SOIL VARIATIONS IN RELATION TO FOREST MANAGEMENT IN LALSOHANRA IRRIGATED PLANTATION[1]

by

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Abstract

The soils of the Lalsohanra irrigated plantation are of various kinds with different problems. Main kinds of soils and their problems have been identified and described. Some reclamation measures have been suggested The soils are dominantly loamy and are homogenized. At places they are clayey and stratified. These soils occur in the valleys locally known as 'dhars'. About 50 per cent of the area is occupied by sand dunes having irregular relief. Salinity and sodicity, dense soil mass and sandy nature are the main soil problems that adversely affect the suitability of the area for shisham and other tree species under irrigation. Under the existing conditions of arid climate and shortage of irrigation water the problematic soils could better be used for original flora or drought/salt resistant tree species. If, however, sufficient water is made available for intensive forestry, the reclamation of saline-sodic soils could be undertaken by using gypsum and growing high delta crops. The dense soil mass could be improved by subsoiling and green manuring. The sand dunes cannot be brought under irrigated plantation. They could be developed as range land, or used for wild life.

Introduction

The Lalsohanra irrigated plantation is situated on the left bank of the Sutlej river, at a distance of about 30 kilometres east of Bahawalpur city. The plantation occupies an area of about 8500 hectares. The area is commanded by the Bahawal Canal. Water-table in the area is deep except in areas adjacent to the main Bahawal Canal and the Desert Branch. The groundwater is not suitable for irrigation.

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The area formed a part of the Lalsohanra lake for quite sometime. The lake served as a water reservoir. It was used to collect flood water which was released for sowing rabi crops. In 1938 the area was brought under the control of Forest Department. Since then the seasonal flooding partially ceased and planting of shisham was started in places.

This paper contains findings of preliminary investigations of soils and their problems affecting forest management in the area. Since detailed soil survey of the area is in progress, a more comprehensive report with maps showing the location and extent of each soil would be prepared in due course of time. Schematic diagrams of the representative soil profiles are appended to this paper.

Physiography

The area forms a part of the Cholistan desert which has been the floodplain of the Sutlej river in the long past (Pleistocene age). The area comprises the following two distinct landform units:

(*i*) Valleys, locally known as 'dhars'
(*ii*) Sand dunes

The general surface of the valleys is nearly level except a few sand dunes dotted here and there. The valley soils are mostly loamy. The sand dunes are higher than the 'dhars' and stand out 1 to 5 metres above the valley floors. They are mostly stabilised with natural vegetation.

An old inundation channel traverses through the area from the north-east to the south-west. The channel has been cut-off from its source (Sutlej river) by Bahawal canal and at places it has been remodelled into an irrigation channel by the Forest Department. The old channel probably used to flood the 'dhars' before the opening of canals.

The deposition of river alluvium has been taking place in the area during seasonal flooding. Texture and thickness of the alluvium over the old surface especially the 'dhars' is not uniform. It varies according to the original relief of the old surface. In depressions, the thickness of the alluvium ranges from 45 to 60 centimetres and on relatively higher parts the covering is only a few centimetres thick. Stratified silty clayey soils have formed in the alluvium in depressions.

Soils

Eight main kinds of soils have been recognised in the study area. They are briefly described as under:

1. *Loamy soils*: These soils are level to nearly level and well-drained. They are homogenized, humified and porous to more than 1 metre depth. The soil texture varies from loam to fine sandy loam. At places they have 10 to 20 centimetres thick cover of homogenized silty material. These soils are free

from salinity and sodicity. They are well-suited to Shisham (*Dalbergia sisso*) as indicated by the standing crops.

2. *Strongly saline-sodic loamy and silty soils*: These soils are nearly level but occupy slightly higher positions than the normal loamy soils described above. They are deep, dense and homogenized to more than 1 metre depth. They can be identified by a nearly continuous, hygroscopic surface salt puff. The soils are saline-sodic throughout the profile. The soil pH ranges from 8.8 to 9.6.

   Most of the area is barren, without any natural vegetation. Small patches, whereas salt puff is thin, are supporting lani (*Salsola foetida*), lana (*Suaeda fruticosa*) and an occasional farash (*Tamarix articulata*) and Mesquite (*Prosopis glandulosa*). Shisham (*Dalbergia sissoo*) was raised by stump planting but it completely failed on these soils.

