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## Potential of Agroforestry for Improvement of Degraded Lands and Soil

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### Abstract

Approximately 96.40 mha area of the country is under degraded land, which is about 29.32% of total geographical area. It indicates that the degradation of land is the major problem in India. The major factors responsible for land degradation are physical, chemical and biological factors. Human activities like shifting cultivation, overgrazing, over exploitation of forest, less management of land, over dose of chemical fertilizers and population growth are also responsible for the land degradation. Under this situation, agroforestry is one of the popular practices adopted by various countries to improve the degraded land through nutrient cycling, runoff control, increase in the soil carbon and biomass. Agroforestry systems like fellow species on shifting cultivation, alley cropping, wind break and shelterbelt *etc.* are commonly used practices to improve the degraded land. Many studies have proved that agroforestry can check soil erosion to some extent, increase soil fertility, and reduce salinity, alkalinity, acidity and desertification.

### Introduction

Land degradation, defined as a decrease in soil productivity caused by changes in nutritional status, soil organic matter, structural characteristics, and electrolyte and toxic chemical concentrations. It is one of the most pressing environmental issues of recent era, affecting a large section of humanity and encompassing around 12 billion hectares of worldwide land area. It is considered as a threat for agricultural, social, and economic stability of various regions. Land degradation, which occurs when the biological or productive potential of the soil is lost leading to the loss of land's ability to support the growth of valuable plants on a long term basis, is putting India's food and environmental security at jeopardy. Being one of the world's most serious environmental issues, affecting 3.2 billion people, especially rural populations, smallholder farmers, and the poorest of the impoverished globally, land degradation is destined to exacerbate without rapid remedial action. India is a largest country having total geographical area of 328.73 million ha, out of total area 264.5 million ha area are utilized for agriculture, forestry, pasture, and other biomass production. Land in India is degraded to various extents and types due to insecure use and poor management practices. According to an analysis conducted by the Space Applications Centre, ISRO, Ahmadabad, reported that India, 96.40 mha land area of the country is under degraded land, which is about 29.32% of the total geographical area of country during 2011-13. In descending order, Rajasthan, Maharashtra, Gujarat, Jammu &

Kashmir, Karnataka, Jharkhand, Odisha, Madhya Pradesh, and Telangana contribute approximately 23.95%. Water erosion is the most significant process of land degradation in the country (about 10.98%), second is vegetation degradation *i.e.*, 8.91% followed by wind erosion (5.55%). The basic approach for controlling degradation of land is to increase vegetation coverage. Vegetation cover helps in stabilizing soils, minimizing the erosion (water and wind) and sustaining nutrient cycling in soils. Agroforestry has the ability to counteract land degradation and desertification. It can reduce land degradation while allowing land to be used for crop and livestock production on a long-term basis.

### Types of Land Degradation

#### 1. Wind Erosion

**W**ind erosion is mainly of three types *i.e.*, Suspension, Saltation, and Soil Creep, by which wind can erode the soil selectively and extensively. The problem of wind erosion is found mainly in the region where, there is no vegetative cover, high wind speed, dry fine soil found, extremely light soil, smooth soil surface, vast exposed area, *etc.* The top soil, which is rich in all plant nutrients and bacterial activity, is eroded away by wind.

#### 2. Water Erosion

**W**ater erosion means loss of upper soil by rainfall, irrigation, snowmelt, runoff, and poor irrigation management. Soil organic and inorganic materials move with water and deposited in lower area. Water erosion is categorized into different five categories *i.e.*, splash erosion, sheet erosion, rill erosion, gully erosion and tunnel erosion.

#### 3. Vegetation Degradation

**S**hifting cultivation, over exploitation of forest, forest-blanks, and over grazing on grassland and scrubland, are the common forms of vegetation degradation. Vegetations are very important to protect the soil and soil fertility. Destruction of flora leads to desertification and it is mainly caused by human activities.

#### 4. Water Logging

**W**ater logging is a problem that occurs when drainage facility is not available in proper manner. Time of water stagnant determines the harshness of water logging. Due to the water logging condition respiration of plants get affected badly. It results in death of plants due to anaerobic condition.

#### 5. Overgrazing

**O**vergrazing practice reduces the ground cover, enabling soil erosion. When plants are completely (including roots) eaten by the domestic and wild animals, then the land becomes exposed and vulnerable to wind and water erosion that leads to soil degradation.

### Potential of Agroforestry for Improvement of Degraded Land and Soil

**A**groforestry has the capacity to boost the physical, chemical, and biological conditions of soils by reducing soil loss through run-off (Table 1), adding organic carbon, nitrogen enrichment through nitrogen fixation through nitrogen-fixing trees and shrubs, and improving physical soil conditions such as water holding capacity, permeability, drainage, and so on. It can supply a diverse range of food and non-food products to local populations, contributing to food and nutritional security, revenue generation, improved livelihoods, and poverty reduction. Agroforestry systems can be implemented in a variety of ways, allowing for the sustainable use of land including the reclamation of degraded land, as well as the provision of a variety of vital ecosystem services, improved soil fertility, and a plethora of other advantages to humans. For example, silvipasture approaches have a larger ability to improve degraded and wasteland soil fertility and quality while also providing some value and palatable pastures/ fodder for integrating livestock. Agroforestry components take advantage of several vertical strata above and below ground, resulting in increased resource utilization efficiency and resource optimization.

