladesh still remains under-utilized, thus cropping intensity is much less than the national average. Most areas remain fallow during dry (rabi) season from December to May due to presence of higher concentration of salts in soil and water, and scarcity of suitable irrigation water. Available adaptation options or technologies are not capable to solve these problems at all. Nevertheless, the areas receive a lot of water from monsoon rain, most of that rainwater is drain-out as surface runoff. The present study results suggest that the use of harvested rainwater and conservation agriculture either in combination or alone could mitigate the problem for bringing huge areas under crop cultivation. The public social safety net programmes such as cash-for-work, food-for-work etc. can be deployed for excavating or re-excavating the abandoned coastal ponds, ditches or canals for storing rainwater. Salt-, drought- and/or heat-tolerant crop varieties with short life span can also be cultivated to get the better results. Early plantation or growing crops with early-maturing varieties can ensure safer harvest in ahead of stress arrives. The avenues have immense potential as climate-smart practices for growing crops preferably non-rice crops during dry season in vast fallow land that will not only ensure food

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security for coastal people but could turn the entire southern Bangladesh as a food surplus zone. The findings refer the broad recommendation, therefore, specific research works based on the locations and resources available are necessary.

Keywords: *Climate-resilient crop varieties; climate-smart practices; conservation agriculture; rainwater harvest; salinity stress; social safety net programmes; south-west monsoon.*

1. INTRODUCTION

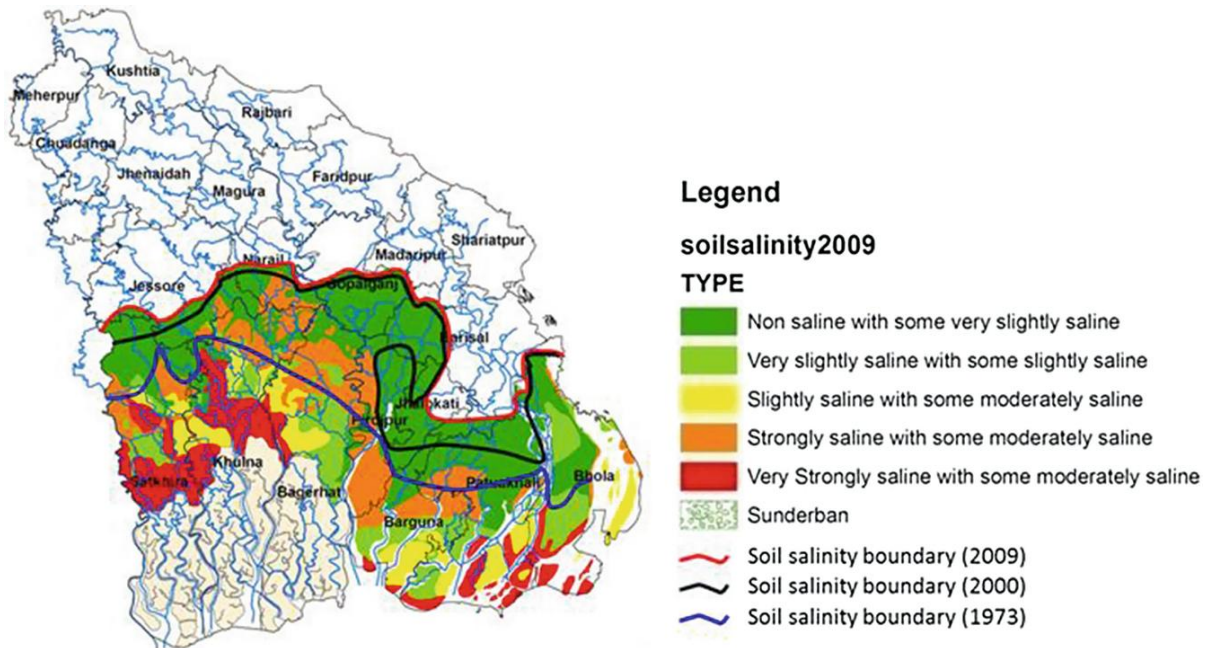
Southern coastal region constitutes 32% of Bangladesh that hosts 28% of the country's population, is treated as one of most climatically-vulnerable regions of the world as the areas are subjected to multiple threats both from slow-onset and extreme weather events. Most cyclones that form in the Bay of Bengal hit Bangladesh coast. Lower topography, innumerable channels and canals and vicinity of Bay of Bengal have made the area most exposed for storm surge or tidal flooding, sea-level rise, salinity intrusion and water-logging [1,2]. Thus, surface and ground waters in the coastal areas of Bangladesh are affected by salinity started from post-monsoon and reached its highest level during the end of dry (rabi) season [3]. Electrical conductivity, total dissolved solids, sodium, and chloride ions of water in coastal river, rivulets, and attached canals and underground sources exceeded the permissible limit for growing crops in the areas [4]. The spatial pattern of soil salinity was also found similar to that of river water salinity and groundwater salinity [5]. Scarcity of fresh water and gradual drying up of top soil due to evaporation loss with onset of rabi (dry) season would accentuate salinity problem. Thus after harvest of aman rice, farmers cannot cultivate crops results most areas remain fallow