3. *Slightly saline-sodic loamy soils*: These soils are nearly level. They are loamy and about 75 centimetres depth and gradually merge to fine sandy loam with increasing depth. These soils are slightly dense. There are a few fine lime nodules in the upper subsoil. The pH varies from 8.6 to 8.8 except in the surface salt crust where it is 9.6. These soils are identified by surface salinity in patches especially near the trenches in which Shisham (*Dalbergia sissoo*) has been planted.

   The condition and stand of shisham in these soils is very poor. Jand (*Prosopis spicigera*) and kikar (*Acacia arabica*) are the main natural tree species and some khowi (*Cymbopogon jwarancusa*) is the main grass. A part of the slightly saline-sodic soils adjacent to the Desert Branch, was planted with Eucalyptus. *Eucalyptus microtheca* grew relatively better than *Eucalyptus melanophloia* on these soils.

4. *Dense loamy soils*: These soils are deep, loamy and homogenized throughout the profile. They contain common fine and medium lime specks in the subsoil between eight to twenty inches depth. The subsoil is virtually devoid of tubular pores and is somewhat cemented. Water and plant roots cannot penetrate through the subsoil. These soils, however, are free from salinity and sodicity.

   Shisham starts dying at the age of five to six years after attaining a height of about 4 metres and a girth of about 15 centimetres. However, some farash (*Tamarix articulata*), lai (*Tamarix gallika*), lana (*Suaeda fruticosa*) and dab (*Eragrostis cynosuroides*) are thirving. These are compaiatively shallow rooted plants.

5. *Stratified fine silty and clayey soils*: These soils are generally very fine sandy loams and silt loams in the top 20 centimetres. The surface soil is underlain

by dense, laminated silty clay at a depth of about 45 centimetres. Below 45 centimetres the soil consists of homogenized fine sandy loam extending to a depth of 1 metres. The soils have no problem of salinity and sodicity They are infested with dab (*Eragrostis cynosuroides*). Shisham stumps fail to establish roots in these soils

6. *Loamy soils with dense clayey substratum.* These soils are loamy to a depth of 1 metres. At places they have a thin 10—15 centimetres covering of very fine sandy loam. The substratum consists of stratified layers of silty clay which is completely dense and impervious. These soils are free from salinity and sodicity. Shisham standards in these soils have attained a height of about 12 metres a girth of .6 to 1 metre at the age of about 20 years. These plants are dying out.

7. *Moderately deep silty soils*: These soils occur locally as channel-fills along the foot of high sand-dunes. The soil depth varies from 50 to 75 centimetres. The soil profiles consist of partially homogenized silt loams and very fine sandy loams developed in the recent river alluvium. The substratum comprise buried sand dune material. The soils have no problem of salinity and or sodicity.

The young Shisham plants are growing well whereas the shisham standards are dying.

8. *Sand dunes*: Sand dunes occupy about 50 per cent of the plantation area. The dunes range from .6 to 5 metres in height. About 90 per cent of the dune surface is stable and has phog (*Calligonum polygonoides*), jand (*Prosopis spicigera*), karir (*Capparis aphylla*), khowi (*Cymbopogon jwarancusa*) and some lana (*Suaeda fruticosa*) as the original flora. The interdunal hollows occupy about 40 per cent of the sand dune area and collect some run-off from the dunes. They have chhimber (*Eleusine flagellifera*), khabbal (*Cynodon dactylon*) and *gorkha* (*Elionurus indicus*) grasses as the important natural vegetation. These grasses are palatable and provide some grazing to sheep and goats.

Locally a few small dunes occurring in the valleys were planted with Shisham by digging deep trenches. Because of sandy nature of soils the trenches were partially refilled by sand due to wind action. Consequently the area could not be properly irrigated and the crop failed after attaining the pole stage.

Sand dunes occurring adjacent to the saline-sodic areas have become slightly saline-sodic as well. White salt incrustation is apparent at the surface of these dunes and the pH of the sandy material is about 8.6 to 8.7. Lana (*Suaeda fruticosa*) is the main natural vegetation on these dunes.

