Article Title (3 to 12 words)	**Soil and Water Management strategies for Sustainable Production in Coastal-Saline Zone of West Bengal**
Article Summary (In short - What is your article about – Just 2 or 3 lines)	The ecology of the coastal region is extremely fragile and vulnerable to serious degradation due to anthropogenic activities. The sustainability of agriculture in the coastal ecosystem of West Bengal is seriously threatened by water logging and soil salinity. High unemployment and extremely poor livelihood security is the characteristic feature of the rural life of the coastal region. A suitable soil and water management strategies is therefore required to mitigate the ill effects of degraded coastal land and water for sustained productivity…..

Your full article (between 500 to 5000 words) - - Do check for grammatical errors or spelling mistakes

Soil and Water Management strategies for Sustainable Production in Coastal-Saline Zone of West Bengal

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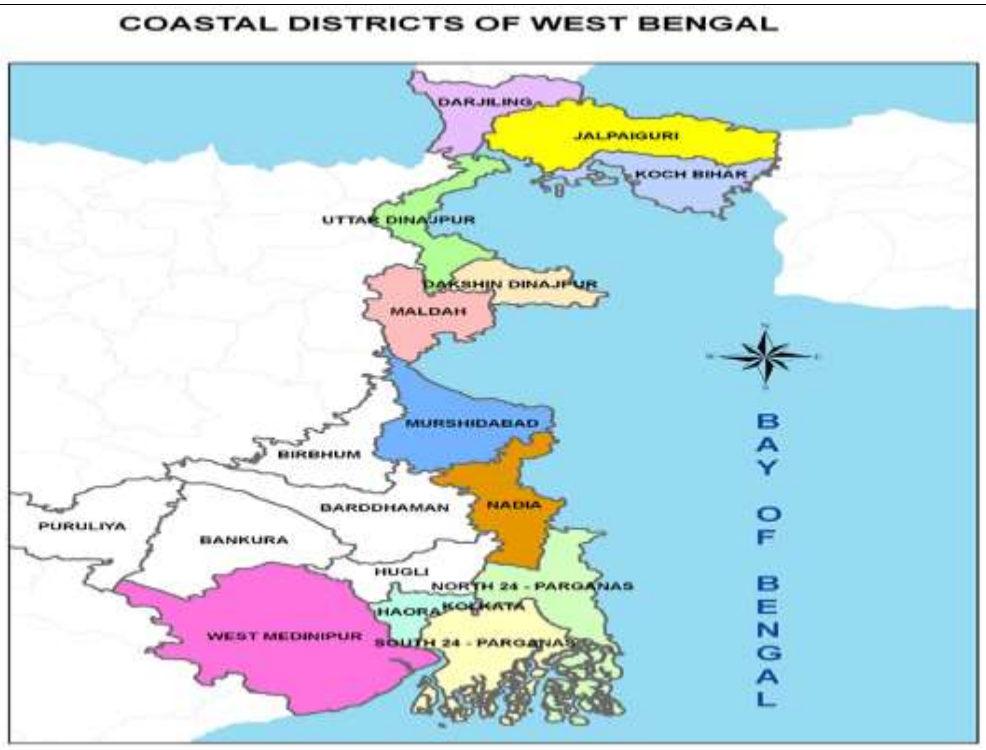
Introduction

The sustainability of agriculture in the coastal ecosystem of West Bengal (Sunderbans deltas constitute a major portion) is seriously threatened by twin problems of water logging and soil salinity. Out of 5.82 million ha of cultivable land in the state, about 0.723 million ha is saline and waterlogged land and vulnerable to crop productivity due to high rainfall runoff accumulation in monsoon season and water scarcity in post monsoon season. Tidal seawater intrusion is also widespread in this coastal region. Such ingression contaminates the fresh groundwater regime and reduces the fertility status of soil, which ultimately affects the agricultural production in negative way. There is a scarcity of good quality surface and groundwater water for irrigation during summer season. The brackish surface water is abundantly available in the areas. Due to presence of brackish water table at a shallow depth there is always an increase in soil and water salinity in dry months. The land remains almost fallow throughout the year after Kharif. During

