TREE PLANTING FOR SUSTAINABLE USE OF SOIL AND WATER WITH SPECIAL REFERENCE TO THE PROBLEM OF SALINITY[1]

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BACKGROUND

The forests are, were, and will remain a major land use all over the world. They are a vast and vital part of the earth's ecosystem and constitute its natural climax vegetation. They are essential for climatic stability, prevention of global warming and conservation of biological diversity. Originally, about 10,000 years ago, two third of earth's surface was covered with forests. Presently, only half of this forest area is left. World-wide, the biggest threat to forest resources has been clearance of forests for agriculture. This has also resulted in aridity in many countries. Although, some salinity generally occurs in arid and semi-arid regions of the country because of low precipitation, high temperatures and high rate of evaporation in them, still, most of the soil degradation, including salinity and waterlogging have occurred in these regions due to removal of natural vegetation of dry tropical thorn forests and disturbance of natural ecosystem and drainage in the first instance which was subsequently extended by faulty irrigation practices for production of food and fiber to meet the needs of increasing population. In the latter case, the seepage of irrigation water from unlined water courses has aggravated the problem to an enormous and critical extent. Unfortunately, role of forests in this regards is little understood and only mechanical means have been used to reclaim salt affected and waterlogged areas at a great expense by the government agencies such as WAPDA and accepted by the public at large.

The problems of salinity and waterlogging are not confined to the cultivated areas in Pakistan. The provincial forest departments have management control over state land area of 10.664 million ha of forests and rangelands in the country. Out of this 230,000 ha are under irrigated plantations in the provinces of Sindh and Punjab. A number of irrigated plantations in Punjab are facing the problem of waterlogging and salinity as a result of seepage of irrigation water from nearby canals. The notable example in this regards is Shorkot plantation in district Jhang. Entire plantation of about 4,000 ha area was rendered unproductive for tree growth due to this reason in 1960s. Other plantations, such as, Changamanga have also been considerably adversely affected in the same manner. The forest departments have also faced difficulty in raising of tree plantations along the road and railwaysides in the province due to presence of waterlogging and salinity. The situation of tree plantations in Sindh and Balochistan provinces is also critical.

The causes and extent of salinity and waterlogging were explained in detail in a recent publication of the Pakistan Agricultural Research Council on the subject of desertification. The twin problems of salinity and waterlogging are enormous. Out of total culturable area of 23.25 million ha in the country, 26-39% area is affected by salinity and 42-57% by waterlogging. About 60% of salinized land suffers from salinity and sodicity; the remainder mainly affected by salinity. In all about 5.5

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million ha of land has gone out of agriculture production for these reasons. Although about 6% of this area has been reclaimed by mechanical methods, still, immense work lays ahead to reclaim the affected area and to arrest the process of further deterioration of soil and water resources in the country. It has seriously adversely affected sustainable use of these natural resources. As already mentioned, the deterioration has come about due disturbance of natural ecological balance and drainage in dry tropical regions and this process can be reversed only if original natural balance is restored to some extent. The forestry practices are also expected to be cost effective vis-a-vis mechanical methods of soil reclamation. The practice of social forestry for this purpose in the rural areas would promote equity and economic well-being of farmers and would thus constitute an important element in rural development. It would also improve forestry situation in forest deficit areas of the country through planting on problematic and marginal lands with salinity.

CURRENT STATUS OF RESEARCH

Inspite of the fact that the problem of reclamation of saline and waterlogged area is immense, research efforts to solve the problem through biological means in general and forestry practices in particular have been minuscule, sporadic and scattered over the years. Local research institutions and scientists have not received any substantial support from the government for this purpose. Almost all funds were provided to WAPDA to tackle the problem at a very high cost through mechanical and engineering means, which a country like Pakistan can ill afford. Presently a number of institution in Pakistan are engaged in research and development for reclamation of saline and waterlogged areas with biological methods in different ecological regions. These are listed below:

Pakistan Forest Institute, Peshawar

- Pakistan Agricultural Research Council/National Agricultural Research Centre, Islamabad
- Punjab Forestry Research Institute, Faisalabad
- Silvicultural Research Division, Forest Department, Hyderabad, Sindh
- Nuclear Institute for Agriculture and Biology, Faisalabad
- Atomic Energy Agricultural Research Centre, Tando Jam, Sindh
- Botany Department, University of Karachi, Karachi

In reviewing the present status of research, it was thought appropriate to present the general picture, without references to specific research to achieve economy of space. Most of papers on the subject describe problems of salinity and waterlogging. Often very little is added to what is already known concerning the nature of such soils. Most of the research todate consists of testing of local and exotic tree species under variable conditions of salinity and waterlogging in the pots in nursery and in the field. This research was in many instances combined with the investigation of different methods of planting trees in soils with these problems. Most commonly, mound, ridge and berm planting techniques were tested. Some studies were also conducted for determining status of soil salinity from plant communities growing on them. A number of salt and moisture tolerant tree species have been identified during more than 60 years of such research in Pakistan for all ecological regions where this problem is encountered. These tree species have a wide range of natural distribution and exhibit plasticity. The species are: *Acacia nilotica, Tamarix articulata, Conocarpus lancefoleus, Populus euphratica, Casuarina equisetifolia, Eucalyptus* species,

Albizzia sp., *Phoenix dactylifera, Prosopis julifera,* and *Sesbania* sp. Research is also being carried out in Sindh on use of saline affluent water for afforestation with a number of these tree species. The Nuclear Institute for Agriculture and Biology, Faisalabad has determined the feasibility of growing Kallar Grass (*Leptochloa fusca*) for sodic soils at their Biosaline Research Station near Lahore. The aim of research on reclamation of saline and waterlogged soils through biological means is to select salt tolerant plant species which can ameliorate these soils, provide some economic returns, and ultimately restore the soils to full productivity.

