Greening the Earth vis-a-vis afforestation of degraded and problem soils

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The tenth World Forestry Congress under **The Paris Declaration** solemnly called upon the decision makers to commit themselves to the **Greening of the World** through affore station, reforestation and sustainable management of trees and forests. Keeping in view the magnitude of problem and need for Greening of the earth, the Director General, Indian Council of Forestry Research and Education has given major thrust on research into reforestation of degraded lands and problem soils (Barren/mined/waste/water-logged/ salt affected lands etc) (43).

It is estimated that 175 M ha land area in India suffers from various problems of soil erosion and land degradation (Bali 1990) of which 104.26 M ha suffers due to water erosion, 38.74 M ha due to wind erosion and aridity, 7 M ha due to sand dunes, 6 M ha due to water logging, 5.5 M ha due to saliniiy (includes coastal saline), 2.50 M ha due to alkalinity, 3.97 M ha due to ravines and gullies, 4.30 M ha due to shifting cultivation and 2.73 M ha due to floods and enundation (44).

This paper discusses salient findings of the research efforts carried out by the Forest Research Institute in greening the degraded and problem soils.

Greening the earth through appropriate soil management techniques

Reforestation of eroded slopy lands : The Western Ghats in India constitute the range of hills running almost parallel to 'Arabian Sea and pass through the states of Kerala, Tamil Nadu, Karnataka, Goa and Maharashtra. About 1600 km long Western Ghats is the watershed for 44 rivers that sustain economy of these states. These Western Ghats, at time, supported most luxuriant tropical moist vegetation (3 B-South Indian Moist Deciduous forests). Due to population explosion, the demand for forest land for non-forestry purposes has resulted in dwindling the area under good forest cover. Due to fire, grazing and excessive unscientific felling and shifting cultivation, a large scale degradation of these forests have further accentuated the problem. These degraded forests, in all major types yielded to secondary savanah vegetation with *Typha elephantina* and *Cymbopogon citratus* as main grass species.

The demand for pulp prompted Kerala state government to afforest about 100 sq km, out of its about 21.50 sq km of grass lands, with *Eucalyptus grandis* (45). However, plant growth in most of the areas remained severely stunted even after 10 to 15 years of planting. Therefore, survey of soil and vegetation of the area was undertaken to identify the limiting factors for slow rate of growth and lower survival percentage of *E. grandis* in the region.

An initial survey of the soils under *Eucalyptus grandis* plantation at Minmutti, in Nagarampara range of Kottayam Forest Division revealed that the stunted growth and mortality of the *Euclyptus grandis* was due to deficiency of N, P and Ca, on severel eroded soils, having skeletal compacted soil profile, (Fig. 1). Sutdies involving four levels each of N (0, 30, 60 and 90 kg/ha) as urea and P_2O_5 (0, 10, 20 and 30 kg/ha) as urea and superphosphate, respectively, in factorial combinations revealed that both nitrogen and phosphorus, enhanced biomass production and stem volume significantly during two year growth period. Influence of nitrogen was of prime significance. The P and N × P interaction was also significant (5, 6, 7, 8, 11, 16).

