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Land Degradation Neutrality: A Pathway to Sustainable Land Management

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Abstract

Land Degradation Neutrality (LDN) is an emerging global strategy aimed at halting and reversing the decline in land quality caused by human activities and natural processes. This paper discusses LDN as a sustainable framework to maintain or improve the amount and quality of productive land. Emphasizing the three key pillars avoidance, reduction, and reversal of land degradation, the study highlights the causes and types of land degradation viz., physical, chemical, biological, and ecological factors. The benefits of LDN such as improved ecosystem services, climate resilience, food security, and livelihoods, particularly in arid and semi-arid regions are outlined. India's context is examined, revealing a significant proportion of degraded land and the urgent need for effective policy and action. By integrating restoration strategies and sustainable land management practices, LDN supports the achievement of Sustainable Development Goal 15.3 and contributes to global environmental stability.

1. Introduction

Land degradation means land becoming less productive and unhealthy due to factors such as erosion, pollution, deforestation, or unsustainable farming. Neutrality means that for every piece of land that gets degraded, an equivalent amount of degraded land is restored, resulting in no net loss of healthy and productive land. Land Degradation Neutrality (LDN) is a condition in which the amount and quality of land resources remain stable or improve by preventing further land degradation and restoring degraded land so that the overall productivity and ecosystem functions of land are maintained. Overgrazing, deforestation, improper agricultural practices, and excessive use of chemical fertilizers and pesticides reduce soil fertility and weaken soil resilience, which is the capacity of soil to maintain its functions and recover from

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disturbances. Urbanization, mining, and industrial activities also contribute by removing vegetation and polluting the soil. Natural factors such as droughts, floods, and climate change further worsen the condition by disturbing the land's natural balance. When land is degraded, soil carbon and nitrous oxide are released into the atmosphere, making land degradation one of the most significant contributors to climate change. According to the National Bureau of Soil Survey and Land Use Planning (NBSSLUP), 146.8 million hectares, or around 30% of the soil in India, is degraded. In India, nearly 29% of eroded soil reaches the sea, 10% accumulates in reservoirs, and 61% is redistributed within the landscape (Singh and Panda, 2017).

2. Land Degradation Neutrality

Land degradation neutrality is not merely about halting degradation but also offsetting losses with gains through restoration, rehabilitation and sustainable land management (Das et al., 2022). The concept is built on three interlinked pillars: avoidance, reduction and reversal of land degradation. The concept of land degradation neutrality has emerged as a global policy objective, officially adopted under Sustainable Development Goal (SDG) 15.3, which aims to combat desertification, restore degraded land and soil and strive to achieve a land degradation-neutral world. Land degradation is a critical environmental issue that refers to the deterioration of land quality, ecological health and productive potential, caused by the combined effects of natural processes and anthropogenic activities such as unsustainable land use, deforestation, overgrazing, and climate variability. It manifests as a reduction or loss of the biological or economic productivity of land especially in arid, semi-arid and dry sub-humid regions, but can affect any land type globally. Key processes contributing to land degradation include soil erosion (caused by wind/water), deterioration of soil properties (physical, chemical and biological) and long term loss of natural vegetation.

Furthermore, climate change aggravates land degradation by increasing the occurrence and intensity of extreme climatic events, including droughts and floods, which further strain land resources. The impacts of land degradation are far-reaching, leading to declining agricultural productivity, biodiversity loss, reduced water availability, and increased vulnerability of human livelihoods.

3. Strategies for LDN

Neutrality in land degradation can be achieved by preventing degradation and restoring degraded land so that the total amount of healthy, productive land remains the same or increases over time. Neutrality is achieved through a combination of prevention, reduction, restoration, monitoring, and community action.

3.1. Adoption of contour bunds and vegetative barriers

Contour bunds act as a barrier for sediment and surface runoff and reduce the length and gradient of slopes, check the velocity of flowing water, allow infiltration into the soil, and help in soil and water conservation. Vegetative barriers of perennial leguminous trees or grass strips slow down runoff and reduce erosion, and with annual crops, offer a simple and effective alternative for erosion control on sloping croplands all over the world (Cullum et al., 2007). Many grasses, including vetiver grass, were demonstrated to be very effective in reducing soil and water losses.

