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DEVELOPMENT OF CULTURABLE WASTELANDS
FOR
PRODUCTION OF WOOD AND OTHER NEEDS

By
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1. Introduction

Degraded soil, mobile sand dunes, overbrowsed sparse vegetation, scorching winds, high temperature - all form the vast canvass of arid and semi-arid lands. Emaciated livestock, ill-fed and ill-clad pastoral population, and medieval habitations complete the picture. This is a result of unwise land use practices as well as several other phenomena like less than normal water availability, high evapotranspiration rates, absence of humid air streams, high soil temperature, reduced ground water discharge, and decreased river flows. The process of desertification is put into motion by several edaphic, climatic, and biotic factors.

Arid regions are usually taken as blank, unproductive, and harsh. However, they encompass a variety of ecological zones ranging from seas of sand dunes to patches of irrigated areas where a variety of crops and fruits can be grown.

Arid lands sustain nomadic population and their livestock, whereas semi-arid zones support a settled population, crops and livestock. A single defining factor linking all these zones is low, erratic, and unreliable rainfall that limits and modifies the growth of vegetation. Drought and crop failure have always plagued arid lands, disintegrating the life support system of various populations irretrievably.

Just as the human suffering in the desert peaks during a drought period, so does the destruction of vegetative cover, the wind erosion on cultivated field, and the formation of unuseable wastelands. Animals eat every available blade of grass. Crops fail to take root in parched ground, the bare

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ploughed soil yields to the winds; and the dust bowl is created. Sand dunes appear where none existed before. The areas have become overcrowded and overgrazed, also by the influx of refugees. Thus, besides climatic and geomorphological factors, the desert conditions persist and get accentuated because of the escalation of human and livestock population.

The common mode of life of the people living in the problem areas is pastoral farming with nomadic habits. People from these regions manage to live on the poorest of diets. The desert vegetation has provided a vast grazing ground to thousands of domestic and wild animals. Heavy pressure on this vegetation occurs in winter when millions of goats, sheep, camels and cattle leave the high hills in search for grazing grounds. Cutting for small timber and fuelwood has reduced the once tree type vegetation to mere scrub with scattered heavily lopped trees. The problem has become even more acute with the arrival of Afghan refugees who have brought large flocks of sheep and goat with them. To meet the requirements of cooking and heating, the plants are dug out with their roots and are burnt. Naturally the deserts are expanding at a fast pace engulfing rich agricultural land in the process. Under such hostile biotic and climatic conditions it is hard to expect any natural recovery of vegetation.

A consequence of the harsh living conditions is the constant migration from these areas to the cities, in order to find better jobs and living conditions. If no sincere efforts will be undertaken to ameliorate the natural, social and economical environment, migration will continue and will result in insurmountable problems, both urban and rural areas.

The prevailing land tenure system is characterized by a large imbalance in the size and structure of the farms. Almost 75 percent of the landholders only share 34 percent of the total farm areas while the upper 3 percent share 23 percent of the total farm area.

Small, subsistence farmers and subsistence tenant farmers cannot be expected to show any interest in the plantation programme. Only medium farmers and the big landlords with sufficient resources could favour the plantation programmes if they are convinced of the economic returns. The question could be raised if these programmes could help the small farmer to alleviate his misery.

Trees and forestry activities under an agro-silvopastoral management have an important role to play in supporting both agriculture and livestock production in many ways. The concept of raising trees under desertic conditions has always been considered an impossible proposition. Nevertheless, the foresters have been making efforts to grow trees, shrubs, and grasses in such areas. The major lines of work have been devising ways and means to conserve the available moisture, and to maximize its storage for subsequent use by the plants. The methods adopted have included planting and sowing in pits, trenches, troughs-cum-trenches, and ridges-cum-trenches. Water harvesting through site preparation and making moisture available to the plants and proper selection of the species have been emphasized. Recently some more studies have been conducted using improved methods of site preparation for water harvesting, moisture conservation, economizing on use of water, and deep planting in conjunction with several xerophytic local as well as exotic tree species.

Ecological Zones

For the afforestation efforts in marginal and problematic lands in Pakistan, the following categorization has been done to ecological zones:

Ecological ZoneCategory of marginal/problematic land

Arid, semi arid,
tropical, subtropical
coastlands,
continental low lands
and western fringes.
Av.ann.rainfall 50-300 mm
Range of temp 0°C - 50°C

1. Sandy soils, sand dunes
 - Inland hotsand dunes
 - Inland cold sand dunes
 - Coastal sand dunes
2. Drought prone areas
3. Severely eroded lands
 - Northern dry mountains including foot hill scrub
 - Western dry mountains and plateau
4. Flood prone areas
5. Calcareous soils
6. Poorly drained water logged soils
7. Shallow stony soils
8. Saline alkali soils

Subhumid, subtropical
table lands and
plateaus
Sub humid
Rainfall range
350-550 mm
Temperature range
0°C - 50°C

- Poorly drained soils
- Severely eroded lands
- Flood prone areas
- Calcareous soils
- Shallow stony soils
- Saline/alkali soils

It would be seen that some categories of marginal lands fall in both ecological zones. Sub humid table lands get comparatively more rain but the rains are erratic, form torrents, cause erosion, and leave very little moisture behind for uptake by the plants.

