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DEPARTMENT OF FORESTS, ECOLOGY & ENVIRONMENT, GOVERNMENT OF KARNATAKA

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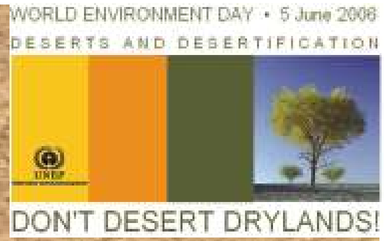

Soil degradation is due to the human activities like intensive irrigated agriculture, over grazing, deforestation, enhanced industrial growth which has lead to soil erosion, compaction, salinization, loss of nutrients and toxicity problems. Such degradation processes intern limit the productive capacity of lands making it more difficult and expensive for the farmers to increase production of crops. Desertification can be defined as degradation of land in arid, semi arid and dry sub-humid areas resulting from various factors including climatic variations and human activities.

Technologies for combating desertification and for mitigating the effects of drought have been developed by different research institutions of the Indian Council of Agricultural Research (ICAR) and the Indian Council of Forestry Research and Education (ICFRE). In addition, the traditional practices, which are still relevant, are highlighted. A few of the technologies and traditional practices are briefly discussed in this issue.

Need for soil and land degradation information

Natural resources are of primary importance for sustainability of the ecosystem and for optimal productivity of the land. Soils are nature's gift to humans and it takes 300-1000 years to form an inch of the topsoil which mainly is due to combined effects of climate, vegetation, organisms, relief and type of rocks and other parent materials (ICAR, 1999). Soils perform many functions such as biomass production, a habitat and green reservoir, and as one of the functional units for the ecosystem. Life supporting system depends primarily on soil health to produce biomass and to absorb and decompose toxins. Impairment in any function of soils reduces their quality, value and capacity to provide the basic necessities to support ecosystems. Therefore scientific management of soil resources is essential for both continued agricultural productivity and protection of the environment. Lack of adequate information on soil resources and improper land use planning has resulted in many of the present problems of land degradation and desertification. Being vital resource and life sustainers, it is essential to protect soil and pass it on to our children and grandchildren from whom we have borrowed it.

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MESSAGE

The flag subject for observing World Environment Day- 2006 pertains to Deserts and Desertification with the succinct message "Don't Desert Drylands". Globally there is a move towards on-farm practices. Combi-agriculture efforts synergizing Horticulture, Animal husbandry, Rainwater harvesting and live vegetative fences including fuel, fodder, fruit and timber yielding plants has been advocated and practiced by those who have succeeded in making dry lands yield sustenance. Organic farming from Fukokowa's Clay-seed balls to contemporary efforts at home gardens provide standing examples and beacon the strategy to make dry lands yield sustainable results by not 'deserting' them. In Karnataka, we have BIAF's model near Tiptur and Kalghatgi near Dharwad indicating possibilities available.

The contents of this newsletter portrays the various dimensions relating to the technologies for Combating Desertification

I am sure this document will spread knowledge and awareness on the subject.