Soil problems affecting management

There are four main soil problems that adversely affect the suitability and use of the area for shisham and other tree species under irrigation. These problems are discussed below:

1. *Salinity and sodicity*: A considerable extent of the area has been affected by salinity and sodicity. This area is identified in the field by the presence of white salt puff at the surface. Thickness of surface salt puff ranges from 2 to 8 centimetres. At places the salts are hygroscopic and give an oily look. Strongly saline-sodic patches are completely barren. High content of salt induces droughty conditions in the soil. Moreover the climate of the area is arid and irrigation water is scarce, the problem of salinity and sodicity would remain more or less permanent. Under these conditions the saline-sodic patches may be left as such. If however, sufficient water is made available for intensive forestry the reclamation of such areas could be undertaken. These soils could be reclaimed by using gypsum and growing of high delta crop such as rice followed by barley for two to three years. Deep rooted crops like berseem and jantar (to be green manured) may be included in rotation. After reclamation (even if partial) the area should preferably be planted with Eucalyptus and other salt tolerant tree species. Since this method seems to be expensive the economics of reclamation should be worked out before undertaking the operation on a large scale.

   The slightly saline-sodic soils have poor stand of shisham crop. However, farash and jand are relatively better growing than shisham on these soils. They could easily be reclaimed within two years by heavy irrigations and cultivation of rice and barley. After reclamation these soils could preferably be planted with Eucalyptus and other salt and drought resistant tree species. If however, sufficient water is not available for reclamation the hardy tree species such as jand and farash may be encouraged to grow.

2. *Dense soil mass*: Certain soils are completely dense even though they are free from salinity and sodicity. The dense soil mass is of the following three main types:

   (*i*) In the homogenized loamy soils there is a zone of lime accumulation in the form of common fine and medium specks at a depth of 20 to 50 centimetres. The lime has filled pores and voides in soil mass. It has also cemented the soil particles. The denseness of soil mass obstructs penetration of water and plant roots. These soils could be improved by subsoiling followed by cultivation of berseem and jantar (to be green manured) for two to three years. After that the area could be planted with Eucalyptus or other drought resistant tree species.

   (*ii*) The second type of denseness is due to the presence of stratified clayey layer in the subsoil. This layer is about 25 centimetres thick and is

dense. The dense material represents the mud deposited from deep flooding. It is in these soils where the stumps of shisham fail to strike roots. Ordinarily, in case of older soils the original stratifications are obliterated as a result of mixing of soil mass by soil animals and root action. With time as the plant roots decay, tubular pores are created in soil. These pores help greatly in providing proper soil-water-air-root relationship. At present it would be of little use to bring such areas under any plantation. If, however, abundant water is made available, the improvement of these soils could be effected by subsoiling, cultivation of deep rooted crops like berseem and jantar (to be green manured) within three to five years.

(*iii*) The third type of soil denseness is encountered in the form of stratified layer at a depth of 1 metre. This layer is completely non-porous and does not allow penetration of plant roots beyond this depth. As long as the roots remain within 1 metre the plant growth is not adversely affected. But a stage comes when the limited root zone cannot maintain the normal growth rate of Shisham. The plants start dying at the age of about 20 years. It is, therefore, suggested that the crop rotation may be modified accordingly or the area may be used for growing drought-resistant tree species.

3. *Shallow depth to sand*: The patches of shallow silty soils are underlain by sand at about 50 centimetres depth. Since the substratum is sandy and has low water and nutrient holding capacity and the soil is susceptible to severe droughty conditions. As long as the plant roots remain within 50 centimetres depth the plants keep on growing. A stage is soon reached when the limited root zone is no longer adequate to maintain normal growth rate and the Shisham plants start dying. These soils should not be planted to Shisham, but could be used for growing drought-resistant tree species.

4. *Sandy nature and irregular relief* : About 50 percent of the entire forest area is occupied by sand dunes. The sands have low water and nutrient holding capacity and are susceptible to severe droughty conditions. Irregular relief makes them inaccessible to irrigation water. Under the existing conditions of arid climate and inadequate water supply, the afforestation of such areas for shisham or other forest species will be wasteful of precious irrigation water. Such areas are, therefore, not recommended for afforestaion. They may be used as range land or for wild life.