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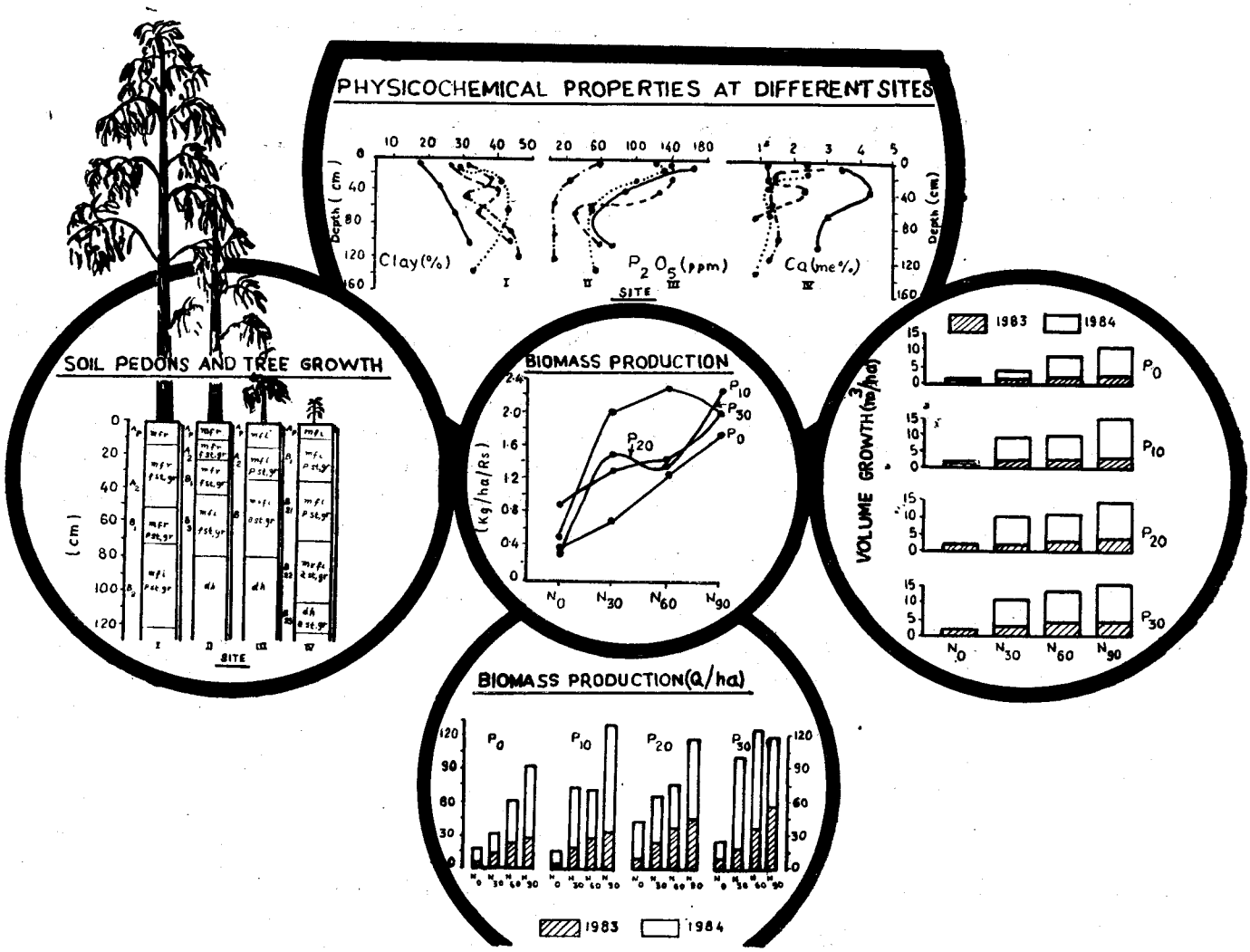

Fig. 1

Response to nutrient application :

Studies carried out (1, 4, 5, 6, 7, 8, 9, 10, 11, 16 19, 23, 28, 30, 31, 33, 39, 42) Conclusively proved that tree species respond to nutrient application. Keeping this in view, ten species were screened for their N, P and K Fertilizer Use Efficiency(NFUE, PFUE and KFUE, respectively). Based on the study, the species were grouped as :

Nutrient Response	Legume Species	Eucalyptus Species
1. N	*Prosopis juliflora*	—
2. N+P	*Acacia catechu*	*E. tereticornis* Var FRI—F5
3. N+K	*Leuceana leucacephala*	*E. tereticornis* Var FRI—4 *E. Grandis*
4. N+P+K	*Acacia nilotica*	*E. citridora* *E. comoldulensis*

Response to site factors :

Species response to site factors (2, 14, 15, 18, 41) texture (22, 28) and rainfall (22) were also worked out. Attempts were also made (18, 41) to develop model to predict soil responses under given set of conditions using cannonical discriminant function and cluster analysis.

Management of Soil Moisture :

One of the main problems of reclaiming the red and laterite soils are the management of soil moisture. Field (3. 20, 27, 37) and green house (26, 29, 32, 35, 36, 38) studies were caried out to evaluate the effect of mulches. **Coir Pith, Rice Husk, Pine needle, Shrub leaves and grevels** which were available loca-

lly were effective as mulch in reducing soil temperature conserving soil moisture and enhancing growth of plants.