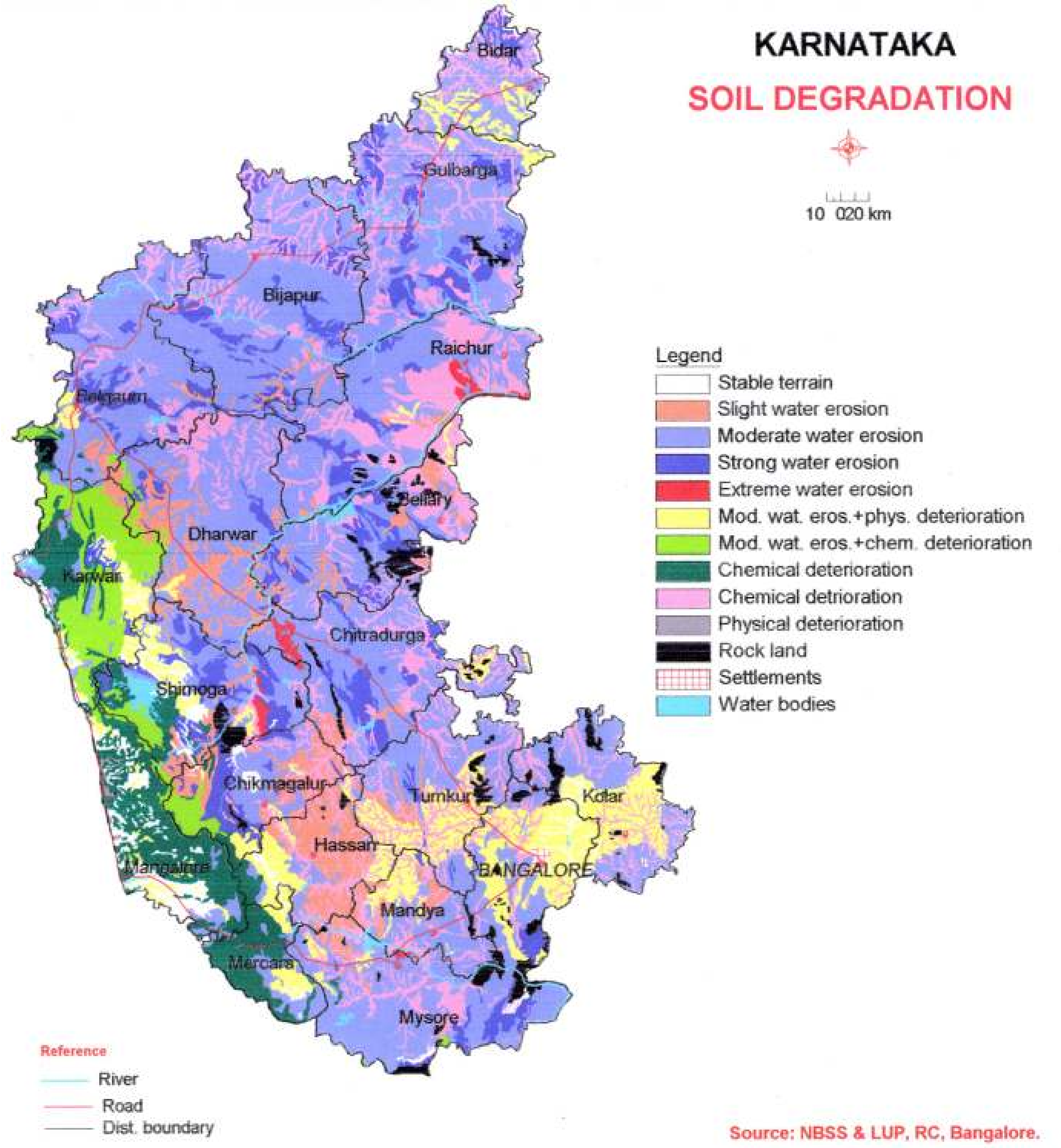
Mohamed Sanaulla I.A.S.,

Desertification is not, as commonly thought, the actual expansion of existing deserts

Soil degradation status in Karnataka

Soil degradation is presently viewed as a serious and widespread problem. in order to tackle this problem and suggest ameliorative measures, it is necessary to assess the extent, type and severity of soil degradation. Hence an attempt was made to assess the soil degradation status of Karnataka State. The detailed procedure for assessing soil degradation status has been followed as given by Sehgal and Abrol(1993). Here, the type of soil degradation refers to the process that causes the degradation; the degree of degradation refers to the present state of degradation.

Soil degradation status of Karnataka can be assessed from the soil map having 121 soil units at association of soil families with phases. Each mapping unit can be assessed for the kind, degree and extent of degradation. The severity class was worked out based on the degree and extent of degradation. The soil degradation status map is given below.



Processes of desertification

The different processes involved in land degradation of the soil include:

- Water erosion
- Wind erosion
- Salinity-Alkalinity
- Waterlogging

In Karnataka major cause for desertification involves water erosion.