the remaining season of the year (Rabi and summer) 90% of the land remains fallow due to soil and water salinity and lack of irrigation water. The local farmers due to the unavailability of fresh water in the adjoining areas are bound to use the easily available saline canal or drainage water for crop irrigation. A suitable soil and water management strategies is therefore required to mitigate the ill effects of degraded coastal land and water for sustained productivity. In acute water scarcity in summer months, rainwater harvesting is an ideal solution to mitigate the irrigation needs of the crop. The application of Green manure, Vermicompost, Farm Yard Manures and other organics helps to improve degraded soil properties and reduce soil salinity. The judicious and integrated use of available organic sources of plant nutrient along with inorganic fertilizer enhanced the fertilizer use efficiency and yield of crops which are generally poor in the coastal saline soils. The integrated farming approaches will help in maintaining good soil health through sustainable soil and water management and will ensure better environmental quality.

Distribution of West Bengal Coastal

The coastal area of West Bengal is the home of some of the poorest people, living in some of the least served and remote areas of the State. The total population is around 82 million the 3 coastal districts i.e. South and North 24 Parganas and Purba (East) Medinipur. These inhabited areas are densely populated. 2.47 million fishermen population lives in these 3 districts.



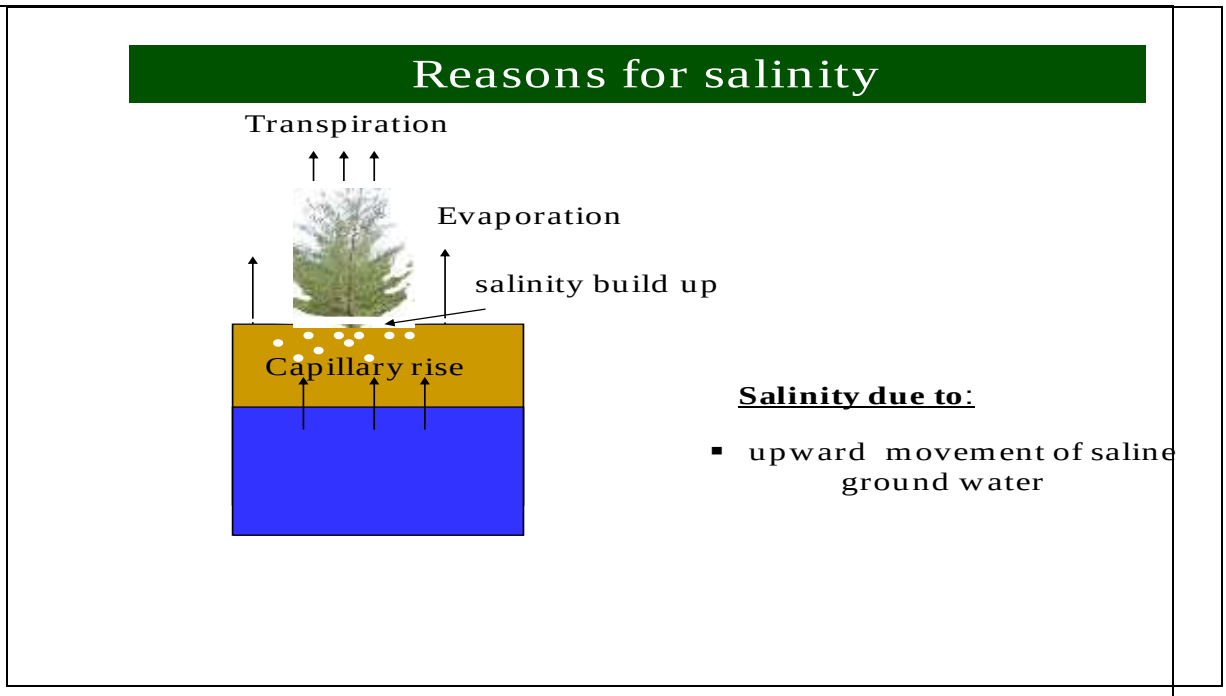
Sundarbans region is located in the estuarine section of the Ganga- Brhamaputra river system at the mouth of Bay of Bengal. This is a unique delta system with dynamic ecosystem.

Characteristic of Coastal Soil

Soils of coastal areas are generally deep to very deep having coarse sandy to fine loamy texture. The soils are calcareous, slightly to moderately saline and alkaline. In many coastal areas uncontrolled of mining of ground water has resulted in intrusion of sea water and development of high salinity (Velayutham *et al.*, 1998).

