

## Salt Affected Soils: Exploring the Impact, Reclamation and Management Approaches

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### Introduction

Salt-affected soils are a widespread problem affecting agricultural productivity in many regions around the world. These soils contain high levels of soluble salts, which adversely affect plant growth and limit crop yields. Understanding the effects of salt on soil and plants, as well as implementing appropriate management practices, is crucial for mitigating the detrimental effects and ensuring sustainable agriculture. In this article, we will explore the effects of salt on soils and plants, along with effective management strategies to address salt-affected soils.

There are different types of salt-affected soils, each characterized by the specific types of salts present and the extent of their accumulation. The three main types of salt-affected soils are:

#### 1. Saline Soils:

Saline soils have a high concentration of soluble salts, mainly sulphates and chlorides of calcium and magnesium in the form of salic horizon (z) in soil. These soils are typically found in arid and semi-arid regions with limited rainfall and where evaporation loss is more than precipitation. Saline soils have an electrical conductivity (EC) value greater than  $4 \text{ dSm}^{-1}$ , exchangeable sodium percentage (ESP) < 15 and pH less than 8.5. These soils are generally characterized by white crusts or layers of salt on the soil surface. Saline soils have good physical conditions due to the flocculation which is caused by calcium.

#### 2. Sodic Soils:

Sodic soils also known as alkaline or sodium-affected soils, have a high concentration of carbonates and bicarbonates of sodium. These soils occur in areas with poor drainage and high sodium content in the parent materials. Sodic soils often exhibit poor soil structure,

leading to soil compaction and reduced water infiltration. They have a high ESP value which is greater than 15,  $EC < 4 \text{ dSm}^{-1}$  and  $pH > 8.5$ .



**Fig. 1: Saline Soil**



**Fig. 2: Sodic Soil**

### 3. Saline-Sodic Soils:

Saline-sodic soils are a combination of saline and sodic characteristics. These soils contain high concentration of both soluble salts and sodium ions. Saline-sodic soils typically occur in areas with a history of poor drainage and irrigation practices. They exhibit  $pH > 8.5$ , both the characteristics of salinity, such as high EC values ( $> 4 \text{ dSm}^{-1}$ ) and sodicity, with high ESP values ( $> 15$ ). These soils often have poor soil structure, low water infiltration rates and reduced nutrient availability.

It's important to note that within these broad categories, the specific composition and severity of salt-affected soils can vary based on the geographical location, climate and geological factors. Soil testing and analysis are crucial for accurately identifying and managing the specific type and severity of salt-affected soils in a given area.

#### Effects of salts:

##### A) On soil:

When salts accumulate in the soil, they disrupt the soil structure and overall soil health. The high concentration of salts causes poor soil aggregation, resulting in compacted soil that is difficult for plant roots to penetrate. Additionally, excessive salts reduce the availability of water to plants by increasing the osmotic pressure, making it harder for plants to absorb water from the soil. The high salt content also affects soil microorganisms, reducing their activity and impacting nutrient cycling processes.

##### B) On plants:

Salt stress has detrimental effects on plant growth and development. As plants absorb water from the soil, the high salt concentration interferes with their water uptake

mechanisms. This disrupts the osmotic balance within plant cells, leading to water stress and reduced turgor pressure. As a result, plants experience wilting, leaf necrosis, and stunted growth. Salt stress also affects nutrient uptake, as high salt levels can hinder the absorption of essential nutrients, leading to nutrient deficiencies and further impairing plant growth.

#### **Reclamation and management strategies for salt-affected soils:**

**a. Soil leaching:** Leaching is an effective method to reduce salt levels in the soil. It involves applying excess water to the affected area, allowing the salts to dissolve and be flushed out of the root zone. In permanent reclamation plans for saline areas, availability of adequate outlets for disposition of saline drainage waters is of paramount importance.

**b. Amendments:** Amendments are materials that directly or indirectly, through chemical or microbial action, furnish divalent cations (usually  $\text{Ca}^{2+}$ ) for replacement of exchangeable Na. Chemical amendments for reclaiming alkali soils have been broadly grouped into three categories:

- i. Soluble calcium salts:  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ,  $\text{CaCl}_2$  and phospho-gypsum.
- ii. Sparingly soluble calcium salts: Calcite and  $\text{CaCO}_3$ .
- iii. Acids or acid formers:  $\text{H}_2\text{SO}_4$ , iron and aluminium sulphates, lime-sulphur and pyrite, etc.

**c. Organic matter:** Adding organic matter, such as compost or well-rotted manure, helps improve soil structure, water-holding capacity and nutrient availability. Organic matter also enhances microbial activity which is improving soil health.

**d. Selecting salt-tolerant crops:** Planting crop varieties that are adapted to salt-affected soils is crucial for successful cultivation. Salt-tolerant crops have developed mechanisms to tolerate and exclude salts, allowing them to grow in challenging conditions. Selecting and using these varieties can lead to improved crop yields in salt-affected areas.

**e. Irrigation management:** Implementing efficient irrigation practices can help to manage salt-affected soils. Techniques such as drip irrigation and sprinkler systems minimize water usage and prevent excessive salt accumulation near the plant roots. Irrigation scheduling should consider soil moisture levels and salt leaching requirements.

**f. Soil salinity monitoring:** Regular soil testing and monitoring of salt levels are essential for effective management. This enables farmers to assess the salt content and adjust management

practices accordingly. Soil testing also helps identify nutrient deficiencies caused by high salinity levels.

**g. Crop rotation and cover crops:** Implementing crop rotation and cover cropping can enhance soil health and reduce salt accumulation. Certain plant species, known as salt-accumulators can absorb excess salts from the soil, helping to improve the soil's condition over time.

#### **Conclusion:**

Salt-affected soils pose significant challenges to agricultural productivity and require careful management to ensure sustainable farming practices. By understanding the effects of salt on soils and plants and implementing appropriate management strategies, farmers can mitigate the detrimental effects of salinity. Soil leaching, organic matter amendments, selecting salt-tolerant crops, efficient irrigation practices and regular soil monitoring are key components of effective salt-affected soil management.

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