MULTI-PURPOSE TREES AND SOIL WORKING TECHNIQUES FOR MANAGEMENT OF DEGRADED LAND

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Introduction

Natural resources are vital for meeting the food, livelihood and environmental security. It is now widely accepted that future of food, livelihood, and environmental security depends upon the attention paid to conservation, sustainable development and management of natural resources. The article highlights the ameliorative effect of MPTs and soil working technique developed by the UHF, Solan (Himachal Pradesh) for rehabilitation of degraded lands.

Land, the most precious natural resource is the basis of man's existence on this planet. In the mountains of north-western Himalaya, agriculture, horticulture, forest, agroforest and livestock husbandry are intricately linked with each other. Expanding industries, upcoming urban settlements, mining for minerals, establishment of hydroelectric power projects, disposal of municipal waste, unscientific disposal of industrial effluents, interalia are the factors accelerating the process of land degradation and associated problems of environment. These factors in turn are causing reduction in the net output from land based production systems particularly in the Shivaliks and outer Himalayan region where competition for land is much intense.

The word 'waste' gives the impression of land being useless or non-usable. This is actually not so. Every bit of land created by nature in pristine form has its own use. Wastelands have been described as degraded lands which can be brought under vegetative cover with reasonable efforts and which are currently underutilized, deteriorating for lack of appropriate soil and water management or because of natural causes. Such lands can result from inherent or imposed disabilities, such as location, environment, chemical and physical properties of soil as well as financial or management constraints (NWDB, 1987). The technical task group of experts set up by the National Wasteland Development Board classified wastelands into two broad classes: (i) Cultivable wastelands: Land whose level of productivity of vegetative cover can be increased with or without inputs and include: (a) guillied and ravined lands (b) salt affected lands (c) surface waterlogged and marshy lands (d) degraded lands (e) deserts (f) fallow and other lands lying unutilized; and (ii) Uncultivable wasteland: Wastelands on which vegetative cover cannot be developed. Such lands includes: (a) barren rocky areas (b) snow covered or glacier area.

Extent of Wastelands in Himachal Pradesh

Geographically Himachal Pradesh occupies an area of 55673 sq. Km and 56.87% of this area has been classified as wastelands (Table 1). The major categories in the order of their dominance leaving apart snow covered or glacial area that covers about 22.56% of total geographical area are: underutilized/degraded notified forest area, degraded pastures/grazing lands, barren rocky, stony area, degraded lands under plantations, uplands with or without scrub and steep sloping areas. These areas collectively cover about 98.26% of the total wastelands excluding snow covered areas (Table 1).

Table1: Wasteland categories and their extent in Himachal Pradesh

S. No.	Category	Area (sq km)	% of total geographical area
1.	Gullied and/or Ravine land	121.89	0.22
2.	Upland with or without scrub	2056.50	3.69
3.	Waterlogged and marshy land	15.69	0.03
4.	Land affected by salinity/alkalinity	1.36	0.002
5.	Shifting cultivation area	0.00	--
6.	Underutilized/degraded notified forest area	4589.98	8.25

7.	Degraded pasture/grazing land	4278.17	7.68
8.	Degraded land/under plantations	2457.59	4.41
9.	Sands-inland/coastal	105.04	0.19
10.	Mining/industrial wasteland	86.66	0.15
11.	Barren rocky/stony/rock area	3858.04	6.92
12.	Steep sloping area	1529.67	2.75
13.	Snow covered/glacial area	12559.42	22.56
14.	Total wastelands	31659.00	56.87

Source: Land Use Statistics at a Glance (1996-97), Ministry of Agriculture, GOI, 2000

Adverse Ecological Manifestations of Land Degradation

Loss of fertile soil due to water erosion is the major constraint in optimizing the productivity of various production systems in vogue under agriculture, horticulture, agroforestry and forests. On erosion prone steep slopes 50% of the rainfall is lost as runoff carrying with it 20 t ha^{-1} of soil (Sharda, 2002). As a result, the sediment yield in tributaries of Himalayan rivers varies from 6.0 to 98.4 m^3 ha^{-1} year-1. Loss of top soil further result into nutrient impoverished and moisture deficient soils. According to land capability classification, wasteland areas in Himachal Pradesh mostly fall in class IV-VII. Due to shallow soil depth, undulating topography, presence of high proportion of gravels, extreme drought condition in the month of May and June and high soil erosion during monsoon, these lands are mostly devoid of the suitable vegetation. There is little scope for cultivation of food crops unless the lands are biologically revived. Employing suitable soil working techniques and planting MPTs suitable to the soils specific conditions thus hold promise to rejuvenate such lands.