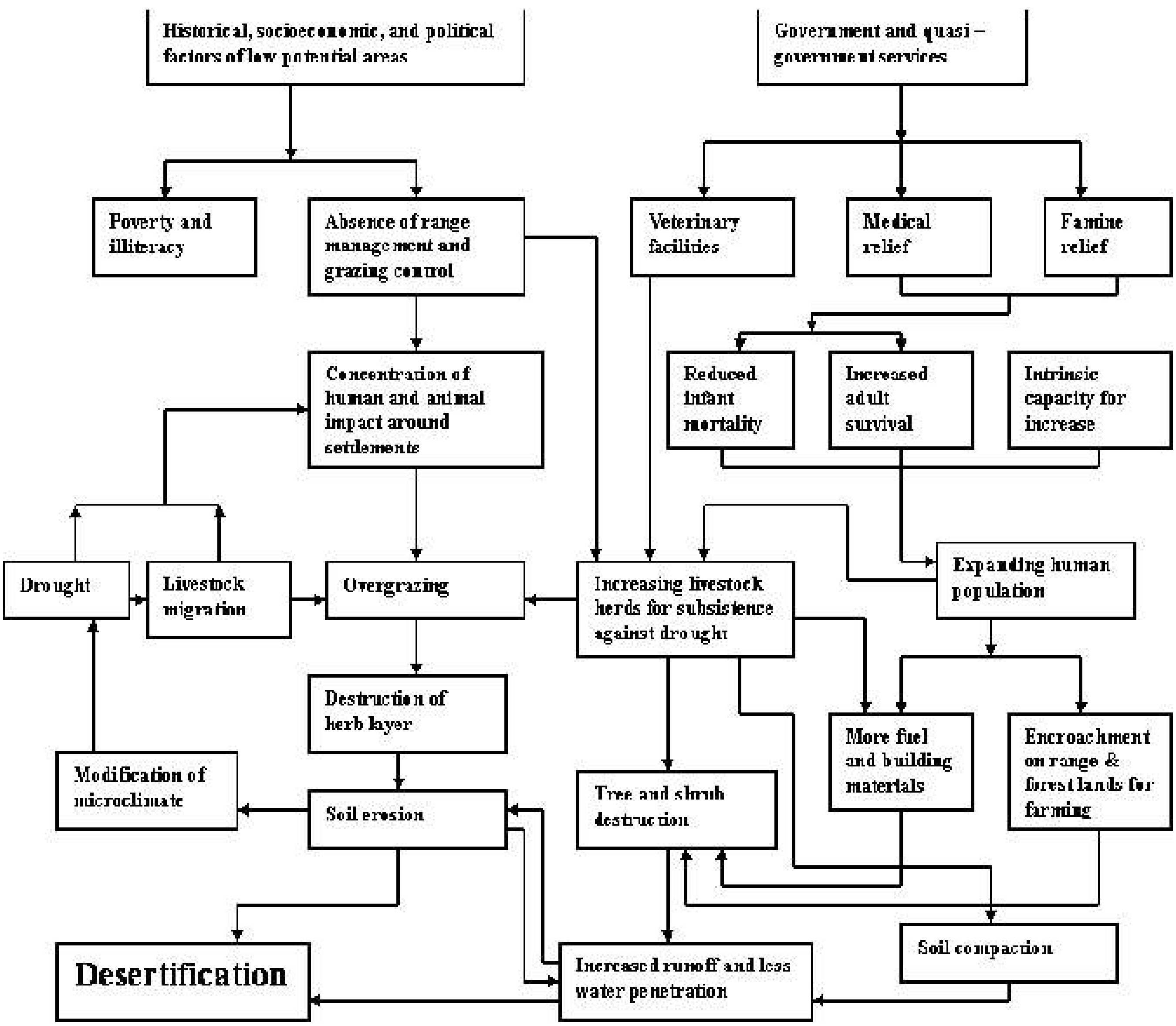
Soil degradation status in Karnataka

Kind of degradation	Degree of degradation				Total area
	Slight	Moderate	Strong	Extreme	
Water erosion	661*	3675	139	1393	5868
	(3.4)**	(19.2)	(0.7)	(7.3)	(30.6)
Nutrient loss	-	-	600	30	630
	-	-	(3.1)	(0.2)	(3.3)
salinity	-	100	-	-	100
	-	(0.5)	-	-	(0.5)
sodicity	-	-	10	-	10
	-	-	(0.1)	-	(0.1)
Water erosion + compaction & crusting	420	472	-	49	941
	(2.2)	(2.5)	-	(0.2)	(4.9)
Water erosion + nutrient loss	55	47	30	-	132
	(0.3)	(0.2)	(0.1)	-	(0.6)

* Figures indicate degraded area in 1000 ha
** Figures in parenthesis indicate percentage of TGA

Source: Karnataka Drought Monitoring Cell

Pathways showing process of desertification (Kaul, R.R., 2000)



I. Technologies for conservation of soil and water

A) Soil conservation techniques:

Integrated nutrient management

Integrated nutrient management is the key to maintain the productivity of soils on a sustainable basis this involves a balanced use of inorganic and organics. The organic could be Farm Yard Manure (FYM), compost and biofertilizers which supply the nutrient requirements of crops and provide stability to yields in rain fed areas, nearly fifty percent of the fertilizer N could be replaced with the use of FYM/compost in a variety of soils.

Availability of FYM in quantities adequate to obtain good response in field crops is a major limitation for wide adoption of this technology in rain fed areas. Alternate sources like green leaf manures and crop residues can be used. The other approach to enhance the use of organics could be the use of compost. Composting is a technique which enables bioconversion of organic residues such as agro-industrial wastes like sugar factory press mud, groundnut shells and coir pith. In addition bio fertilisers such as azotobacter, azospirillum, rhizobium and PSB (phosphate solubilizing bacteria) etc could be used. Use of organic manures supply's important primary secondary and micro nutrients; in addition it also improves the soils physical condition, moisture, microbial properties and thereby improves yield.

Permanent vegetative cover through alternate land use systems

A soil prone to lower yields/risks, and lack of response to inputs can be best utilised for alternative land uses where self generating grasses, legumes and perennial woody tress constitute the major components. Agro forestry approach that includes systems like agri silviculture, agri horticulture, horti pasture and silvi pasture can be successful as an alternate land use. Management of lands of lower capability through such interventions is the best way of integrating livestock production in rain fed areas, thus contributing to the sustainability of the production system. Alternate land uses not only provide fodder, fuel wood and timber and fruits but also enhance the quality of resource base through greater biomass production and provide a land cover for most part of the year which constitutes the basic step for control of soil erosion. Off-season rainfall which otherwise goes unutilised in single kharif cropping areas can thus be best utilised with such production systems. Trees also make the micro-climate more favourable to crop growth.

Alternate land use systems for different agro-ecological regions

(1) Agri-silviculture: This system is suitable for soils of less fertility with annual rainfall up to 750mm. A large number of tree-crop combinations, particularly of nitrogen fixing trees (NFTs) with sorghum, groundnut, castor and pulses were evaluated in Alfisols and Vertisols. *Faidherbia albida* and *Hardwickia binat*a and green gram combine well with widely spaced (8m x 8m) *Faidherbia albida* trees. *Hardwickia binata* trees being erect and relatively slow growing did not compete with associated arable crops especially in the initial 8-10 years. Therefore, these two tree species hold promise for development of agri-silvicultural systems.