3. Species Recommended and Methods of Planting *for different soils*

Work done during the last 3-4 decades in this field has been summarized below:

The problematic areas marginal areas	Species recommended	Methods of planting	Remarks
<u>Saline Alkali soils</u>	Acacia nilotica, Casuarina equisetifolia, Eucalyptus camaldulensis, E.microtheca, Leucaena leucocephala, Phoenix dactylifera, Pithecolobium dulce, Populus euphratica, Prosopis cineraria, P. juliflora, Sesbania aculeata, S. aegyptiaca, Tamarix aphylla.	Plant 6-9 month old plants in polythene tubes either on flat ground or on the berms of 0.3-0.5m deep trenches - Replace with sweet soil - Plough and dibble seed	Provide hand watering or flow irrigation, if possible. Otherwise plant with the onset of rainy season. Irrigate if possible
<u>Shallow/stony Soils</u> Northern and central parts of the country	Acacia cyanophylla, A.modesta, A.tortilis, A.victoriae, Ceratonia siliqua, E.camaldulensis Zizyphus mauritiana	Plant 1-1/2 year old polythene tube stock in winter with rains and again in monsoon season in 0.3 m deep pits.	Hand water or irrigate if possible
Extreme northern and western parts of the country	Cupressus arizonica, Fraxinus xanthoxylodes, Gleditschia triacanthos, Juniperus excelsa, Pinus elderica, Pistacia khinjuk, Prunus eburnea	Two year old tube plants in 0.3 m deep pits with stone mulch in one metre radius either in early spring with the start of snow melt or in the monsoon.	Snow fencing is helpful to retain moisture for a longer period. Irrigate twice a month, if possible, for better survival.

Sandy soils/
sand dunes

Inland hot sand dunes	<i>A. senegal</i> , <i>A. tortilis</i> , <i>A. victorae</i> , <i>Calligonum polygonoides</i> , <i>Prosopis cineraria</i> , <i>P. juliflora</i> , <i>Saccharum munja</i> , <i>Tamarix aphylla</i> , <i>Zizyphus mauritiana</i> , <i>Z. nummularia</i> , <i>Parkinsonia</i> , <i>Ricinus communis</i> Grasses; <i>Lasiurus</i> , <i>Panicum</i> , <i>Erianthus</i>	15-20 cm cuttings in case of <i>Calligonum</i> , <i>Tamarix</i> , <i>Arundo donax</i> , <i>Vitex negundo</i> , with winter rains. Other species 6-12 month old plants in polythene tubes. In parallel strips or chess board design from crest to the heel of the dune. - Direct seeding of grasses.	
Inland cold sand dunes	<i>Arundo donax</i> , <i>Calligonum polygonoides</i> , <i>Robinia pseudoacacia</i> , <i>Tamarix gallica</i> , <i>Vitex negundo</i> .	Plant cuttings, tube plants with winter rain/snow	
Coastal sand dunes	<i>Prosopis juliflora</i>	Plant one-year old tube stock	Use sub-soil water to irrigate, daily for one month.
<u>Calcareous soils</u>	<i>Acacia nilotica</i> , <i>Albizzia spp.</i> , <i>Azadirachta indica</i> , <i>Eucalyptus camaldulensis</i> , <i>Melia azedarach</i> , <i>Tamarix aphylla</i>	Plant one year old polythene tube plants in 30 cm deep pits in monsoon season or with winter rains, if any. Breaking of the soil in the areas with hard pan layer is essential.	In areas below 250 mm annual rain, provide hand watering in the first year if no flow irrigation is available.
Northern dry mountains; rainfed lands including foot hill eroded scrub	<i>Acacia nilotica</i> , <i>A. modesta</i> , <i>Arundo donax</i> , <i>Droussonotia papyrifera</i> , <i>Dodonaea viscosa</i> , <i>Eucalyptus camaldulensis</i> , <i>E. microtheca</i> , <i>Ipomoea carnea</i> , <i>Saccharum munis</i> , <i>Tamarix aphylla</i> , <i>Prosopis juliflora</i> , <i>Zizyphus mauritiana</i> , <i>Agave sissalana</i> , <i>Dendrocalamus strictus</i>	-Sow/plant on berms or beds of trenches/troughs in monsoon season/winter rains. -Dig trenches along the contour. -Prepare staggered ridges	

Western dry mountains and dry western plateau

Ephedra nebrodensis, Cupressus arizonica, Fraxinus xanthoxyloides, Pistacia khinjuk, Prunus eburnea, Pinus halepensis

-Plant 1-1 1/2 year old tube plants in 30 cm deep pits in snow-fenced areas
-Irrigate if possible from May-July
-Aerial seeding not successful.