i) Soil Working Technique for Planting of Multipurpose Tree Species (MPTs):

Planting of MPTs which are fast growing, nitrogen fixing, good coppicers and possess fibrous root system, are suitable for rehabilitation of degraded lands. These are grown without supplying any external input like FYM, fertilizers and irrigation water. However, plantation failures are very common in hills due to varied growth and development constraints of the sites available. Shallow soil depth, gravelly soil, low soil moisture especially during May-June, low organic matter content and poor soil fertility are dominant limiting factors resulting into poor survival and growth of trees. Hence, appropriate soil working techniques are important for early establishment, higher survival rates and enhanced growth of the planted stock.

Soil Working

Soil working is one of the most important operations in the plantation establishment as it affects soil erosion, moisture conservation, plant growth and plantation cost. The most common soil preparation methods in practice at most places including Himachal Pradesh are: pitting; patch or strip soil working; herringbone or fish-scale plantations, tie-ridging, contour stone walls, V-ditch/ridge-ditch and gradoni or banquettes. The last two soil workings have been found very successful in establishment of MPTs (Verma & Mishra, 1996).

Gradoni soil working has enabled in achieving enhanced plantation survival rates of 80-90%. The two important contributing factors of this soil working are, modified soil conditions and enhanced available soil water content. Studies on the effect of soil working techniques on the available soil moisture levels throughout the year in broad leaved species plantations during the first two years of establishment have revealed that in gradoni and ridge-ditch soil workings available soil moisture remains 2-2.5 times higher than traditional pits in root zone even during the drought period in May-June in hills. Plantation blocks of different MPTs e.g., *Celtis australis, Grewia optiva, Acacia mollissima, Morus alba, Punica granatum, Acacia catechu, Ulmus villosa, Acrocarpus fraxinifolius, Toona ciliata, Quercus leucotrichophora* and *Bauhina variegata*, etc. have been raised successfully using either gradoni or ridge-ditch method on degraded hill slopes at Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni-Solan, Himachal Pradesh.

ii) Multipurpose Tree Species (MPTs) and Soil Health

MPTs has the potential to ameliorate, protect and conserve the soil health. Ameliorative effects of MPTs on marginal and

degraded hill slopes in subtropical-subtemperate mid-hills of H.P. (1270 m asl) were observed by Verma *et al*., (2005). There was reduction in soil pH under pure *Acacia mollissima* plantations planted at 1.25m x 0.5m spacing. Organic carbon was found maximum under 1 row of Eucalyptus + 2 rows of *Acacia mollissima*. Available nitrogen and potassium were recorded maximum under pure Acacia mollissima whereas, available phosphorus and calcium were found high under pure *Eucalyptus hybrid* plantations.

Ameliorative effects of nitrogen fixing trees on degraded soils in the low and mid hills of Himachal Pradesh were also reported by Bhola (1995), Nayak (1996) & Sharma (1999). Seventeen MPTs were tested (Sharma, 1999) for their soil ameliorative attributes viz. organic carbon, available N, P and K on shallow silty clay loam soils at Solan, Himachal Pradesh. Soil organic carbon accumulation was recorded maximum under *Grewia optiva* followed by *Leucaena leucocephala* after ten years of planting. *Melia composita* and *Bauhinia variegata* showed lowest improvement in organic carbon (Fig. 1). Available N was maximum under *Leucaena leucocephala* followed by *Dalbergia sissoo* and *Bauhinia retusa* (Fig. 2). Improvement in available phosphorus was highest under *Melia composita* and lowest under *Bauhinia variegata* (Fig. 3). Maximum enrichment in available K was observed under *Ailanthus excelsa* followed by *Celtis australis* (Fig. 4).

