

## SALT-AFFECTED SOILS

### Introduction:

Salt-affected soil is a general term used for those soils which have been adversely modified for the growth of most plants because of the presence of excess soluble salts, exchangeable sodium (Na) or both. Salt-affected soils are found in all the continents and under almost all types of climates. However, their distribution is wide spread and extensive in arid and semi arid regions as compared to humid. Nature and properties of these soils are diverse and require specific approaches for management and reclamation to maintain their productivity.

### Importance of salt-affected soils:

- Pakistan spreads over an area of 79.61 million hectares (M ha)
- The country is the ninth biggest nation of the world in terms of population.
- Population will be 201 million in the year 2010.
- Land resources of the country are degrading, causing environmental problems
- Almost 70 % of the country falls under arid and semi-arid regions.
- In irrigated belt salinity is threatening about 6.68 M ha.

### EXTENT OF SOIL SALINITY/SODICITY PROBLEM IN PAKISTAN

(Area in m.ha)

Source: Soil Survey of Pakistan, 1998

Sr. #	Category	Punjab	Sindh	Baluchistan	NWFP	Pakistan
1	Saline sodic porous	1.1070	0.3185	0.1654	0.0316	1.6225
2	Saline sodic dense	0.8358	0.0395	0.0022	-	0.9275
3	Saline sodic gypsiferous					
i	Porous	0.0507	0.0214	0.1931	-	0.2652
ii	Dense	0.0570	0.0269	-	0.0075	0.0914
4	Saline	-	0.3351	0.6363	-	0.9714
5	Saline gypsiferous					
i	Porous	0.1666	1.2454	1.3167	-	2.7287
ii	Dense	-	0.0733	-	-	0.0733
	<b>Total:-</b>	<b>2.2171</b>	<b>2.1101</b>	<b>2.3137</b>	<b>0.0391</b>	<b>6.6800</b>

## CLASSIFICATION OF SALT-AFFECTED SOILS

Generally soils are classified into these three classes keeping in view the salt type.

1. **Saline soils:** A soil having sufficient amount of soluble salts to adversely affect the growth of most crop plants but not containing excessive exchangeable  $\text{Na}^+$ . Most of the soluble salts in saline soils are composed of cations Na, Ca and Mg and of anions like  $\text{Cl}$ ,  $\text{SO}_4$  and  $\text{HCO}_3$ . Small quantities of cations K and  $\text{NH}_4^+$  and anions  $\text{NO}_3$ ,  $\text{CO}_3$  and  $\text{BO}_4$  also occur in these soils. Saline soils have:

$$\text{EC}_e > 4 \text{ dSm}^{-1}$$

$$\text{SAR} \leq 13$$

$$\text{ESP} \leq 15$$

$$\text{pH}_s \leq 8.5$$

2. **Sodic soils:** A soil having sufficient amount of exchangeable  $\text{Na}^+$  to adversely affect the growth of most crop plants but not containing excessive soluble salts. Soil properties like structure, aeration, hydraulic conductivity are deteriorated by the excessive amount of exchangeable  $\text{Na}^+$ . Sodic soils have:

$$\text{EC}_e \leq 4 \text{ dSm}^{-1}$$

$$\text{SAR} > 13$$

$$\text{ESP} > 15$$

$$\text{pH}_s > 8.5$$

3. **Saline sodic soils:** A soil having both soluble salts as well as exchangeable  $\text{Na}^+$  in sufficient amounts to adversely affect the growth of most crop plants. A saline sodic soil has:

$$\text{EC} > 4 \text{ dSm}^{-1}$$

$$\text{SAR} > 13$$

$$\text{ESP} > 15$$

$$\text{pH}_s \text{ may or may not more than } 8.5$$

In some literature, the term "alkali" is used in place of sodic, i.e. for soils having excess exchangeable  $\text{Na}^+$ . Hence, the terms "saline-alkali" in place of saline sodic and "alkali" in place of sodic are used. However, the use of the term "alkali" is being discouraged because of its ambiguity with the term "alkaline" which refers to the soils having  $\text{pH} > 7.0$ .

Soil Type	EC <sub>e</sub> (dS m <sup>-1</sup> )	ESP	SAR	pH <sub>s</sub>
Saline	≥ 4	< 15	< 13	< 8.5
Sodic	< 4	≥ 15	≥ 13	≥ 8.5
Saline sodic	≥ 4	≥ 15	≥ 13	≥ 8.5

## *Genesis of Salt Affected Soils*

### Genesis/Formation of Salt-Affected Soils (causes of salt-affected soils):

Soil genesis refers to the mode of origin of the soils with special reference to the processes and factors of soil formation for the development of the soil from unconsolidated parent material. Genesis includes reducing the size of parent material particles, rearranging the mineral particles, adding organic matter and other materials like salts, changing the kinds of minerals, creating horizons and producing clays. It is a continuous but slow process. The following factors mostly contribute towards the genesis of salt-affected soils in Pakistan.

1. **Salty parent material:** The original and major source of salts is the primary minerals in parent material which serve as the parent material for soil formation. In Pakistan, like most of the arid and semi arid regions of the world, precipitation is inadequate for leaching of salts out of the root zone. Consequently, soluble salts and exchangeable Na have been accumulated for thousands of years during the process of soil formation. This is the case of primary/old/ancient salt-affected soils. These soils existed before the advent of the canal irrigation system in the Indus Plains of Pakistan.
2. **Uneven distribution of rainfall:** Most of the rainfall occurs during monsoon (July-August) while during major part of the year the salts present in the soil tend to move upward with water through capillary action. At the soil surface, water evaporates and leaves behind salts on the surface.
3. **Aridity:** Most of the soils of Pakistan are located under arid and semi arid region. The rainfall that is received during a year is not sufficient to leach away the salts from the root zone, i.e. there is not upward movement of water in the soil.
4. **Physiographic unevenness:** Micro unevenness of the soil surface is generally not observable. This situation can be visualized from the different depths of standing water after rainfall. The rain water flows from the convex parts over the sloping

parts and is accumulated on concave parts. In parts where there is low effective leaching, accumulation of salts takes place. Hence, patches of salts develop in an uneven soil. Considering the entire Indus Plain of Pakistan, there is almost zero slopes due to which natural drainage is poor which promotes the salination and sodication processes.

5. **Irrigation (Genesis of Secondary or man made salt-affected):** Brackish under ground water is another and important source of causing salt-affected soils. Secondary or man made salt-affected soils have formed after the introduction of artificial canal irrigation system in Pakistan. The extent of secondary salt-affected soils is very small than primary salt-affected soils. Insufficient or unequal application of irrigation water, imperfect soil drainage, waterlogging, poor quality of ground water, lack of proper management of soil & water, seepage from canals and water courses or combination of these factors are the major causes of formation of the secondary salt-affected soils.