Hardwickia binata based Silvi-pasture

Major factors causing desertification

(1) Unsustainable agricultural practices	Extensive and frequent cropping of agricultural areas.
	Excessive use of fertilizers.
	Shifting cultivation without allowing adequate period of recovery.
(2) Unsustainable water management	Poor & Inefficient Irrigation Practices.
	Over abstraction of ground water, particularly in the coastal regions resulting in saline intrusion into aquifers.
(3) Conversion of land for other uses	Prime forest into agricultural land.
	Agricultural land for other uses.
	Encroachment of cities and towns into agricultural land.
(4) Deforestation.	Unsustainable forest management practices.
	Forest land clearances for agriculture (including shifting cultivation)
	Other land use changes (projects- energy, roadways, etc.).
	Overgrazing, excessive fuel wood collection.
	Uncontrolled logging and illegal felling
	Forest fires.
(5) Industrial, mining and other activities without satisfactory measures for prevention of land degradation and land rehabilitation.	
(6) Demographic pressures - human and livestock.	
(7) Frequent droughts/failure of monsoon and their link with global climate phenomena.	

(2) Silvi-pasture: This system is suitable for marginal soils. It involves integrating a tree component with a perennial legume or grass species as pasture. *Cenchrus ciliaris* and *Stylosanthes hamata* can be used in different soil types and rainfall zones. *Stylosanthes hamata* is an improved pasture legume that can be raised on marginal lands and on field boundaries.

Acacia albida based agri-silviculture

(3) Agri-horticulture: In medium deep soil areas receiving annual rainfall of more than 750mm, agri-horticultural systems consisting of a fruit tree intercropped with annual arable crop is recommended. Land treatment for collection of runoff and water harvesting techniques to provide supplemental irrigation during the summer months are critical to the success of this practice. Apart from prudent use of stored soil moisture, the water needs of fruit trees have to be effectively modulated by pruning, Custard apple and also pomegranate and amla are other fruit crops suitable for this system.

Litchi chinensis based agri-horticulture practice

(4) Alley cropping: In this practice, Arable crops are grown in alleys formed by the trees or shrubs, established generally on contours. This system is suitable for land with medium fertility which receives 500-750mm rainfall. Trees or bushes grown in alleys act as live bunds and control runoff. Width of the alley and management of the tree crops are the key to success with this system. Permanent alleys provide fodder during drought.

Alfisols: The central concept of Alfisols is that of soils that have an argillic, a kandic, or a natric horizon and a base saturation of 35% or greater. They typically have an ochric epipedon, but may have an umbric epipedon. They may also have a petrocalcic horizon, a fragipan or a duripan.

Vertisols: The central concept of Vertisols is that of soils that have a high content of expending clay and that have at some time of the year deep wide cracks. They shrink when drying and swell when they become wetter.

B) Soil conservation through water optimisation techniques

(1) Soil and rainwater conservation: High intensity rainstorms during monsoons cause significant loss of topsoil both in Alfisols and Vertisols. Gully and sheet erosion are the most common. A combination of mechanical, agronomic and vegetative practices can help in arresting soil loss and runoff in cropped lands.

Mechanical measures like contour, graded bunding and bench terracing are designed for lands of different slopes as permanent structures which can be termed as 'hardware' treatments. Contour bunding in cultivated lands intercepts the runoff, reduces soil loss and provides increased opportunity time for water intake. This practice is useful in low rainfall areas <600 mm having soils with high infiltration/permeability rates. In Alfisols, contour bunding helps not only in controlling runoff but also increases crop yields, while it is not suitable for deep black soils due to prolonged water stagnation. Graded bunding is suitable for areas having higher rainfall >700 mm for safe runoff disposal. Adoption of these practices by the farmers has been dismal due to inherent limitations of small holdings and in fact that such bunds cut across their field boundaries/holdings. As an indigenous system, the farmers install small bunds and mud-cum-pebble bunds across the slope to control moisture and soil erosion.

(2) Inter-terrace land treatments: Inter-bund land treatments are of semi-permanent nature, primarily useful to minimise the velocity of overland flow. These practices have a significant role in checking of soil loss and ensure better

Soil and rainwater conservation

Tillage

Mulching

utilisation of rainwater for crop growth. Land treatments like ridging, compartmental bunding, conservation furrows, broad-bed and furrows widely tried across the country are some such examples.

Soil and water conservation measures can also be used to sustain fruit trees in the dryland horticulture or horti-pastoral systems. Micro-catchment relief system developed for Alfisols helped in stabilising the yield of citrus in drought years. In this system, small beds are created with elevation at the centre (20 cm height and 3 m wide). The water is allowed to run into the parallel rows of pits on both sides, to the planting basins. The surface of the ridge is covered with a thin layer of tank silt to seal the macro-pores and facilitate runoff.

(3) Water harvesting and recycling: In medium to high rainfall areas this technique can be used. The advantages of storing harvested runoff in dug out ponds and utilising it for life saving irrigation of kharif and rabi crops have been thoroughly researched [Singh(1986)]. Regions falling in 500-1000 mm rainfall zone possess a harvestable runoff potential of 5.54 m ha m. Although village level water harvesting tanks have been traditionally in vogue, research during last 25 years has led to standardising the variables with respect to the catchment, size of the dugouts and utilisation of stored water.