3.2. Conservation agriculture

Conservation agriculture (CA) is one of the crucial approaches to tackling land degradation while addressing the challenges of environmental sustainability and food security. By utilizing techniques such as minimal soil disturbance, maintaining permanent soil cover, and implementing crop rotation, CA improves soil health, boosts soil organic carbon (SOC) levels, and fosters biodiversity (Naorem et al., 2023). This helps to alleviate the negative impacts of traditional agricultural practices, which often lead to soil erosion and loss of fertility (Francaviglia et al., 2023). Studies suggest that CA can enhance crop productivity from 3.8% to 76.2% and significantly improve water productivity, thus contributing to SDGs and efforts to mitigate climate change (Kumawat et al., 2023; Francaviglia et al., 2023).

3.3. Reforestation and afforestation initiatives

Numerous studies have evidenced that reforestation and afforestation efforts are essential strategies in the fight against land degradation. These programs boost agricultural output and enhance environmental health by restoring vital ecosystem services and promoting biodiversity. For example, Greece's Agricultural Land Afforestation Program seeks to combat soil erosion and desertification by providing compensation for income losses during non-productive periods (Daliakopoulos et al., 2023). Similarly, Senegal's reducing emissions from

deforestation and forest degradation (REDD) initiative focuses on tree planting and agro-forestry practices to strengthen ecosystem resilience and encourage community involvement in forest management (Dieng et al., 2023).

4. LDN and its Advantages

➢ Preservation of ecosystem services, such as nutrient cycling, water regulation, and carbon storage, which are critical for maintaining agricultural productivity and ecological balance.

➢ Enhances climate resilience by stabilizing soils, reducing vulnerability to erosion, and improving moisture retention, particularly important in arid and semi-arid regions.

➢ Helps to keep land healthy and productive by balancing land loss with restoration.

➢ Protects important natural functions like soil fertility, water storage, and climate regulation.

➢ On a global level, LDN supports environmental goals like carbon storage and the UN's Sustainable Development Goals (SDGs).

5. India's Initiatives

India has made a strong national and international commitment to achieving Land Degradation Neutrality (LDN) by 2030. This commitment is aligned with the United Nations Convention to Combat Desertification (UNCCD) and Sustainable Development Goal (SDG) 15.3, which aims to maintain or improve the amount and quality of land resources necessary to support ecosystem functions and food security (Samra, 2020).

5.1. Key Policies and initiatives

5.1.1. National action plan (nap) to combat desertification and land degradation

India launched its first NAP in 2001, which was updated to align with the UNCCD's 10-year strategy. The latest plan, released in 2023, focuses on forestry interventions and aims to restore 26 M ha of degraded land by 2030.

5.1.2. Watershed management

The Integrated Watershed Management Programme (IWMP) uses micro-watershed planning, remote sensing, and spatial data for targeted interventions. This includes soil and water conservation, gully plugging, contouring, and both vegetative and engineering solutions.

5.1.3. Agroforestry and afforestation

Programs like the National Afforestation Programme (NAP), National Mission for Green India, and the Sub-Mission on Agroforestry promote tree planting, agroforestry models, and restoration of open forests and degraded lands.

5.1.4. Soil health and reclamation

The Rashtriya Krishi Vikas Yojana (RKVY) targets the reclamation of problem soils (alkali, saline, acid) for agriculture. ICAR institutes have reclaimed millions of hectares of salt-affected soils and developed region-specific agroforestry and land management models (Table 1).

Table 1: Programmes and Targets for land degradation neutrality

Policy/Program	Focus/ Intervention	Target/ Outcome
National Action Plan (NAP)	Combat desertification Forestry interventions	Restore 26 Mha by 2030
Integrated Watershed Management Programme	Micro-watershed, Soil & water conservation	Area-specific restoration
National Afforestation Programme	Tree planting, agroforestry	Forest and non-forest land restoration
RKVY	Agricultural productivity	Agricultural productivity

6. Progress and Impact

➢ Restoration efforts, such as in the Banni region of Gujarat, have improved soil health, productivity, and livelihoods, serving as models for replication.

➢ India is on track to meet its LDN target, contributing to an additional carbon sink of 2.5 to 3 billion tonnes of CO_2 equivalent by 2030.

7. Conclusion

Land Degradation Neutrality is an essential step towards keeping our land healthy and productive. It offers a balanced solution that ensures no net loss of productive land. This helps protect soil, water, plants, and people's livelihoods. India is working towards LDN through programs like forest planting, soil health improvement,

and watershed management. All these measures can ensure better crop yields, mitigate climate change, and support farming communities. Reaching LDN by 2030 is key to a better, more sustainable future.

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