Table 1: Effect of different barrier hedges, trees, and grasses on runoff and soil loss

Sl. No.	Treatment	Runoff (%)	Soil loss (t ha <sup>-1</sup> yr <sup>-1</sup> )
1	Corn on contour	40	21.0
2	Leucaena hedges	21.30	12.1
3	Panicum (0.75 m wide)	36.7	7.0
4	Eulaliopsis (0.75 m wide)	42.7	10.0
5	Veteveria (0.75 m wide)	39.6	8.1
6	Leucaena trees (6-8 years)	20.4	8.4
7	Eucalyptus trees (6-8 years)	16.3	5.8

(Source: Tomar et al., 2021)

Agroforestry systems, especially on degraded areas, are more productive than mono cropping systems. On degraded fields, silvipasture systems have proven to be extremely effective. Some tree species, such as *Acacia farnesiana*, *Tamarix articulata*, *Prosopis juliflora*, *Pithecellobium dulce* and *Parkinsonia aculeate*, have been proven to be particularly

efficient in the reclamation of salt-affected areas. Eucalyptus was discovered to be particularly effective at reclaiming waterlogged areas due to its high transpiration rates. Agroforestry provide different environmental and ecological services as shown in Figure 1.

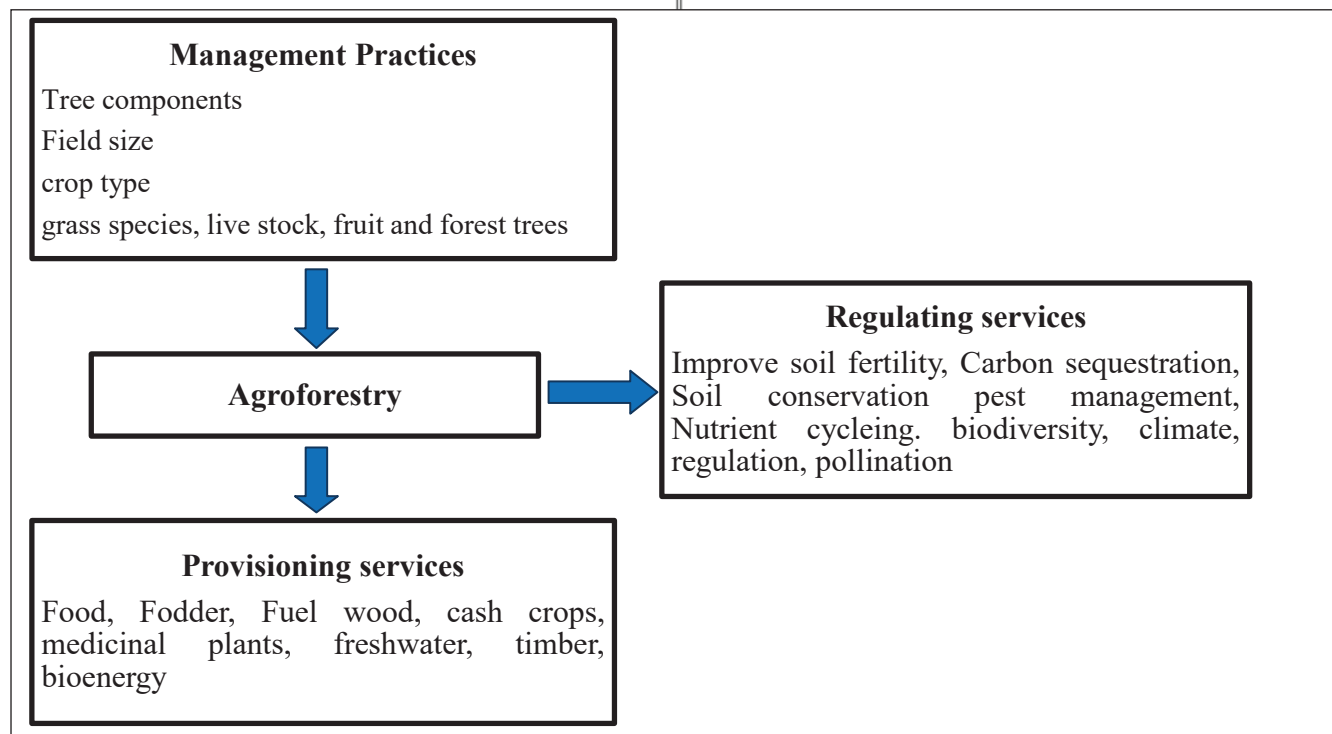


Figure 1: The environmental services of agroforestry systems in degraded landscapes (Source: Gupta *et al.*, 2020)

### Conclusion

**D**egradation of land is serious problem throughout the world as well as in India. Approximately 96.40 mha land is degraded in India due to the different factors. There is a crucial need to take steps to halt the degradation process and restore the productivity of degraded soils and land. Restoring the productivity of land is essential as the population of India and world is growing very fast and there is need of food, livelihood and environmental security for the increased population. In this context, agroforestry is very good substitute to improve the degraded land, livelihood and environmental security.

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