(4)Tillage: Tillage has a marked influence on the conservation of soil and rainwater. These operations make the soil surface more permeable thus favour water intake. Deep tillage (25-30 cm) assists in opening up of the hard soil layers and faster penetration of rainwater. Deep tillage in problem soils promotes better root system development and thus higher yields in low rainfall years due to more efficient use of the sub soil resources. Soil moisture content is more at planting time if the soil is tilled in the off-season. Excessive tillage however is not beneficial. In sandy soils, it accentuates wind erosion.

(5) Mulching: Mulching signifies placement of fresh or dried organic resources on around the root zone or on field. This includes incorporation of organic wastes which also contribute to conservation of soil and rainwater. Mulching can be used to reduce the runoff from cropped fields significantly, to reduce evaporation, to increase infiltration, to improve soil structure, to increase crop yields and to control weeds. It also breaks the surface crust which forms after each downpour. This practice was generally more beneficial under receding moisture conditions for rabi crops than for kharif crops where intermittent high rains create micro-environment favorable for fungal growth. For heavy black soils, vertical mulching is recommended to facilitate greater intake of rainwater. *Gliricidia/Leucaena* branches can be used as cover after planting and incorporated in the soil following canopy development.

Control of land degradation by adoption of integrated watershed approach

Bringing the entire arable and non-arable area under productive utilization, is the key to control land degradation. Since water is central to any agricultural, horticultural, silvi-cultural or pastoral activity, it is vital to conserve and utilize rain water based on the terrain hydrological unit i.e. watershed. The essential components of watershed development approach are:

- Efficient conservation of rainwater through comprehensive land management techniques, adopting a cost-effective mechanical and vegetative blend of conservative structures.
- Adoption of improved crop management technology.
- Development of alternate land use systems for different land capability classes for stabilising and maximising productivity of otherwise unproductive lands.

Watershed component and land development

- Land development including *in situ* soil and moisture conservation measures like contour and graded bunds fortified by plantation, bench terracing in hilly terrain; and nurseries for fodder, timber, fuel wood, horticulture and non-timber - forest produce
- Afforestation including block plantations, agro-forestry and horticultural development. Shelter-belt plantations, sand dune stabilisation, etc.
- Drainage line treatment with a combination of vegetative and engineering structures.
- Development of small water harvesting structures such as low-cost farm ponds, nalla bunds, checkdams and percolation tanks and ground water recharge measures.
- Renovation and augmentation of water resources, desiltation of tanks for drinking water and irrigation.
- Pasture development either by itself or in conjunction with plantations.
- Repair, restoration and upgrading of existing common property assets and structures in the watershed to obtain optimum and sustained benefits from previous public investments.

source: Guidelines for Watershed Development (Revised 2001) Department of Land Resources, Ministry of Rural Development

Stabilisation of sand dunes

Azadirachta indica - Acacia tortilis shelterbelt

C) Techniques to protect soil against wind erosion

Control of wind erosion: Wind erosion can be controlled either through mechanical and chemical methods of sand stabilisation, or through vegetative measures. Mechanical control measures are however site-specific and need periodic monitoring as the solutions are not permanent. The major technological interventions in this context are stabilisation of shifting sand dunes and shelterbelt plantation.

(1) Stabilisation of sand dunes: The old dunes have greater stability and mostly cultivated. The new dunes are highly mobile and devoid of vegetation. Much of the sand dune Stabilisation programme is directed towards the old dunes, so that the production potentials of these lands can be restored. The activities include

(a) Protection of the area from human and livestoc encroachment.
(b) Creation of micro-windbreaks on the dune slopes, using locally available shrubs either in a checker board pattern or in parallel strips.
(c) Direct seeding or transplantation of indigenous and exotic species.
(d) Plantation of grass slips or direct sowing of grass seeds on leeward side of micro-windbreaks.
(e) Management of re-vegetated sites. Bio-fencing, using locally non-palatable species is a cheaper and more effective form of barrier.

(2) Shelter belt/wind break plantation: Establishment of micro shelterbelts in arable lands, by planting tall and fast-growing plant species such as castor bean on the windward side, and shorter crops such as vegetables in the leeward side of tall plants helps to increase the yield.