(Photographs 1-2) from December or January to May [6,7] that has brought coastal people to food insecurity as the livelihood of coastal dwellers are mostly agrarian. The affected areas constitute 1.05 million hectares (mha) arable land out of 2.88 mha of coastal and offshore lands in Khulna and Barisal divisions [7].

With integrating 'mitigation' and related other dimensions, Climate Change Adaptation (CCA) concept has recently been promoted to Climate-Smart Agriculture (CSA) approach for better managing the risk exposure to a great extent. A practice may be considered as 'climate-smart', if it falls within the three main pillars such as sustainably increasing agricultural productivity and incomes, adapting and building resilience to climate change, and reducing greenhouse gas emissions, where possible [8]. The approach is already proved as a sustainable device to the underlying discipline [9]. With utilizing befitted technologies and assets like natural, physical, financial, social and human, available in the areas there exist a huge potential of CSA practices for turning the dry fallow lands into the cultivable one. Therefore, the aim of the study is to explore the major technologies or opportunities as mean of CSA practices during the dry season in the salinity affected coastal region of Bangladesh.



Photographs 1-2: Vast land remains fallow (with adjacent roadside ditches) during dry season in the coastal areas of Bangladesh. Photo Credit: Author



Map 1. Development of salinity in soil in the Khulna and Barisal divisions in south-central and south-west areas of Bangladesh from 1973 to 2009. Map Credit: SRDI [7]

2. METHODOLOGY

The study was conducted in the Plant Ecology Laboratory, Department of Crop Botany, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh. Climate change related books, booklets, journals, articles, leaflets, folders, published and unpublished reports, grey literatures and newspaper articles etc. related to the agricultural production especially for coastal regions were collected and analysed. Stakeholder consultation with the personnel working at research institutions, state- and not-state extension agencies, GO and NGO bodies, and Development Projects was carried out to know their innovations or technologies and extension of those to the growers in the coastal areas. Opinions of relevant experts were also collected through personal communication. Additionally, direct field visits or on-spot observations were performed on locations of interest in the various places of coastal Region of Bangladesh.

3. RESULTS AND DISCUSSION

3.1 Water Harvest Potentialities in the Coastal Areas

About 347,671 ponds are scattered in the coastal areas of Bangladesh that comprised approximately 37,530 hectares of land [10]. Due

to lack of proper maintenance, most of those have been abandoned which can be re-excavated for storing rainwater. The coastal areas are profusely criss-crossed by a larger number of channels/canals (Photograph 3) that could store rainwater if appropriate control measures are established. The barren road-side ditches (Photographs 1-2) or abandoned borrow pits can be rehabilitated to store large volume of rainwater to irrigate rabi crops. It is observed from site visit that the said water reservoirs in the coastal areas don't dry up until March and the salinity level of water therein does not go so up that unsuitable for crop growth (Photograph 4) [11]. For providing supplemental irrigation during rabi season, these local reservoirs can be rehabilitated to store much amount of water from monsoon rain. The government's social safety net programmes like cash-for-work, food-for-work, and like so can be deployed in the areas for digging or excavation or re-excavation works [12].

