RECLAMATION OF SALT-AFFECTED SOILS

Factors Affecting Reclamation

There are several methods for the reclamation of salt-affected soils. The suitability of each method depends upon a number of considerations, e.g.

1. physical, chemical and mineralogical characteristics of the soil
2. internal soil drainage
3. presence of pans in the subsoil
4. climatic conditions
5. content and types of salts present
6. quality and quantity of water available for leaching
7. quality and depth of ground water
8. desired rate of replacement of excessive exchangeable Na^+, if present
9. presence of lime or gypsum in the soil
10. availability and cost of the amendments
11. Availability of the equipment for soil tillage, if needed
12. Crops grown in the region
13. topographic features of the land
14. the time available for reclamation.

Good internal soil drainage, land levelling, and deep ground water (preferably below 3 m) are considered essential prerequisites for successful reclamation. From reclamation point of view, the salt affected soils are divided into two categories, i.e. saline and sodic/saline-sodic.

Saline soils are generally reclaimed by leaching with excess water that carries salts into the deeper soil layers. The quantity of water that must leach through the soil profile to remove soluble salts depends primarily on the initial soil salinity and moisture level, the technique of applying water, and the soil type. Water suitable for irrigation is normally considered suitable for soil reclamation. The suitable depth of ground water depends on ground water quality, and the crop(s) to be grown. In arid regions with hot climate, ground water should be well beyond the capillary range.

For sodic/saline-sodic soils, reclamation generally proceeds by increasing Ca^{2+} on the exchange complex at the expense of Na^+ and the replaced Na^+ being removed along with the excess soluble salts if present, either to lower depths or even out of soil profile. Thus reclamation requires a certain flow of water through the profile.

Methods of Reclamation of sodic/saline-sodic soils

The methods of reclamation of the saline-sodic/sodic soils may be grouped into the following categories

1. Physical methods
2. Chemical methods
3. Biological methods
4. Hydro-technical method
5. Electro-reclamation method
6. Synergistic approach

Apart from decrease in salinity/sodicity hazard, the method employed at a particular site must be able to improve soil physical conditions by eliminating the Na^+ dominance that causes undesirable changes in physical properties of sodic soils. Soil aggregates in sodic soils slake and disperse and hence reduce porosity. An effective amendment/method improves soil hydraulic conductivity and infiltration rate and decreases bulk density. Improvement in certain physical properties of sodic soils during reclamation is generally attributed to the increased levels of Ca^{2+} both in soil solution and on the exchange complex. This flocculates the dispersed soil thereby improving water conducting soil properties.

Physical methods

Several methods, viz. deep ploughing, subsoiling, hauling, sanding, and horizon mixing are used to improve salt-affected soils by physical/mechanical treatments:

1 Deep ploughing

Deep ploughing consists of ploughing to a depth from about 40 cm to 150 cm. This is a beneficial method on stratified soils having impermeable layers. After a series of experiments, it was found that a single deep ploughing having 40 to 75 cm depth economically improved the calcareous sodic soils both physically and chemically. Under conditions where the subsoil is more sodic than the surface soil, then deep ploughing should be avoided. However, this method is very helpful to speed up soil reclamation if the subsoil is gypiferous, i.e. the subsoil contains a good quantity of gypsum.

2 Subsoiling

It consists of pulling vertical strips of steel or iron, called knives or tines, through the soil to open channels to improve soil permeability. Generally, the tines are set about 60 to 90 cm apart. A powerful tractor is necessary to pull a subsoiler.

The beneficial effects of subsoiling may continue for several years if the lime layer is broken, otherwise the effect may persist for only one season. Subsoiling (50±5 cm crosswise furrows at a distance of 120-150 cm) was found as an effective tool for the reclamation of calcareous saline-sodic soils with rice-wheat rotation in a period of three years.

3 Sanding

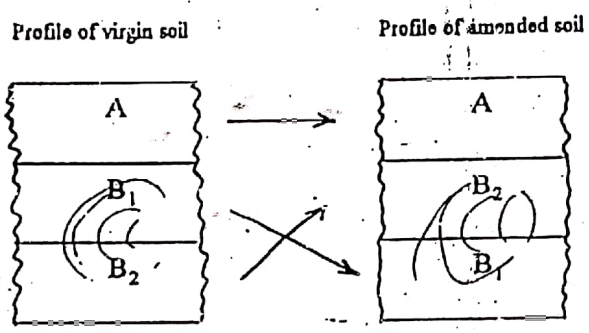
Sanding is an effective means of making a fine-textured, surface soil more permeable by mixing sand into it. This method brings a relatively permanent change in the texture of the surface soil. Sanding results in improved root penetration and better air and water permeability which facilitates leaching of salts. The depth of applied sand should be at least 10 cm for mixing with the surface soil for better results.

Hauling

This technique involves removal of the salt affected surface soil and replacing it with a good soil up to a desired depth. Hauling is absolutely useful but it might not be applicable every where because this method is considered expensive..

Horizon mixing

This method is used when the surface soil is good but the upper subsoil has undesirable characteristics. This situation occurs in saline-sodic/sodic soils having a favourable soil surface underlain by a slowly permeable, sodium-affected B horizon which is underlain by a more permeable horizon sometimes containing gypsum. The objective of profile mixing is to retain the surface soil while inverting the subsoil and substratum. this is done by removing the surface soil, deep ploughing the subsoil and substratum, then again replacing the surface soil.



The purpose of first three methods is to increase soil permeability directly by fine and coarse textured layers and to obtain a more uniform layer (deep ploughing), by breaking the impermeable layers (subsoiling), and by incorporating sand to a fine textured soil (sanding). Hauling deals with the replacement of the salt-affected surface soil with a good soil while horizon mixing covers an undesirable soil layer with a better material from a lower layer.

Chemical methods

The choice of a chemical amendment at any place depends upon its relative effectiveness as judged from improvement of soil properties and crop growth, its availability, cost, handling and application difficulties, and the time required to react in the soil and to replace the adsorbed Na^+. However, nature of the sodic soil to be reclaimed has an over-riding consideration in this respect. Amendments have shown different levels of effectiveness in reclaiming sodic/saline-sodic soils of varying characteristics. Chemical amendments generally used in saline-sodic/sodic soil reclamation fall into two broad categories:

1. **Inorganic amendments**, these can be further subdivided into three types.
   a) Soluble calcium salts, like $CaCl_2$, gypsum (mined gypsum) and phosphogypsum (a by-product from the manufacture of high-analysis P fertilizers).