II. Technologies for management and reclamation of degraded lands

a) Technologies for management of soil affected by water erosion

Areas covered by shallow ravines can be utilised for silvi-pasture which will also encourage livestock enterprise. Aerial seeding of grasses of improved strains like Marwar Anjan and 358 of *Cenchrus diiaris*, Marwar Dhawan, 175 & 296 of *Cenchrus setigerus* etc. may also be tried to reclaim the shallow ravines. Erecting mechanical checks and stabilisation of ravine slopes wherever possible should be taken up to prevent further degradation.

b) Technologies for rehabilitation of mine spoils

In many mine spoils higher pH build up exchangeable sodium, magnesium, sulphur, phosphorus as well as salinity-alkalinity are the major constraints. Re-vegetation of the mine spoils is therefore a challenging task. Mine areas like gypsum, bentonite, Fuller's earth, arid clay can be rehabilitated with species of trees, shrubs and grasses such as *P juliflora, Salvadora persica, A. tortilis, Albizia amara, Parkinsonia aculeata, Dichrostachys nutans, C. decidua, Desmostachya bipinnata,* and *C. Ciliaris.*

Mine-spoils and quarry base which are permanently out of cultivation have erosion rate of about 1000 times more than that of the normal soils. Mine-fillings and quarry wastes are a hazard as the surface runoff brings the mine and quarry wastes into the territory of fertile/ cultivable soils thereby rendering them unfit for cultivation. Therefore, there is an urgent need to address the areas covered by mine-spoils and quarry wastes by taking up tree planting on a massive scale. This will help prevent surface runoff in the affected areas.

c) Technologies for management of salt affected or water logged soils

Salt affected land lying in low rainfall areas should be focused for silvipasture development while those lying in high rainfall areas can be considered for rice cultivation with suitable amendments and varieties. Much of water logging and salinity-alkalinity hazard is associated with inappropriate water management. This can be partly countered by vertical and horizontal sub-surface drainage. Lining of canals, judicious use of canal water and efficient management of command areas are necessary to arrest further degradation of land resources.

The sodic soils can be reclaimed or moderated by the application of gypsum. The requirement of gypsum has been standardized. With proper choice of crops only the upper 15cm of soil needs to be amended by application of gypsum.

The other amendments useful for reclaiming salt affected soils include pyrite and organic manures. Studies on the residual sodium carbonate (RSC) water-degraded soils indicate that irrigation with waters of RSC of 7.1-8.8 ml/lit can rehabilitate the soil if it is treated with gypsum at the rate of 100% soil gypsum requirement plus an additional quantity of gypsum to neutralize the excess RSC in irrigation water [source: Joshi and Dhir, 1991].

A number of Afforestation and agro-forestry techniques are now available for rehabilitating the salt-affected soils. Tree species such as *Prosopis chilensis, P juliflora, Tamarix troupii, Tamarix aphylla, A. nilotica, Acacia auriculaeformis, Casuarina obesa, C. equisetifolia,* and *Eucalyptus camaldulensis* are highly tolerant to soil salinity thus suitable for plantation in such areas.

Poor water management and land development, results in water logging and land degradation leading to salinity. Saline soils are often associated with water logged areas due to the rise in the water table. Surface stagnation of water in these soils is a serious problem during monsoon. Cost effective measures for managing surface and sub-surface drainage are the key to minimise the adverse effects of water logging/soil salinity. Following are some of the measures for reclaiming water logged saline soils:

(1) Drainage management: Desalinisation of the soils through sub-surface drainage can be achieved through the rainwater conserved in the field by providing strong bunds.

(2) Irrigation system improvement: Drip and sprinkler irrigation can increase the water use efficiency by 70-80% in contrast to conventional system of surface irrigation with unlined field channels which have an efficiency of 20-30% only. Improvement in the conventional methods by borders/furrow irrigation and brick lined water courses had an efficiency of 40-60%. These improvements can bring down the rate of secondary salinization by irrigation water.

(3) Disposal of drainage effluent: Sub-surface drainage systems produce poor quality drainage water which needs to be disposed off carefully. Feasible alternatives for use of high salinity drainage water is by blending it with canal water.

(4) Agronomic practices for managing salinity/alkalinity: About 25% higher seed rate over the normal is recommended to account for mortality of young seedlings and poor tillering of crops in salt affected soils. Heavy irrigation is recommended before sowing to leach down the accumulated salts so as to improve germination and initial growth of the crops in such soil conditions.

d) Alternative land uses for salt affected soils

Suitable tree species such as *Prosopis juliflora, Acacia nilotica*, and *Tamarix articulata* are recommended for plantation in salt affected soils. Growing leguminous tree species such as *Prosopis Acacia, Casuarina*, etc. can help ameliorate alkali soils at much faster rate than non leguminous trees because of farmer's ability to build-up soil N/organic matter status. Growing legume trees in highly sodic soils can contribute in their amelioration for crop production, in future.

Grasses in general are more tolerant to alkali conditions than most field crops. Promising grasses in alkali soils are *Leptochloa fusca, Chioris gayana, Brachiaria mutica,* and *Cynodon dactylon*. Other grasses for utilisation of saline soils are *Aeluropus lagopoides, Chioris barbata, Echinocloa colonum, Dicanthium annulatum, Phragites* and Sida spp.

e) Agro-forestry for moderately alkaline soils/reclaimed soils

Promising trees for agro-forestry on moderately sodic soils or the reclaimed ones are *Populus deltoides, Eucalyptus tereticornis, Acacia nilotica* and *Tectona grandis*. Populus-based agro-forestry system has proved more remunerative due to faster growth and better market price. Intercrops such as rice-berseem and rice-wheat can also be taken during the initial period of tree growth.