Acknowledgements

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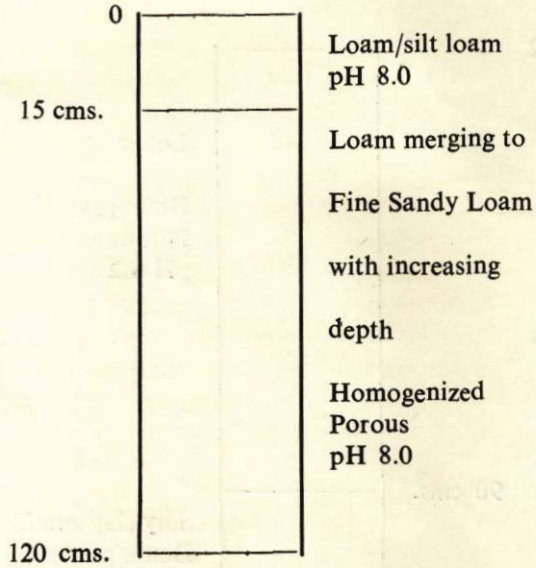
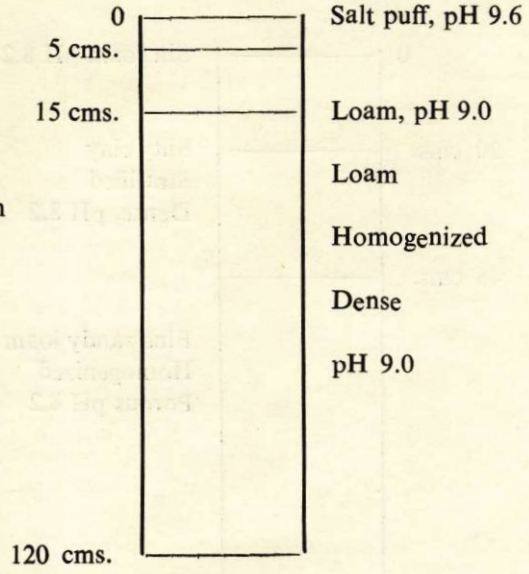
Schematic diagrams of Representative Soil profiles (without Scale)