3.2 Rainfall Occurs During South-West Monsoon and Scenarios of Water Loss and Harvest

Large amount of rainfall (average 1493 mm as per Bangladesh Meteorological Department) that occurs during the South-West (S-W) monsoon (i.e. June-September) in the coastal areas of Barisal and Khulna divisions (Fig. 1). Total

amount of rains at that period was found higher in Barisal division (1569 mm) as compared to that from Khulna division (1132 mm). However,

the S-E monsoon rainfall pattern is slightly shifted recently with an increasing rain thrust that is occurring in Khulna division [13-14].



Photograph 3. Canal inside the crop lands in the coastal area of Bangladesh that can store rainwater with appropriate control measure.

Photo Credit: Author



Photograph 4: Growing boro rice in a coastal area of Bangladesh using the water from adjacent pond that harvested during the last monsoon. Nearby a vast land remains fallow due to lack of water and higher degree of soil salinity. The photograph was taken during middle of March

Photo Credit: Author

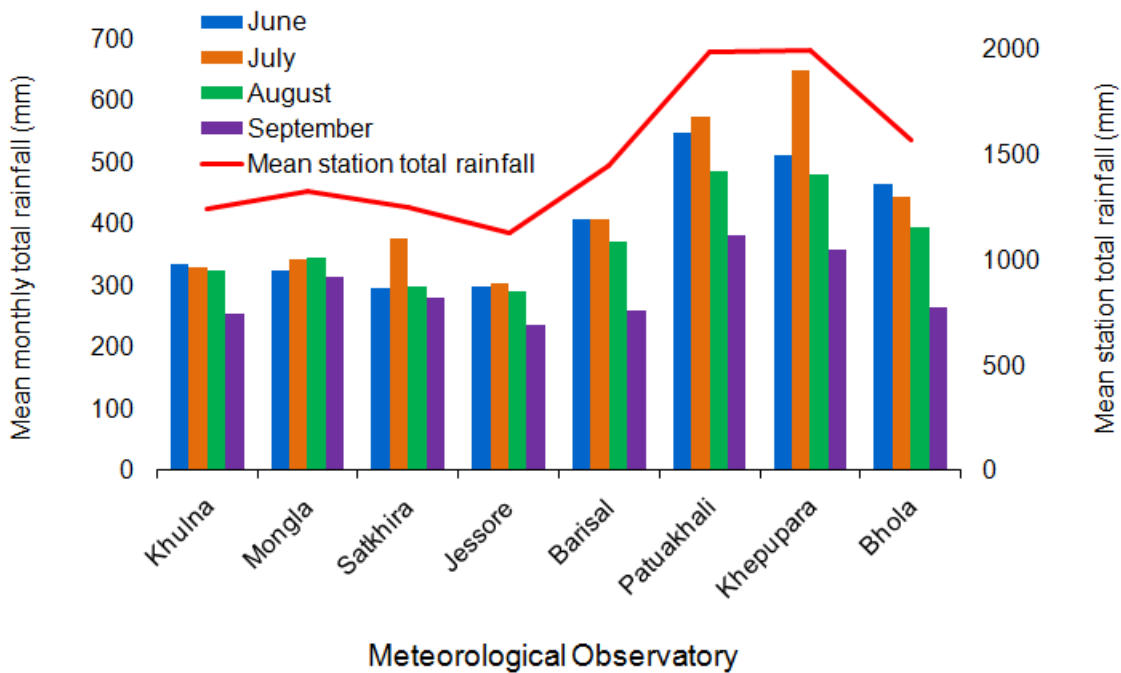


Fig. 1. Mean monthly and station total rainfall during South-West (S-W) monsoon season (from June to September) recorded in meteorological observatories of Khulna and Barisal divisions of Bangladesh