Horticulure: Promising fruit tree species such as *Zizyphus mauritiana* (ber), *Psidium guajava* (guava), *Punica granatum* (pomegranate), *Emblica officinalis* (amla), *Carissa carandum* (karaunda), *Tamarindus indicus* (imli), and

Syzygium cumini (jamoon) can be grown in highly alkali soils by adopting proper site modification technology including the use of organic and inorganic amendments.

III. Traditional/Indigenous technologies for combating desertification

Traditional knowledge and practices have their own importance as they have stood the test of time and have proved to be efficacious to the local people. Some of these traditional practices have been adopted in the fields of agriculture - crop production, mixed farming, water harvesting, conservation of forage, combined production system, biodiversity conservation, forestry, etc. to mention a few.

a) Traditional/Indigenous technologies in agriculture

(1) Tank water based crop production

The tank system is traditionally the backbone of agriculture production in semi-arid region. Tanks collect rainwater and are constructed either by bunding or by excavating the ground. It is estimated that 4 to 10 ha of catchment is required to fill one ha of tank bed.

(2) Mixed farming

The bulk of natural resource base of the arid region is most suited to pasture based livestock farming. The traditional wisdom of the dry land farmer clearly manifest in the evolution of system of mixed farming including crop and animal husbandry which matched the potential and limitations of the natural resource base.

b) Traditional water harvesting systems

India has a rich history of use of traditional systems of water harvesting. Conservation of both surface and groundwater has been an integral part. In fact ponds and tanks represent an important community resource for drinking water in rural places

c) Combined production system

The practice of agro-forestry viz., cultivation in spaces between trees and shrubs, has been traditionally practised by the desert dwellers. For example, *Prosopis cineraria* in cultivated fields and *Ziziphus mauritiana* in rangelands are common in arid and semi-arid parts. Density of *P.cineraria* varies from 20 to 40 trees per ha. In dry land regions planting of trees along field boundaries, roads and around homesteads and watering points for shade is a common traditional practice.

Prosopis cineraria based Agro-forestry System

d) Protection of Vegetative Cover- Sacred Groves

There are several scared tree groves dedicated to temples spread over the entire country. Communities zealously protect these groves against interference of any kind. These groves are excellent examples of biodiversity conservation.

IV. Technologies to mitigate the effects of drought

a) Measures to combat land degradation caused due to drought

The specific management strategies to tackle droughts depend on their type and intensity. For example, deficit of rainfall during the onset, progress and withdrawal of monsoons can cause early, mid and late seasonal droughts. Measures to tackle early season droughts include transplantation and changing the crop and varieties, whereas mid season droughts can be controlled through reducing the leaf area by regulating the plant population or management strategies like mulching and keeping the field weed free. *In situ* water conservation and water harvesting and recycling as supplemental irrigation obviously can mitigate drought to a great extent. However, there are very few options to manage terminal droughts due to early withdrawal of monsoon. Harvesting the crop for fodder is the only way to slightly reduce the damage Nevertheless, most of the drought management strategies need to be adopted from the beginning of the season in order to be effective. In other words, “one has to provide for drought management, before planting the crops even if the forecast is for a good year”. Therefore, the farmers sow a mixture of crops and thin out the crop stand as the intensity and duration of rainfall becomes clearer over the passage of time.

B) Use of early warning systems

Long-term weather data can be used for forecasting of the rainfall and behaviour of monsoons. While long term forecasts are still not possible for various limitations in the data sets and the complexity of parameters involved in the behaviour of monsoons, short range (48h) and medium range (3-7 days) forecasts of the likely aberrations of the spatial and temporal distribution of rainfall are now possible. However, an effective and timely information delivery system needs to be developed and put in place for the forecasts to be effective.

c) Agriculture based technologies

(i) Crop-weather modelling

With the availability of high speed computers it has become possible to include large number of variables and data sets from many years and locations in order to predict the behaviour of the rainfall and temperatures for a particular location. GIS (Geographical Information System) has become an integral part of the data base management and it can interlink various data bases in the RDBMS for getting query based outputs. Once the effective usable agro met data base is established which covers not only weather data but also the soil and crop growth information, effective models can be developed using GIS which may be made relevant for specific targeted areas.

(Ii) Contingent crop planning

Aided with the output from the weather forecasts, an effective land use planning strategy should comprise the use of this valuable information into specific contingent plans for different areas in order to moderate the effects of drought and minimise the land degradation.

(iii) Mid-season correction

Even in a timely sown crop, long dry spells during the growing season can cause significant drop in yields. Since such drought spells occur during a standing crop, the farmer has limited options to prevent the negative effect. However, certain specific corrective measures can be taken to minimise the effect of mid- season drought. Such droughts usually occur when the crop is 40-50 days old with maximum leaf area which results in fast depletion of soil moisture. Therefore, reduction of leaf area either by rationing or thinning can mitigate the drought effects to some extent. Weed control and mulching are other short-term measures which can mitigate drought by conserving the scarce moisture. In case of long duration crops like castor, pigeon pea and sorghum, at 2% urea spray is useful after a good rain wets the foliage and the plant starts recouping.

FAQs:

What is Desertification?