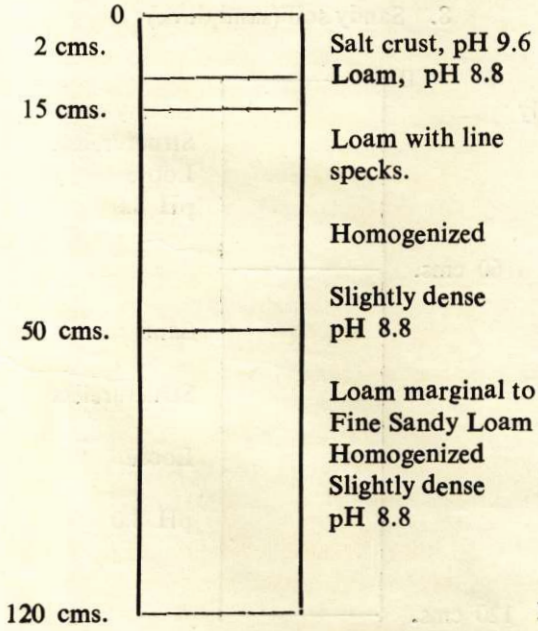
1. Loamy soil



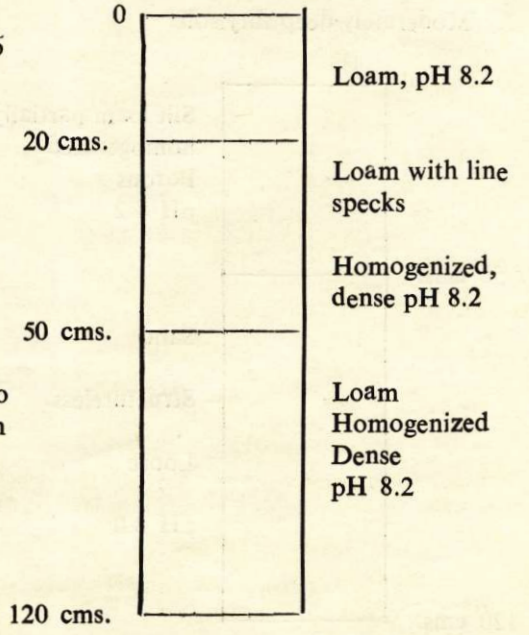
2. Strongly saline-sodic loamy soil



3. Slightly saline-Sodic loamy soil

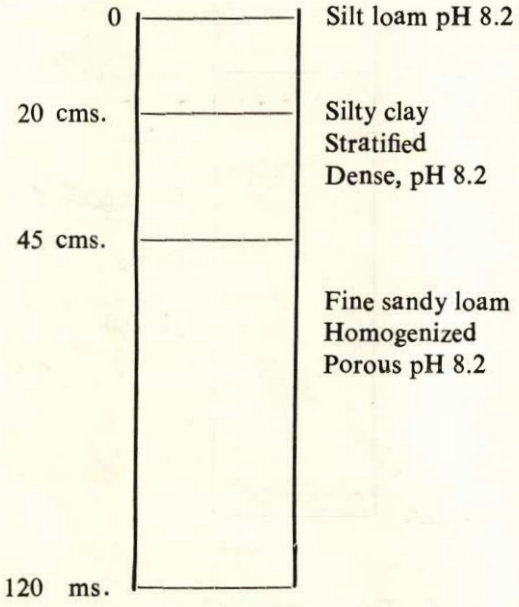


4. Dense loamy soil

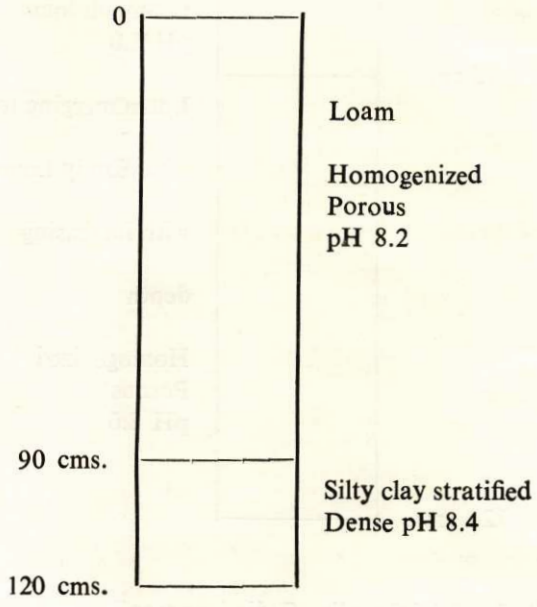


Schematic diagrams of Representative Soil Profiles (Without Scale)

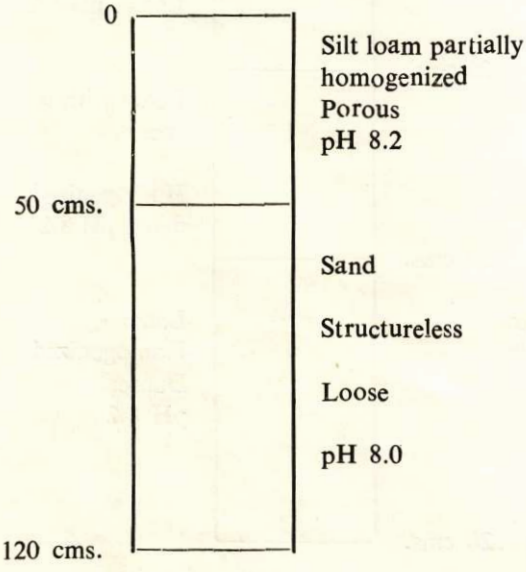
5. Stratified fine silty and clayey soil



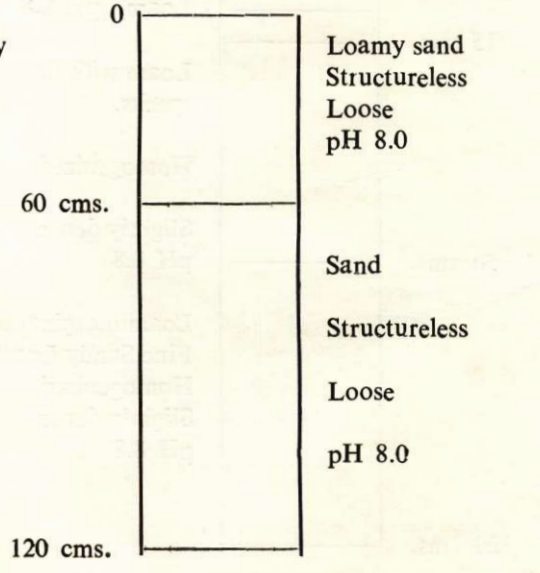
6. Loamy soil with dense clayey substratum



7. Moderately deep silty soil



8. Sandy soil (sand dune)



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