Saline alkaline and water logged soils:

In India more than 10 m ha waste lands are due to salinity, alkalinity or water logging. These problem soils are formed due, mainly, to combined effect of climate, topography and hydrology. Destruction of forests, improper use and management of land coupled with unthoughtful developmental activities are contributory towards their formation. The problem encountered in their management are the poor physical, chemical and biological conditions. The physical attributes that render them inhospitable for plant growth are low infiltration rate, impeded drainage, poor soil structure, very hard consistency when dry, resulting in water logging during rains, severe moisture stress during dry period, and low moisture availability. The constrains regarding chemical properties are poor and imbalanced available nutrient status, excess of water soluble salts and dominance of sodium in exchange complex,

Research activities carried out by the Forest Research Institute (12, 17, 24, 34, 37, 40) are grouped into :—

(a) Screening of tree seedlings.
(b) Field experiments.
(c) Transfer of Technology.

Screening of species for salt tolerance (Pot culture) :

Tree species were screened for their tolerance to salinity and alkalinity (12, 17, 24, 37, 104). Based on the results various species are grouped in to different salinity and alkalinity (pH) tolerance and presented here·

Salinity Tolerance

< 2.5 dS/m	2.5—5.0 dS/m	> 5.0 dS/m
C. pentendra	*A. indica*	*P. juliflora*
A. auriculaeformis	*P. pterocarpum*	*A. nilotica*
A. lebbek	*L. leucocephala*	
C. equisetifolia	*E. camaldulensis*	
E. grandis	*E. tereticornis*	
	E. tereticornis Var FRI - 4	
	E tereticornis Var FRI—5	

Alkalinity (pH) Tolerance

< 8.5	8.5—5.9	> 9.0
A. lebbek	*L. leucocephala*	*P. juliflora*
A. auriculaeformis	*E. camaldulensis*	*A. nilotica*
C. pentendra	*E. tereticornis Var FRI-4*	
C. equisetifloia	*E. tereticornis Var FRI-5*	
E. grandis		

Soil Technology for sodic soils (Field experiments) :

Sharma and Prasad (46) carried out a number of field experiments under different silvi-climatic zones in Haryana (Revar and Seonsar) and U.P. (Kanakasinghpur Khara). Following paragraphs describes briefly the salient results noted so far.

Soil Management :

At revar, different soil management treatments were applied to ten species. Results indicated that the application of soil ameriorants (3 kg gypsum), organic residue (2 kg rice husk), fertilizers (75 g urea, 50 g SSP, 25 g muriate of potash), micronutrients (2.5 g $ZnSo_4$ 2.5 g $FeSO_4$) and insecticide (5 g BHC) increased survival and height growth of P. *chilensis, callistemon citrinus, T., articulata, E. tereticornis, A. nilotica, T. arjuna* and P.*pinnata where as A. lebbek, M. azederach and A. indica* died within one year. Application of organic residue as mulch alone was not beneficial. *E.* tereticornis and *A. procera* also responded to soil management treatments at Kanaksinghpur.

Season of Planting :

Experiment conducted at Seonsar with *C. Citrinus, T. articulata, E. tereticornis* and at Khara with *T. arjuna and P. pinnata* indicated that pre-monsoon(July) and post-monsoon (September-October) planting are better than monsoon plantation for better survival and growth.

Sources of Organic Residue :

Experiments conducted at Seonsar (*T. articulata*). Kanaksinghpur (*T. arjuna*) and Khara (*P. pinnata*) confirmed that application of organic residue is essential for higher survival and better growth of plants in sodic soils. Among the different organic sources tried

rice husk was much superior followed by farm yard manure. Application of green manure (dhaincha or Jalkumbhi) though better than control (no organic residue) caused greater mortality than F.Y.M.

Method of Gypsum Application :

Application of 5kg gypsum in the pit was superior over broadcast application of the same amount at Kanaksinghpur on *T. arjuna* and at khara on *P. pinnata*. When gypsum was not applied severe mortality at both the locations was noticed and plants were stunted in growth.

Time of Gypsum Application :

In another experiment, gypsum was applied 6 weeks before transplanting and at the time of transplanting mixed with dug up soil and filled in the pit at Seonar. *T. articulata* responded to 6 week before application whereas for *C. citrinus* gypsum applied at the time of planting was superior considering survival hight and collar circumference. Time of gypsum appli cation had no significant effect on *E. tereticornis*.

