TREE SPECIES IN RECLAMATION

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Summary

Human-induced land degradation has resulted from the intensification of agricultural and mining practices and from destruction of forest ecosystems. In addition, many soils are naturally infertile or physically difficult to cultivate. Salt-affected and acid soils occur over several thousand million hectares of land worldwide. Mine sites usually present difficult physical (e.g., overburden) and chemical (alkaline, acidic, saline, nutrient imbalance) conditions for tree survival and growth. When suitable tree species are used and appropriate land management practices are employed, these soils can afford opportunities for sustainable tree growing, including plantation and farm forestry.

Successful tree growing, and therefore capacity for reclamation, on salt-affected land will need to take into account particularly: (i) maintenance of root-zone salinity at desired levels; (ii) use of appropriate planting methods; and, very importantly, (iii) correct choice of species and provenances. Strategically placed trees can lower shallow water tables in wet and/or saline locations on both rain-fed and irrigated land, but their impact is related to such issues as soil texture, depth and salinity of the water table and the density of tree planting.

Long-term changes in root-zone salinity are less predictable, but either water table fluctuations or leaching with rain or irrigation water will be necessary to maintain acceptably low levels. Evidence indicates that both salinity and sodicity can be reduced by tree growth and that choice of tree species (mainly related to extent and rate of root growth) can influence the degree of amelioration.

Successful establishment of fast-growing plantations on acid soils will need to particularly: i) select suitable tree species and provenances, and root symbionts such as rhizobia and mycorrhiza, and, ii) manage soil phosphorus and aluminum by appropriate

application of fertiliser, lime (and/or gypsum) and organic matter. Management of nitrogen in acid soils in order to reduce leaching of nitrate is another major issue. There is very little evidence to suggest that tree growth can reduce soil acidity. In fact, most evidence is to the contrary; this is related to losses of base cations during harvest, slash fires, erosion and site preparation. Differences in leaf chemistry among species may well influence opportunities to reduce acidity, e.g., decomposition of leaves high in bases can reduce exchangeable aluminum in soils.

1. Introduction

Almost 2000 M ha of land worldwide have become degraded through water and wind erosion, and chemical and physical soil deterioration over the past five decades. Five different causes of physical human intervention have resulted in land degradation: (i) deforestation and removal of natural vegetation; (ii) overgrazing of vegetation by livestock; (iii) improper management of agricultural land; (iv) over-exploitation of vegetation for domestic use; and, (v) (bio) industrial activities leading to chemical pollution. Types of degraded land include salt-affected, waterlogged and acid soils, mine sites and severely eroded land.

Reclamation of degraded land is often attempted with fast-growing tree species with the aim of satisfying community demand for wood products, minimizing incursions into natural forest and allowing establishment of native forest species following amelioration of soil conditions. However, appropriate emphasis should be given to the use of site-specific indigenous species if diversity-linked ecosystem redevelopment is to take place and provide longer-term stability for plantation and farm forestry.

Key edaphic constraints to the establishment and growth of trees on degraded land are: (i) deficiency of essential nutrients and soil organic matter; (ii) high concentrations of toxic elements and compounds; (iii) high soil compaction and soil strength; and (iv) low activity of symbiotic micro-organisms. Examples of reclamation through tree-growing interventions might include: (i) lowering of shallow, saline water tables that result in development of salinised land; (ii) increase in pH of acidic soils to reduce impacts of toxic elements, such as aluminum on plant growth; (iii) increase in soil organic matter leading to improved soil structure; and, (iv) improved physical and chemical conditions for plant growth on ex-mine sites.

This chapter provides an overview of tree species suitable for different types of degraded land including opportunities for genetic improvement, how trees respond to chemical and physical constraints in degraded environments and the characteristics of tree species likely to influence their capacity to reclaim such sites.

The focus is on salt-affected and acid soils. Mine sites usually present difficult physical (e.g., overburden) and chemical (alkaline, acidic, saline, nutrient imbalance) conditions for tree survival and growth. Some of these constraints are dealt with under salt-affected and acid soils.

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Biographical Sketch

Dr Nico Marcar is a Principal Research Scientist at CSIRO Forest Biosciences (Canberra). He has over 20 years International and Australian experience in evaluating trees, shrubs and grasses for salt and water-logging tolerance. Most recently, he has been involved in field evaluation and genetic improvement of *Eucalypts* and *Acacias* for salt and water-logging tolerance. He has managed two major collaborative projects in Pakistan and Thailand dealing with sustainable tree growing in saline environments. He has authored over 100 journal and conference papers, book chapters, books and technical reports in this area.