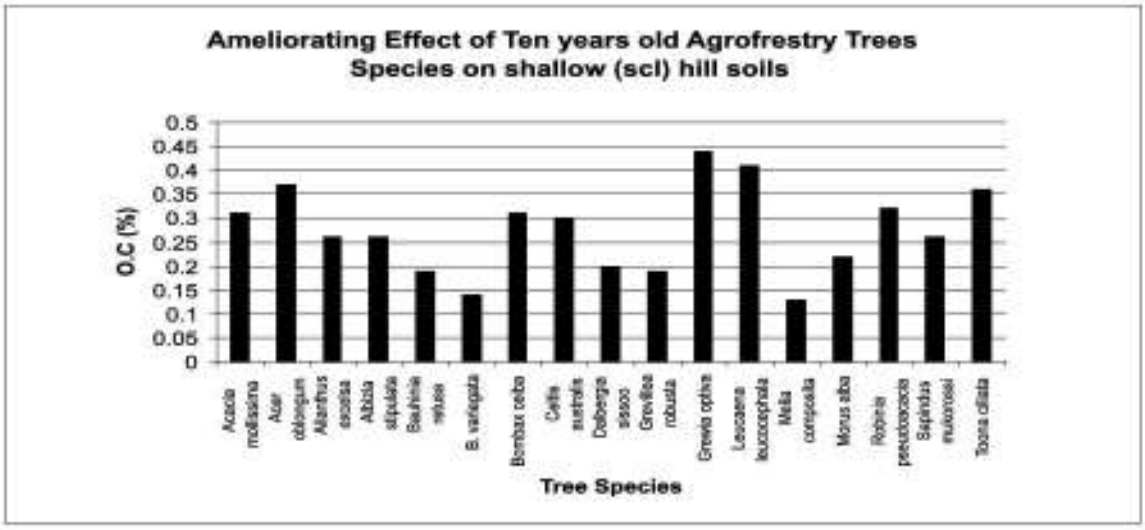

Fig. 1: Ameliorating effect of ten years old agrofrestry trees species on shallow (scl) hill soils (Source: Sharma, 1999)

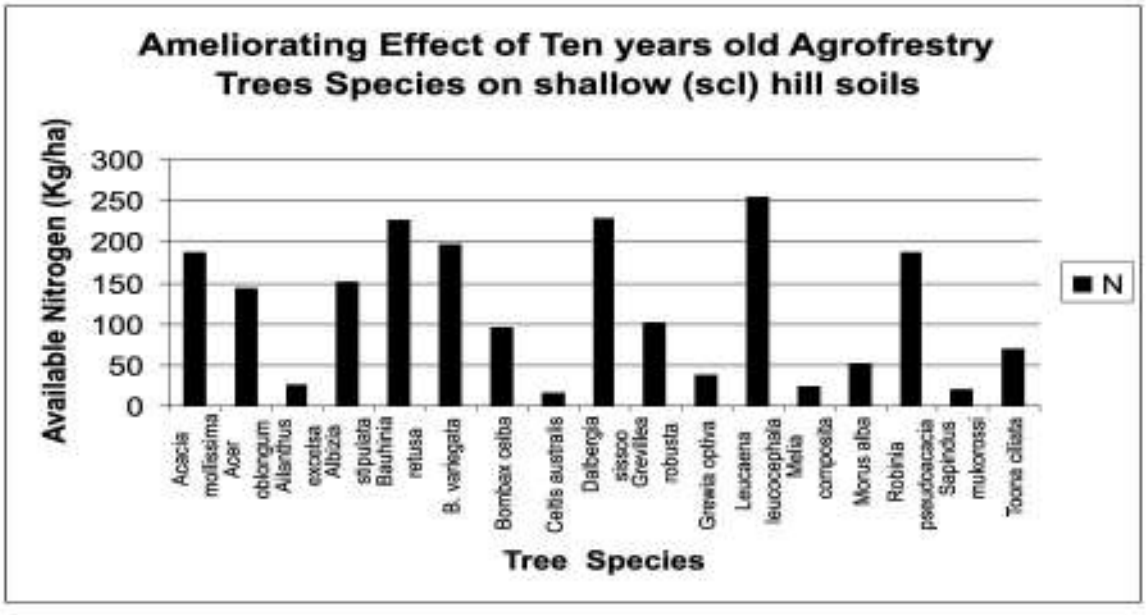

Fig. 2: Ameliorating effect of ten years old agrofrestry trees species on shallow (scl) hill soils (Source: Sharma, 1999)