Saline soils

Soil salinity is one of the most important limiting factors of productivity in the coastal agro ecosystem. The saline soils have excessive concentration of natural soluble salts, mainly of chlorides, sulphates and carbonates of calcium, magnesium and sodium. The total concentration of salts is estimated by way of electrical conductivity. (EC) of saturated soil extract is more than 4 dS/m, exchangeable sodium percentage (ESP) less than 15 and pH less than 8.5 they are called "saline soils".



Strategies for soil & water management

Land Leveling: Rain water harvesting in farm pond and raising of farm land for Improving Crop Productivity in Saline Environment

Twenty percent of watershed/ farm area will be converted into on-farm reservoir (OFR) to harvest excess rainwater in Kharif for irrigating Rabi/summer crops and supplemental irrigation for Kharif crops. Rainwater storage in OFR improves surface drainage to the extent of 75 percent and thus, provides the scope for cultivation of high yielding rice varieties, agriculture-aquaculture farming and multiple crops in rain fed coastal region (Fig. 1).

Fig. 1. farm pond excavation and land raising in the Farmers field

Land Shaping: Ridge and furrow cultivation

The land will be shaped into alternate ridges and furrows. The ridges will remain relatively free from drainage congestion and soil salinity. The rainwater stored in furrows will be used for initial irrigations during *Rabi*. The ridges will be used for vegetable and other high value crops round the year instead of mono cropping with rice in *Kharif* (Fig. 2).

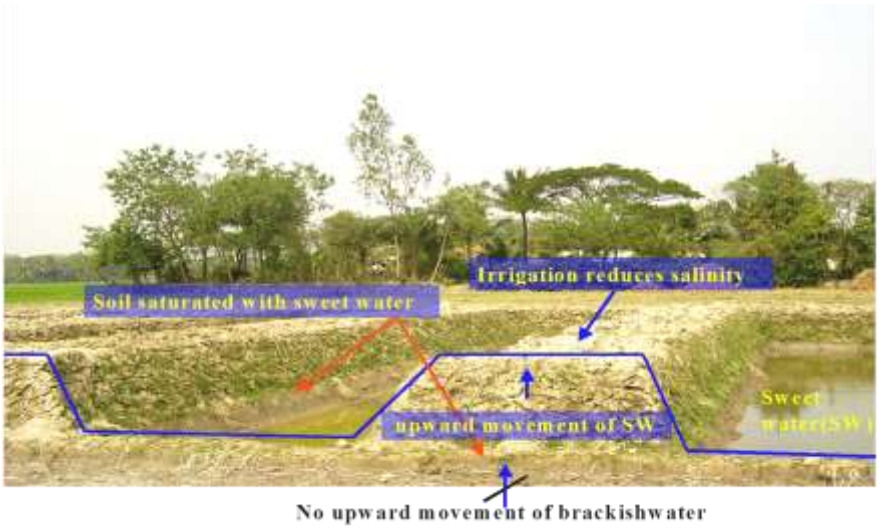


Fig. 2. Land shaping for ridge and furrow cultivation

Land Shaping: Paddy-cum-fish cultivation

Trenches of about 3 m width X 1.5 m depth will be dug around the field. The excavated soil will be used for making raised bunds of about 1.5m width (top) around the field to protect the fishes to be grown in paddy-cum-fish cultivation. The ridges will also be used for vegetable and other high value crop cultivation round the year with the rain water harvested in trenches (Fig. 3) will be used for irrigation. The trenches will also serve as shelter for fishes in paddy-cum-fish cultivation.

Fig. 3. Land shaping for paddy-cum-fish cultivation

Integrated Nutrient Management

The saline soils do not support plant growth primarily because of excessive salts in the soil solution which, due to high osmotic pressure, prevent absorption of moisture and nutrients in adequate amounts. Higher salinity condition exerts adverse effect on physical properties reduces drainage, aeration and microbial activity. The integrated use of inorganic fertilizers with organic amendments and biofertilizer has a great scope in coastal saline soils. Use of green or farmyard manure improved the N fertility status of soil with gradual increases in yield of crops. Higher dose of organic matter are required for the salt affected soils due to lower microbial activity in the soil. Beside this application of organics improved physical condition of soil and facilitate leaching of soluble salts. It also conserves moisture in the soil and dilutes the salt concentration for higher yield. Nutrient supply through green manure/ organic manures single or in combination with inorganic fertilizer is extremely important for the sustainability of crop yields on salt affected soils.