Flood prone areas

Foot hills

Ailanthus altissima, Amorpha fruticosa, Bauhinia yeriegata, Cassia fistula, Dalbergia sissoo, E. camaldulensis, E. tereticornis, Ipomoca carnea, Robinia pseudoacacia, Saccharum munja, Salix tetrasperma, Poplars, Vitex negundo

Dig 30-50 cm deep pits of 30 cm dia
-Plant cuttings of Ipomoca, Vitex, in moist soil
-Use 6-9 month old tube plants in other cases.
-Use entire plants of Ailanthus, Robinia, Amorpha,
-Use root-shoot cuttings of Dalbergia sissoo and rhizomes or tufts of Saccharum munja

Plains

Acacia nilotia, Dalbergia sissoo, E. camaldulensis, Populus euphratica, Prosopis cineraria, Tamarix dioica

-Broad cast seed of A. nilotica from boats during inundation
-Do aerial seeding with A. nilotica and P. cineraria seed.
-Plant 6-9 month old tube plants of other species
-Use root-shoot cuttings of Dalbergia sissoo

Hand water tube plants/ root shoot cuttings by digging small wells; 16-18 waterings in the first year, 10-12 in the second.

Drought prone areas

Acacia albida, A. aneura, A. nilotica, A. modesta, A. victorea, A. tortilis, Tamarix aphylla, Tecoma undulata

-Adopt techniques for water harvesting/moisture conservation such as trenches with catchment, mulches, deep planting, drip irrigation.
-Use 6-9 month old tube plants.

-Hand water for one year in areas with less than 250 mm rainfall.
-Hand water in other areas also if summer rains fail
-Use drip irrigation system.

Research Needs

In view of the variety of ecological conditions, the pre-requisite for the development of arid areas is a systematic study of factors such as climate, water supply, the state of soil, and the condition of vegetation. Additionally, the socio-economic conditions of the people living in these areas and the biotic interference are some of the major causes of formation and extension of deserts. Arid zone development, therefore, is a complex matter, and requires active collaboration of a number of scientists of different disciplines.

Organization of a data base on all aspects of phenomena and systems prevailing in the arid and semi arid areas is a prerequisite for development of such areas. Protection and perpetuation of the vegetation, the state of wildlife, the pressure exerted by ever increasing human populations, ecological retrogression, loss of genetic resources, water/moisture management, etc. all need to be looked into. Keeping these considerations in view, a list of priority areas of research in forestry and allied disciplines in arid and semi arid lands has been prepared.

Priority Areas of Research in Arid and Semi Arid Lands

- A. Nursery establishment and management of the crops
 - Identify, demarcate, and collect seed from superior stands, isolated groups/single trees suitable for arid and semi arid areas, marginal, and wastelands.
 - Develop improved techniques for site preparation.
 - Study water requirement of tree species.
 - Establish plantations of local and tested exotic species, using different techniques of water harvesting and moisture conservation, and conduct economic analysis.

- Establish spacing, thinning, and rotation trials for optimum production for different end uses tree species mixture.

B. Range Management and Improvement

- Seed with adaptive indigenous and exotic grass/legume species.
- Improve the quantity and quality of forage by planting of suitable fodder trees/shrubs.

C. Farm Forestry System

- Document and evaluate existing tree planting practices of marginal land dwellers and identify preferred species.
- Layout tree/crop interface studies using most common crops and trees. Test range of spacing/crop designs.
- Integrate livestock in agroforestry systems.

6. On-going Research Projects of PFRI Regarding Development of Wastelands

1. Effect of watering frequencies on the performance of species under rainfed condition (FPDP/USAID).
2. Multipurpose tree species network trials under F/FRED for Arid Zone.
3. Multipurpose tree species network trials under F/FRED for semi-arid Zone.
4. Multipurpose tree species network trials under FPDP and F/FRED (Humid and sub-humid tropics).
5. Choice of species and techniques for afforestation of arid and semi-arid lands.
6. Selection of species and planting techniques for afforestation of water-logged and saline areas.

7. Introduction of salt tolerant Australian woody species in ~~1990-91~~ waterlogged and saline/sodic area of Shorkot plantation.
8. Afforestation methods of salt infested areas.
9. Effect of various super absorbents on the survival and growth of species.
10. Effect of watering levels of tubed nursery plants on their out-planting success. (FPDP/USAID).
11. Introduction of fast growing broad leaved species in hills and scrub forests.

Conclusion:

The species and methods of planting as recommended in para 3 of the report should be practised by the field officers or others concerned with the development of culturable wastelands keeping in view the nature of soil and ecological zone.

Some research studies are being conducted by Punjab Forestry Research Institute, Faisalabad and these, when concluded, will also add to the existing information. Pakistan Forest Institute, Peshawar has also been working on this important problem since long and is still continuing. More and more information will be available with the passage of time. A few priority areas of research in arid and semi-arid lands have been given in Para 5 of this report and these will serve as guide for future research work.

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