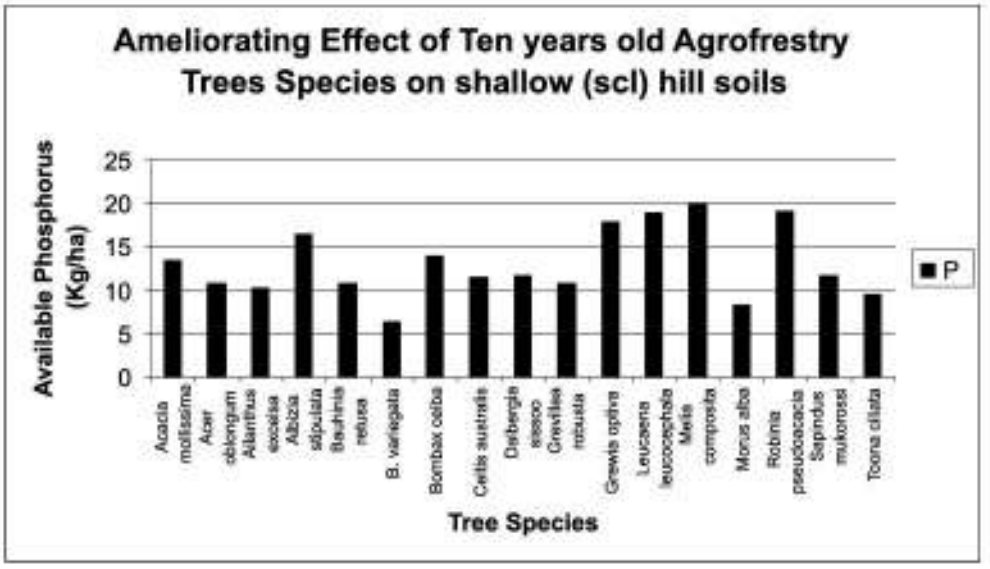

Fig.3: Ameliorating effect of ten years old agrofrestry trees species on shallow (scl) hill soils (Source: Sharma, 1999)

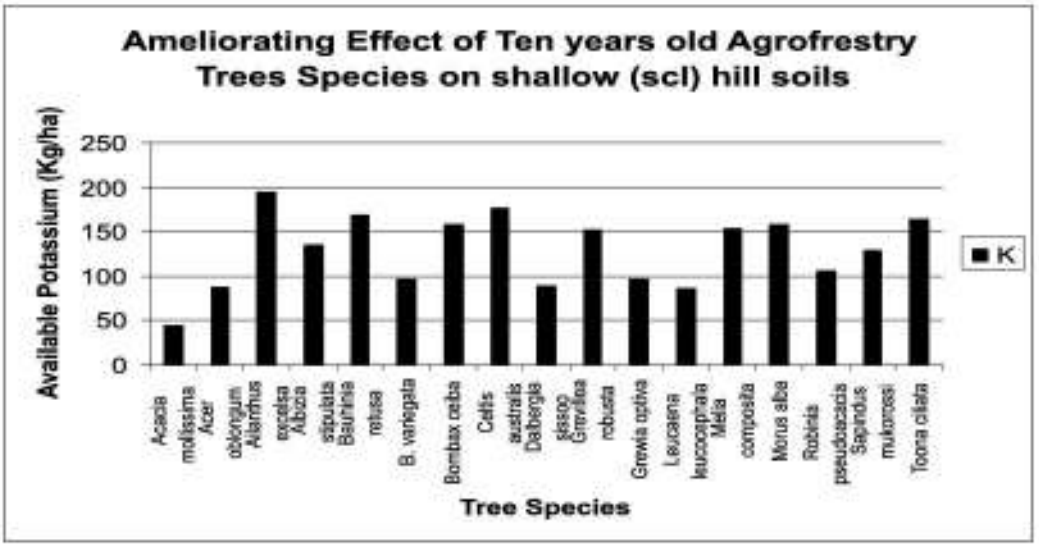

Fig. 4: Ameliorating effect of ten years old agrofrestry trees species on shallow (scl) hill soils (Source: Sharma, 1999)

Conclusion

The primary landuse systems in Himachal Pradesh are facing strong competition for social and economical development. Resultantly, vulnerability to degradation processes has increased. Besides technological reasons the major contributing factors towards land degradation are non-agricultural and non-forestry land use. At present, 56.87 percent of the total geographical area of the state is under wastelands including snow covered and glacial area of (i.e. 22.56%). Wastelands are suffering from serious soil loss and depletion of economic biomass resources. Soil working techniques presented in this article holds promise to ameliorate, protect and conserve the soil health. Further, introduction of multipurpose tree species have proven useful for improving the wastelands, which has a potential to cater to the need of the farmers, besides soil and water conservation in the wastelands of H.P.

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