MANAGEMENT OF COASTAL SALINE SOILS OF ORISSA

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The state of Orissa covering a geographical area of 15.57 million ha lies in the tropical belt in the eastern region of India between 17°47’-22°33’ N latitude and 81°31’-87°30’ E longitude. The state can broadly be divided into four physiographic zones based on the existing relief features. These are (1) The north plateau (2) Central table land (3) Eastern ghat region and (4) Coastal plains. The coastal plain of Orissa has been formed of the older and newer alluvium of recent and tertiary origin. This region is the most developed part of the state supporting about 36% of the total population and 43% of the urban population. Out of 314 blocks of the state, 82 developmental blocks are situated in this coastal region. Though the soils of this region are very fertile and productive but due to the following regions, the soil become saline and unproductive especially near sea coast and estuaries.

- Salinity due to ingress of sea water to the land surface,
- Salinity ingressation due to back water flow where sea water enters to the inland area and during high tides through estuaries,
- Salinity is found due to locostrain action around the lake Chilika.

Soils with high total soluble salts, expressed in terms of electrical conductivity, ECe greater than 4 dS/m are called salt affected soils. In Orissa coastal salt affected soils occupy an area of about 254,100 ha, out of this 24,160 ha are under mangrove vegetation, 32,522 ha bare and 193,410 ha under agriculture. Salinity spread over the coastal districts of Ganjam, Cuttack, Jagatsingpur, Jajpur, Kendrapara, Puri and Balasore.

The soils are mostly clay to clay loam with pH varying from 5.0 to 8.0 and with a conductivity of 5.0 to 35.0 dS/m with exchangeable sodium percentage of 15-30 per cent. The salts are mainly composed of chlorides and sulphates of Na and Mg and to a lesser extent of Ca and K. Soil salinity varies with the season and is at its maximum in May and it decreases with the onset of the monsoon reaching lowest during September. Depth of groundwater and its salinity also show seasonal variation. During the pre-monsoon period if groundwater is at 2-3 m or more, it rises almost to the surface in the monsoon period and again falls in the dry season. However, the salt content of these soils is low (<4 dS/m) during rainy season due to dilution and flushing of salts by heavy rains.

In general, the entire costal belt of Orissa is mono cropped with traditional rice varieties. Hardly any Rabi or summer crop is grown due to increase in salinity. The decline in productivity of coastal salt affected soils sometimes ranges from 10-15% or even more, because of salt influence. Farmers of saline track of this region are sometimes ever unaware that salts present in the soil are reducing yield, since many a times there is no evidence of salt in form of surface crust or efflorescence or of any other visual symptoms. In years of well distributed and good rainfall, farmers can harvest a good salt resistant paddy crop from coastal saline soils, but in years of poor monsoon the paddy crop may be seriously damaged due to salinity.
Poor yield of crops in these soils are due to:

- Failure of germination and death of seedlings,
- Plasmolysis of germinating seeds and roots,
- Deficiency or toxicity of some micronutrients, (toxicity due to B),
- Hydrogen sulphide injury,
- Reduced uptake of K, Ca, Mg, due to presence of excess Na,
- High salinity interference in the growth and activity of soil microbial population.

Management options:

- Removal of excess salts from the root zone through leaching,
- Adoption of suitable agronomic measures,
- Growing of salt resistant crops and crop cultivars,
- Use of amendments,
- Alternative uses of coastal saline soils.

Leaching:

For reclamation of saline soils, salt leaching is widely practised. Leaching influences distribution and removal of soluble salts from soil profiles and prevents their accumulation in the root zone. Salinity level in the root zone needs to be kept below 4 dS/m for realizing good yields of major crops. WTCER conducted leaching experiments on two different sites of salt affected soils viz. Ambiki (Erasmá block) in Jagatsingpur district and Astaranga (Astaranga block) in Puri district. The relationships between EC/ECw(ECw) and EC are electrical conductivities of saturation extracts of the soils before and after leaching, respectively) and Dw/DS (Dw and Ds are the depths of water and soil, respectively) established for the soils were EC/ECw = 0.876-0.570 (DW/DS), R²=0.98 for Ambiki soil and EC/ECw = 0.382-0.197 (DW/DS) R²=0.92 for Astaranga soil. These relationships indicated that for 80% reduction in soil salinity, each cm of Ambiki and Astarang saline soils should be leached with 1.19 and 0.92 cm water, respectively. Thus, for removing 80% of salts from 50 cm soil depth of Ambiki and Astaranga soils need to be leached with 60 cm and 46 cm of water, respectively.