The biggest drawback of most of the above studies is that they fail to describe status of salinity and depth of water table in the experimental area in a quantitative manner e.g. in terms of salinity, sodicity, EC, pH, ESP, etc. Because salt affected soils are so characteristically 'spotty' and vary considerably in physical and chemical properties, there is always considerable variation in salinity level over an area. Further, fluctuating water table is also a problem in such areas. Unless both are defined and quantified specially over a period of time, the results of the research studies would be highly variable within a study as well as from one study area to another inspite of the fact that identical plant species and planting techniques are used in them. Plant germplasm used in these studies are also highly variable. Therefore such studies are usually not replicable from one locality to another. The plant material is also not useable in all such studies for the same reasons. Under the circumstances only few tree species such as *Acacia nilotica, Tamarix articulata* and *Eucalyptus camaldulensis* have been used to some extent for reclamation of saline and waterlogged areas so far. Planting techniques of mound, ridge and berm and soil working have been found to be very costly for their wide applicability by the farmers. Recent test introduction of salt tolerant plants from Australia are promising, but would take some time before they are grown on a large scale. The field studies of these species were well-laid out and status and level of salinity and water table were also determined. The results are highly useful.

NEED FOR FURTHER AND NEW RESEARCH

Only few local tree species are suitable for planting on saline and waterlogged areas. Planting of exotic *Eucalyptus camaldulensis* has recently been taken up locally by both government agencies and farmers on a fairly large scale in moderately salt affected soils. Other salt tolerant tree and bush species from Australia, notably, *Acacias, Casuarinas, Eucalypts* and *Prosopis* species are presently confined to field experiments and have not yet been included in large planting programmes in the country. The main problem in this regards is the availability of sufficient quantity of seed of those species which have proved to be promising in the field trials. Australia could provide seed till the time Pakistan is in a position to produce seed of its own from the seed orchards. This work should immediately locally be started. Further, Australia has only provided the seed of a small number of species so far for testing under Pakistani conditions. There is considerable scope of test introduction of numerous other species from that continent.

The current research on biological reclamation of salt-affected soils mostly consists of species trial in large field studies. Variation in soil conditions and planting material are not investigated in detail. Unlike agriculture and forage crops, trees are planted at large spacings over a large area. Therefore sampling

procedures for soil are always a problem. These should be standardized. Because large number of soil and water samples are often necessary in analysing and monitoring a given soil situation, simple and reliable tests are needed for this purpose. New methods of testing salt affected soils and plants should be found out.

Tree species still constitute wild crops and exhibit large genetic variation. It is generally understood that considerable improvement can be made by careful selection of appropriate provenances. Therefore, efforts should be made to select such provenances and to propagate them vegetatively to obtain genetically uniform material of those trees and bushes which have proven to be suitable for problematic soils. For this purpose, salt-tolerant trees of different species be selected and multiplied by micropropagation and tissue culture techniques for their further testing and field planting.

Detailed studies of indicator plants growing in saline environment has always intrigued the investigators with the prospects of obtaining secrets of halophytism and factors underlying salt tolerance, stress physiology and physiological adaptation of tree plants. These studies have to be intensified in order to facilitate selection and multiplication of suitable trees for reclamation purposes.

More research is needed on management and preparation of salt affected soils for planting trees and shrubs in order to reclaim them on permanent basis at economical cost. Similarly, research is required in post planting management. Farmers should also be trained for carrying out these activities on their farms. A guide published on occasion of the workshop held at Faisalabad in December, 1990 is one of few useful publication for foresters and forestry scientists. A network of research trials started by different organizations be established to facilitate frequent exchange of scientific information amongst scientists who are responsible for these trials.

CONCLUSION

Research and development in reclamation of saline and waterlogged land by biological has been underway on limited scale in Pakistan for more than sixty years. Emphasis was placed throughout this period on selection of suitable tree species and method of their planting on salt-affected soils in different ecological regions in the country. Some local *Acacia* and *Tamarix* and exotic *Eucalypts* and *Prosopis* species have been found to be suitable for this purpose and are currently successfully planted on fairly large scale on such soils in some localities. From various studies, it is quite evident that tree species can play an important role in the reclamation of saline and waterlogged soils. A positive change in the soil structure, chemical and physical properties and watertable may be brought about through vegetation. Soil working was also found to be useful. On the other hand, a variable degree of success was achieved while testing different methods of planting of these species. These methods were generally not found to be cost effective and therefore, did not find wide applicability in tree planting programmes. In view of past success, policy on reclamation of saline soils should emphasize biological and afforestation means. There is considerable scope of extension of work of selection of tree species and developing technologies of their planting on saline and waterlogged soils. For this, the research efforts will have to be intensified and expanded to cover all types of saline and waterlogged conditions.

Sampling procedure of salt affected site should be standardized and simple tests evolved for determining salt contents of soil and sub-soil water of the experimental areas. Selected planting material has to vegetatively propagated by micropropagation and tissue culture techniques for preservation of purity of germplasm. Presently selection of suitable trees for reclamation is confined to few local and Australian species. Other Australian trees and shrubs should also be included in this work. Detailed studies have also to be carried out to determine changes in physical and chemical properties of soils after the establishment of tree crops. There is a need to demonstrate economic feasibility of different methods of saline soil reclamation including tree planting so that the latter becomes a recognized and accepted method for this purpose. The research activities of all institutions relating to reclamation should be coordinated through networking to avoid duplication.

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