Table 1. Effect of soil treatments on rice equivalent yield under different rice based cropping system

Cropping system (C)	**System rice equivalent yield (t ha^{-1})**			
Soil treatment (S)	**Rice-tomato (C_1)**	**Rice-sunflower (C_2)**	**Rice-chilli (C_3)**	**Mean**
S_1	5.17	5.63	4.69	5.16
S_2	6.62	7.78	6.33	6.91
S_3	6.74	7.83	6.37	6.98
S_4	7.41	8.69	7.14	7.75
Mean	**6.49**	**7.48**	**6.13**	
	C		**S**	**C×S**
SEm(±)	**0.038**		**0.048**	**0.09**
LSD (p=0.05)	**0.12**		**0.148**	**0.26**

(Source: Mitran et al., 2016)

Water management strategies for reclamation of coastal water logged and saline soils

Poor water management and land development, results in water logging and land degradation leading to salinity. Saline soils are often associated with water logged areas due to the rise in the water table. Surface stagnation of water in these soils is a serious problem during monsoon. Cost effective measures for managing surface and sub-surface drainage are the key to minimize the adverse effects of water logging/soil salinity.

Leaching

To assess the water requirement for leaching, one must differentiate between two situations that may be encountered. In the first instance, water is required to leach down the excess salts present in the root zone to reduce the root zone salinity to permissible level for a given crop or vice-versa to select a crop in tune with the water available and anticipated leaching level.

Drainage management

The waterlogged areas require efficient irrigation management and installation of proper drainage system which includes open drains, closed pipe drains and drainage wells. In coastal areas, the drainage aims to remove excess water applied during irrigation and the water stagnation in the low land to ensure appropriate salt balance in the soil and to maintain a most suitable depth of the ground water table for agricultural crops. In low-lying coastal areas, there is virtually no dry land without drainage. Desalinization of the soils through sub-surface drainage can be achieved through the rainwater conserved in the field by providing strong bunds.

Conjunctive Use of Saline and Fresh Water

The conjunctive water use refers to the integrated management of surface water and ground water. The technology of blending in conjunctive use involves mixing of canal water and drainage waters differing in quality to obtain blended water that is suitable for irrigation.

Irrigation system improvement

The distribution of water and salts in soils is different according to the method of irrigation used. The surface irrigation methods including the border strips, check basins and furrows, even after following the best design criteria generally result in excessive irrigation and non-uniformity in

water application. Pressurized irrigation methods such as sprinkler and drip are typically more efficient as the quantity of the water to be applied can be adequately controlled but the initial investment and maintenance cost of such systems are high.

Table 2. Yield and Water use efficiency as affected by irrigation methods with saline and good quality water in tomato.

Method of irrigation	Good quality water (ECe = 0.25 dS/m)		Saline water (ECe = 6.5 dS/m)	
	Yield (t/ha)	WUE (t/ha-m)	Yield (t/ha)	WUE (t/ha-cm)
Subsurface drip	26.8	3.0	23.6	2.6
Surface drip	17.5	1.9	15.7	1.8
Surface irrigation at 35 mm CPE	16.4	1.4	0.9	0.9
Surface irrigation at 60 mm CPE	13.9	1.2	6.7	0.6

Source: Agrawal and Khanna (1983)

Conclusion

Resource management including scientific management strategies for degraded coastal land and water is one of the important aspects for sustainable productivity in the poor and fragile agro-ecosystem of coastal saline belt for enhancing livelihood security of the farming communities. It can be achieved through integrated farming system approaches. Cultivation of crops through land shaping techniques i.e. farm pond & raised land, ridge & furrow, board bed & furrow bed cultivation, paddy-fish integrated farming provides efficient utilization of land and water by harvesting of rain water, facilitating drainage, reduced salinity for better agricultural production under water scarcity and saline environment of coastal region. For successful implementation of the concerned technological interventions a ground based policy should be formulated through institutional linkage between the Government, local administration & Institution, NGOs, Research Institute for sustainable management of degraded coastal land and water and other resources to ensure livelihood security of the farming communities.

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