Desertification is not the natural expansion of existing deserts but the degradation of land in arid, semi-arid, and dry sub-humid areas. It is a gradual process of soil productivity loss and the thinning out of the vegetative cover because of human activities and climatic variations such as prolonged droughts and floods. What is alarming is that though the land's topsoil, if mistreated, can be blown and washed away in a few seasons, it takes centuries to build up. Among human causal factors are overcultivation, overgrazing, deforestation, and poor irrigation practices. Such overexploitation is generally caused by economic and social pressure, ignorance, war, and drought.

Why is it important to fight desertification?

Desertification is at the root of political and socio-economic problems and poses a threat to the environmental equilibrium in affected regions. The land's loss of productivity exacerbates poverty in the drylands, forcing its farmers to seek a way of living in more fertile lands or cities.

Desertification also has grave natural consequences. It makes land areas flood-prone, causes soil salinisation, results in the deterioration of the quality of water, silting of rivers, streams and reservoirs. Unsustainable irrigation practices can dry the rivers that feed large lakes. Land degradation is also a leading source of land-based pollution for the oceans, as polluted sediment and water washes down major rivers.

Cause for desertification?

The immediate cause is the removal of vegetation. Unprotected, dry soil surfaces then blow away with the wind or are washed away by flash floods, leaving infertile lower soil layers that bake in the sun and become an unproductive land. Overgrazing destroys valuable plant species, leaving mostly unpalatable ones. Too many livestock on too little land;

removal of crop residues for feed/construction use; deforestation for fuelwood and construction materials; and inappropriate irrigation practices that lead to salinity. Losses of vegetation and biodiversity threaten habitat for other species.

Population is a reason for desertification?

Overpopulation leads to too many people farming too little land, leading to unscientific forming and poor management of soil and its fertility. This could lead to less productivity thus low income and hence the less investment on fertilisers, this further impoverishes the soils.

Does poverty cause land degradation and desertification?

This issue is controversial. It is clear that they suffer especially from its consequences because they are highly dependent on the land's productivity for their livelihoods. But this can be suggested that the use of technologies that increase land and labor productivity faster than population growth.

How does climate change cause desertification?

A major new threat is climate change. With the less rainfall dry areas could become even hotter and drier, especially semi-arid regions. If climate change increases the frequency and/or intensity of droughts, it would aggravate desertification. Given the uncertainty in the models, other outcomes are also possible; although the reasons are not understood and it appears that more factors than just rainfall are involved.

How can it be prevented and rehabilitated?

Among practical measures undertaken to prevent and restore degraded land are prevention of soil erosion; improved early warning system and water resource management; sustainable pasture, forest and livestock management; aero-seeding over shifting sand dunes; narrow strip planting, windbreaks and shelterbelts of live plants; agro-forestry ecosystems; afforestation and reforestation; introduction of new species and varieties with a capacity to tolerate salinity and/or aridity; and environmentally sound human settlements.

Because poverty forces the people who depend on land for their livelihoods to overexploit the land for food, energy, housing and source of income, and desertification is thus both the cause and consequence of poverty, any effective strategy must address poverty at its very center. It must take into account the social structures and land ownership as well as pay proper attention to education, training and communications in order to provide the fully integrated approach which alone can effectively combat desertification.

Some of the model sites where the technologies applied for combating desertification:

- Some watershed projects to name are Kabal Nala and Kuthangere in Bangalore Rural, Arasinakere in Mysore, Hirehalla in Belgaum.
- Kudremuk afforestation project to restore the land due to iron ore mining.
- Ingaldal mines afforestation project in chitradurga to restore lands degraded due to mining of copper tiles.
- Silvi-pasture has been widly adopted by hundreds of farmers in north Karnataka, Rayalaseema area of Andhra Pradesh and Marathwada.
- Sujala watershed project is being implemented in seven districts, namely Kolar, Chikkabalapur, Tumkur, Madhugiri, Chitradurga, Haveri and Dharwad of Karnataka.
- Moisture conservation using shallow inter culture in rabi sorghum to minimize soil cracking in deep black soils of Bellary, Karnataka.

Conclusion:

Desertification is caused primarily by over exploitation of natural resources beyond their carrying capacity by an unrelenting pressure of man and his animal support system. Solution to combat desertification lie in the total management of the causes of desertification. However an intricate web of human action and natural constraints that heighten the effect of desertification suggest that there are no easy options to combat it. However, among the sub-processes of land degradation, soil fertility loss, although reversible in nature, remains the most widespread in extent and key element of combating the adverse effects of desertification. Integrated nutrient management systems when combined with rainwater conservation and its efficient use and other standard agronomic practices provide sustainable solution to this man made problems.

Faidherbia albida(Ana tree)

Cenchrus ciliaris(Buffel grass)

Stylosanthes hamata(Caribbean stylo)

P juliflora(algaroba)

Parkinsonia aculeata(Jerusalem thorn)

Prosopis chilensis(chilean mesquite)

Salvadora persica(mustard tree)

Tamarix aphylla(athel pine)

Eucalyptus camaldulensis(River red gum)

Dichrostachys nutans(sickle bush)

Acacia nilotica(scented thorn)

Casuarina(River she-oak)

Desmostachya bipinnata(Halfa grass, Kush)

Tectona grandis(Teak)

Psidium guajava (guava)

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