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Land Degradation: Finding the Solution

Through Agroforestry in the Indian Himalayan Agro-Climatic Zones

Land degradation has emerged as a big challenge for policymakers, environmental stakeholders, and forest dwellers worldwide. Re-establishment of land productivity, or "land degradation neutrality," to support services and the functioning of ecosystems as well as to ensure food security has become an important target for sustainable development. India being the second most populous and mega-diverse country in the world, land degradation is definitely a major problem. Viewing India on the basis of agro-climatic zones, every state with a different geographical and forest pattern and a different agricultural model has exploited the land and forest cover, converting it into degraded, barren, or fragmented land. The agro-climatic zones of the Indian Himalayas, classified as western and eastern Himalaya, present a different picture of ecological functioning and climatology. The majority of the region is occupied by mountain ranges with glaciers, deep valleys, gorges, and high peaks, along with the traditional human settlements. The continuous developmental activities, unplanned agriculture practices, migration to the plains, and overexploitation of natural resources have resulted in a high rate of land degradation in the region. Under these circumstances, it has become essential to restore the paradise of this vast ecosystem by adopting management practices to ensure livelihood, food security, and a healthy environmental system. Climate-smart agriculture with multifaceted approaches has demonstrated greater potential for mitigating the crisis and halting the ecological deterioration of the Indian Himalayan ecosystem. This review focuses on land degradation in India, with special emphasis on Indian Himalayan regions, and land restoration through the adoption of suitable agroforestry practices for sustainable land use and management.

Key words: Land degradation, Land restoration, Sustainable land management, Agroforestry, Indian Himalayas

Agroforestry practices have shown potential in the rehabilitation of degraded land, enhancing soil fertility, carbon sequestration, mitigating climate change, ensuring food security and supporting livelihoods in Indian Himalayan agro-climatic zones.

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Introduction

Land degradation is one of the significant global issues of the 21st century, causing deleterious impacts on the environment, agricultural productivity, food security, and all life forms on the earth (Eswaran *et al*., 2019). According to statistics, about 40% of the world's land has been degraded, threatening USD 44 trillion (UNCCD, 2022). Human attempts to achieve food, water, health, and development activities related to climate change will altogether create immense pressures, deepening land degradation further (Xie *et al*., 2020). Environmental and socio-economic factors, coupled with the functioning of human society, contribute equally to land degradation processes (Adam, 2009). The issue can be better addressed by mobilizing investments and concrete policy commitments at the global level, followed by a careful assessment of the costs and benefits of action versus inaction in the process of adopting Total Economic Value (TEV) (Nkonya *et al*., 2016). The related biophysical traits and socioeconomics of a locality, targeting hotspots with degradation risks in various areas and years, should also be prioritized to resolve the crisis (Li *et al*., 2021).

Land degradation needs an immediate solution on the basis of a distressed global population; responses of environmental policy and its association with global environmental issues like biodiversity and climate change (Gisladottir and Stocking, 2005). The declaration of 2021–30 as the "Decade for Ecosystem Restoration" by the UN not only recognizes the drivers of ecosystem degradation globally but also helps in halting and reversing the process for the benefit of all components of nature.

The Indian Himalayas have the most complex and diversified ecosystems with distinct geographical, ecological, and biophysical settings. Continuous exploitation of natural resources, deforestation, unplanned agricultural and developmental activities, unsustainable practices, tourism activities, and waste generation has threatened the ecosystem functioning in the Himalayan regions. Besides, natural causes like landslides, water and soil erosion, earthquakes, and climate change are altogether responsible for the degradation of land and the loss of the valuable biodiversity of the region. The environmental sustainability of the Indian Himalayas is much higher compared to other states in India (Nandy, 2020). This article analyzes the scenario of land degradation from India's perspective, focusing on the western and eastern Indian Himalayan agro-climatic zones, and makes an attempt to find the best possible solution through agroforestry. Further recommendations and integration of land degradation, restoration, and sustainable land use (SLM) practices for healthy environmental functioning are also explored.