Adoption of suitable agronomic measures:

- In the beginning of wet season or at the time of rice transplanting, in general the salt concentration is high to very high in the surface (0-30 cm) soil, which creates problems for establishments of rice seedlings. In that situation, it is beneficial that 3 to 4 seedlings instead of 1 may be used for avoiding reduction in plant population due to mortality,
- Use of 30 – 40 days old seedlings instead of 15 – 20 days seedlings should be used,
- In saline, soils transplanting of rice seedlings during wet season may be done after receiving 3-4 heavy rains, if rains are late transplanting should be postponed for a few days, so that excess salts from the surface soils could be removed through leaching or flushing,
- During dry season, ridge and furrow method of planting seeds has been found beneficial,
- Cropping on sides of alternate ridges of irrigated furrows leaving intermediate furrow as fallow and frequent irrigation can improve crop productivity.
Growing of salt resistant crop and cultivars:

Proper selection of crops and salt tolerant cultivars are very important for any success since salinity will remain a major constraint in the coastal region. For better results, crops must be selected according to salinity levels prevailing during peak summer months of April to June. Salinity tolerance of some important agricultural crops is given in Table 1 and salt tolerant important crops’ cultivars and their yield potential are given in Table 2.

Table 1. Salt tolerance of some important agricultural crops

<table>
<thead>
<tr>
<th>Sensitive EC_1&lt;1.2</th>
<th>Moderately sensitive</th>
<th>Moderately tolerant</th>
<th>Tolerant EC_6&lt;8</th>
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</thead>
<tbody>
<tr>
<td>Chickpea</td>
<td>Broadbean</td>
<td>Wheat</td>
<td>Barley</td>
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<tr>
<td>Beans</td>
<td>Maize</td>
<td>Mustard</td>
<td>Cotton</td>
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<tr>
<td>Sesame</td>
<td>Groundnut</td>
<td>Cowpea</td>
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<tr>
<td>Sugarbeet</td>
<td>Sugar cane</td>
<td>Oats</td>
<td>Safflower</td>
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<tr>
<td>Onion</td>
<td>Alfalfa</td>
<td>Sorghum</td>
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<tr>
<td>Carrot</td>
<td>Berseem</td>
<td>Soybean</td>
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<tr>
<td>Mungbean</td>
<td>Radish</td>
<td>Spinach</td>
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<td></td>
<td>Rice</td>
<td>Pearl millet</td>
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<td></td>
<td>Cauliflower</td>
<td>Musk melon</td>
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<td></td>
<td>Chillies</td>
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</tr>
</tbody>
</table>

* Other salt tolerant varieties are: Damodar, Dasal, Getu, Sadomota, Nonasail, Lunishree, SR-26 -B


Use of amendments:

Coastal saline soils with high exchangeable sodium but acidic in reaction could be reclaimed by application of lime or by using paper mill sludge which replaces some of the exchangeable Na⁺ or H⁺ by Ca⁺⁺. Use of organic manure, recycling of straw and incorporating green manure crops also reduce salinity and improve soil structure. Application of lime @ 2 t/ha in salt affected coastal soils at Ersama and Astaranga blocks of Orissa, significantly increased the rice yield of Gayatri variety.
**Alternate Use of Coastal Saline Soils:**

Rice is the main agricultural crop in this region. Vast potential exists for rice-based agro-silvicultural programmes for coastal saline regions. Proper selection of rice varieties for mixed farming system can improve the system a lot and produce more biomass per unit land area.