Data Source: Bangladesh Meteorological Department

Most of the rainwater is drained-out as surface runoff, which can be conserved in the aforesaid reservoirs in the coastal areas. It is optimized from a Farm Pond Storage Simulation (FPSS) model that 2.44 mm/day/m water may be reduced from a pond due to runoff/seepage and percolation losses [10]. The estimated crop evapotranspiration was found 74% of that of potential evapotranspiration as determined by pan evaporation method. The model also showed that approximately 19% of rainwater becomes runoff from the command area which could be stored for supplemental irrigation to rabi crops.

Harvested rainwater is considered as a climate-smart irrigation technology for sustainable crop production in water-scarce and salinity prone areas [15-19]. Islam et al. [20] found profitable horticultural production in hilly areas of Khagrachari district of Bangladesh using harvested rainwater. Rainwater harvested in Mini-Pond is being used to provide supplemental irrigation even for boro rice cultivation in north-western drought prone areas of Bangladesh [21-23] where the altitude is much higher (11-48 m) than the coastal areas (0-2 m) but the amount of rainfall is much lower than the other parts of the country. Pandey and Biswas [24] showed

through testing a robust water balance model in south-west region of Bangladesh that harvested rainwater through on-farm reservoirs during rainy season can be utilized for crop cultivation in the dry season. So, there is an ample opportunity to grow rabi crops in the aforesaid under-utilized fallow lands by providing supplemental irrigation from harvested rainwater that would not only ensure food security of coastal people but may also turn the entire area as a food surplus zone. Experts also suggest that harvested rainwater has immense potential for providing irrigation to the salinity affected dry fallow land for growing rabi crops especially non-rice crops in the coastal areas of Bangladesh [4,6,10,25-27].

3.3 Practice of Conservation Agriculture

Conservation Agriculture (CA) refers the practices of either zero or no tillage or minimum tillage (conservation tillage) or use of mulch covers by plant residues or debris (mulch tillage). There are a lot of techniques of CA used globally [28]. The CA plays an important role in increasing soil organic matter and in reducing soil erosion. Zero tillage conserves soil moisture and curtails greenhouse gas (GHG) emissions (i.e. mitigation option) and the practice is proved as an important CSA option for crop production

[29-30]. It can also minimize the heat stress [31]. Moreover, it curtails or saves the production cost, time, energy and minimizes environmental pollution [32]. Similarly, as a CSA option, mulch cover conserves soil moisture, minimize soil salinity stress, reduce GHG emissions and the technology is beneficial for crop cultivation [33-34].

3.4 Cultivation of Climate-Resilient Crop Varieties

Salt-, drought- or heat-tolerant crop varieties with short life span can reduce the climate exposure or stresses in the aforesaid areas [35]. Cultivation of early-season varieties or early plantation may ensure safer harvest in ahead of stress arrives. Therefore, the crop varieties with said characteristic [23] can be cultivated with harvested rainwater irrigation and/or conservation agricultural practices in the dry season.

4. CONCLUSION AND RECOMMENDATION

The uses of harvested rainwater and conservation agriculture are considered as the ecologically viable climate-smart agricultural practices for growing crops during the dry season in the salinity affected vast fallow land in the coastal region of Bangladesh. The social safety net programmes of the government like cash-for-work, food-for-work etc. can be utilized for excavating or re-excavating ponds, ditches or canals for storing rainwater during monsoon season. Additionally, salt-, drought- and/or heat-tolerant crop cultivars with short life span or early maturing characteristics can be used to get better results. Most crops except boro rice can be cultivated with said practices. Specific research works in the underlying discipline are recommended.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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