Transfer of Technology :

Based on the various experiments carried out by **Indian Council of Forestry Research and Education**, a package of practice was developed for salt affected soils. In order to transfer this technology to the farmers field, the Forest Research Institue, Dehradun collaborated with the Farm Forestry Division of the Indian Farmers Fertilizer Company (IFFCO) at Sultanpur. The idea was to develop salt affected waste lands through farm forestry in order to economically uplift the rural people, reclaim sodic soils through afforestation and bring about ecological changes in the landscape of the area. The author and coworker (S. D. Sharma) in association with the IFFCO worked out details of requirement, trained the villagers and supervisors in handling and application of treatment, mixing them and in transplanting the seedlings. They also initially supervised planting of about 200 ha land in Kanaksinghpur farm forestry cooperative. They also periodically visited the area, and suitably advised. Neem, Kanhi, Arjun, Eucalyptus, Subabul, Prosopis, Ber, Guava, Karaunda and Sesbania were planted both as pure and mixed tree crop. It was heartening to note that the supervisors andfarmers who had no experience of planting tree could successfully plant on these salt affected wastelands where the survival was about 80% using FRI expertise. In this large scale plantation using the input prescribed by the ICFRE, the cost per ha(for 2000 plants)worked out to Rs. 19,5000/-only (Rs 9.75 only).

Studies so for carried out indicated nine components viz. Species, Drainage, Gypsum, Irrigation, Organic residue, control against pests and diseases, Fertilizers, Soil working and Biotic interference; mostly responsible for the sucess of any plantation in degraded and problem soils in order to green the earth. Relative importance of each factor, considering cent per cent response due to optimum application of all the factors listed, is shown in Fig. 2. It may be noted that ammendments, crop residue, suitable species, provision

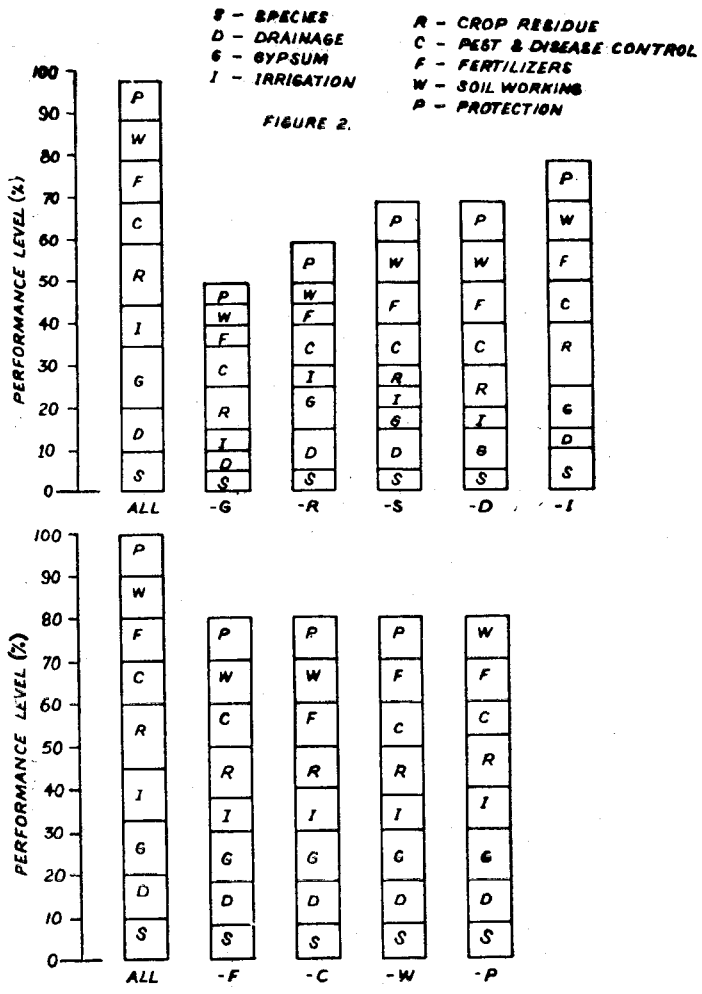

FIGURE 2.

of irrigation and drainage and are the primary factors for success of any attempt made in greening the earth.

Conclusion :

Considering the gigantic task of greening the earth through aforestation of degraded and Problem soils, one of the thrust area of research undertaken by the Indian Council of Forestry Research & Education has been to develop technology for greening our 175 M ha degraded and problem soils. It was felt that answer to our sustainable forests and self sufficiency in pulp and paper lies in growing trees on these degraded and problem soils which will not only green the earth but also restore the ecology of the area and provide vital raw material to the pulp and paper industry.

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