**Agro forestry system:**

Plant species growing naturally on saline soils, viz. *Casuarina glauca, Melaleuca bracteata, Melaleuca glomerata, A. ampliceps, A. orasia* were ranked as highly salt-tolerant species for coastal saline areas of eastern region. *P. juliflora* also showed the best growth along with bushes like *Tamarix spp., S. oleoides* on saline soil having ECe< 40 dSm⁻¹ pH< 8.2 and CaCO₃< 12 per cent and *A. nilotica* and *P. juliflora* showed good performance in saline soil with ECe < 27 dSm⁻¹, pH<7.9 and CaCO₃ < 5 per cent in rooting zone. *Salvadora persica* is able to grow on highly saline soil (ECe 70 dSm⁻¹).

**Silvi-pastoral system:**

Forage shrubs and grasses for revegetating salt land are Atriplex semibaccata, *A. cinerea, Atriplex spp., Puccinellia ciliata, Paspalum vaginatum* and *Maireana brevifolia*, etc. These plants are known as halophytes (salt plants).

**Agri-horticultural system:**

Fruit trees can be planted with intercrops of vegetables, pulses and oilseeds because they perform favourably in wide spacing left by the narrow crown of the trees and a deep root system that has no allelopathic effect on the intercrop. *Annona cherimola Mill, Cordia abyssinica, Grewia subinaequalis DC., Magnifera indica* Linn. and *Ziziphus spina-christi* can be grown in combination with food crops.

**Horti-pastoral system:**

*Syzgium cumini, Tamarindus indica, Ficus spp., Emblica officinalis* and *Aegle marmelos* can be planted in the pasture lands to serve as fuel, fodder and fruit requirements of the local population.

**Horti-silvi-pastoral and horti-agri-silvicultural system:**

In an integrated land-use system fruit trees may be either planted on farm boundary to serve as shelter belts or fence, or composite-planted with other fruit plants crops, forest trees, vegetables, grasses or fodder crops. Ber, jamun, cordia, palmyra plum, custard-apple, mahua, *Prosopis cineraria* and *Acacia senegal* are suitable for shelter belt and wind break plantation. Shelter belt plantation with tamarind, jamun, mulberry, *Prosopis cineraria* can be very effective. Ber, karonda, Capparis decidua can serve as good fence plantation.
Fish and Marine Products:

In Orissa traditional aquaculture has been practised for many generations. However, not much effort has been made to upgrade these culture systems to enhance productivity. But the region has a great advantage of favorable climate for 2 to 3 crops in a year. The region has great potential for carp cultivation and both the indigenous and exotic carps can be cultivated. Other species include *Labeo calkbasu*, *Labeo fimbriatus*, *Labeo gonius*, *Labeo bata*, *Putinus pulchellus*, *Putinus kolus*, *Putinus sarana*, *Cirrhinus cirrhosa* and even minor carps that fetch high price in the markets.

**Preventive measures:**

- Construction of salt embankments,
- Improving the drainage to flush out the soluble salts,
- Construction and proper maintenance of sluice gates across the creeks, for checking the inflow of tidal water,
- During rice growing period in monsoon season opening of the sluice gate is to be done more frequently and for longer period to maintain desired water levels for optimum crop growth,
- Land should be properly leveled and bunded, which facilitate leaching of excess soluble salts and draining of excess water
- Excess water may be stored in dug out ponds for subsequent utilization for irrigation to dry season crop,
- If sufficient irrigation water of good quality is available, introduction of a second rice crop in winter and summer months will help in reducing the root zone salinity.
- If very limited irrigation water is available, growing of crops like linseed, cotton, safflower, beet, chilli, onion, watermelon, pumpkin, bittergourd etc. during dry season will reduce soil salinization through reducing evaporation losses of soil water,
- If no irrigation water is available, ploughing the land after harvest of monsoon paddy crop will help in creating soil mulch to reduce soil moisture evaporation and thereby minimize soil salinisation.
- In absence of a dry season crop soil mulching with waste materials like rice husk, rice straw, shaw dust could be practised.
- Mixing of these materials in the soil improves physicochemical properties of the soil facilitating leaching of soluble salts,
- As far as possible summer fallow after rice should be avoided,
- Raising of shelter belt over and nearing the saline tract save the adjoining land from salt cycling.