Land Degradation Scenario of India

With a land area of 328.72 million hectares (Census of India, 2011), India ranks seventh in the world, second in arable land area at 1.55 billion hectares (World Bank, 2023), and first in livestock population at 536.76 million (Census Livestock, 2019). Deforestation, overexploitation, inappropriate agricultural practices, climate change, an increasing human population, erosion, and urbanization contribute to converting productive land into the desert or drought-stricken land in the country. According to remote sensing and GIS database analysis, land degradation and desertification affect 97.85 million hectares (29.77%) and 83.69 million hectares area of the country respectively in 2018-19. Water erosion, vegetation degradation, and wind erosion account for 11.01, 9.15, and 5.46% of desertification and land degradation for the same timeframe. Rajasthan, followed by Maharashtra, Gujarat, Karnataka, Ladakh, Jharkhand, Odisha, Madhya Pradesh, and Telangana with 23.79%, whereas the remaining states contribute less than 1% to land degradation and desertification in the country. States like Jharkhand, Rajasthan, Gujarat, Delhi, and Goa exhibited more than 50%, whereas Kerala, Assam, Mizoram, Arunachal Pradesh, Bihar, Haryana, Uttar Pradesh, and Punjab showed less than 10% area under desertification and land degradation (DLD) during 2018-19 (SAC, 2021).

Land Degradation status of the Indian Himalaya Agro-climatic Zones

Indian Himalayan region extends 2500 km in length and 150 km wide in the east, and 400 km wide in the west, divided into two agro climatic zones- Western Himalayan Region comprising Jammu and Kashmir, Himachal Pradesh and the hill region of Uttarakhand (Kumaun-Garhwal), and the Eastern Himalayan Region comprising Arunachal Pradesh, the hills of Assam, Sikkim, Meghalaya, Nagaland, Manipur, Mizoram, Tripura, and the Darjeeling district of West Bengal. The early nineteenth-century human settlements, development activities, and land-use change have resulted in deforestation and habitat fragmentation, causing a reduction in biodiversity in the region. Land degradation and soil and nutrient loss have always been major challenges in the Indian Himalayan regions (Mishra *et al*., 2022). According to an analysis 27.45 t ha^{-1} yr^{-1} or 20.34% of the land area in the Indian Himalayas (Justin *et al*., 2021), is categorized under a very severe risk class, requiring appropriate conservation (Sharda and Mandal, 2018).

The land degradation and desertification atlas depicts that the Western Himalayas are witnessing more vegetation degradation of forest and grassland, along with mass movement, as compared to the Eastern Himalayas, which also include water bodies and land with scrub. In the present circumstances mitigation of soil degradation and desertification, transforming marginal agricultural areas to rangeland and forest land, and application of recommended management practices with the potential to sequester carbon, control anthropogenic emissions, enhance and sustain agronomic productivity, and improving the environmental system, should be prioritize for conserving soil and water resources (Lal, 2012).

Balancing Land resources through restoration

Land restoration is the process of reducing, avoiding, and reversing land degradation to normalize the biodiversity and ecosystem services that sustain all life on Earth. It is a regenerative process in parallel with a continuum of land and water management adapted to local conditions and applied to preserve natural areas, manage productive landscapes, like forestry and agriculture, and restore past ecology (UNEP, 2021). According to estimates, there is 2.2 billion ha of degraded land worldwide, 1.5 billion ha of which is suitable for mosaic restoration through agriculture, trees, and forests, and 1 billion ha of croplands affected by land-use change on previous forestlands that benefit from tree plantations as an important part of ecosystem services (FAO, 2022).

Land restoration is a significant and urgently needed activity to fulfill future energy needs, minimizing Greenhouse Gas (GHG) emissions and also addressing water scarcity and food insecurity issues. It aims for more sustainable production and consumption; and shifting to a productive economy to reduce waste generation, and pollution (UNCCD, 2022). Further, it also helps to stabilize climate change and biodiversity loss caused by the depletion of natural resources. The restoration activities provide the most fertile land, reduce the risk of disaster, and ease the recovery of habitats, biodiversity and ecological and natural processes on Earth. Land restoration is meant to generate sustainable opportunities for farmers, indigenous and local communities, and all sections of society to boost incomes, secure food, and make communities less vulnerable. Spatial analysis based on the distribution and configuration of land uses, coupled with its social significance and a multi-stakeholder process, along with an appropriate balance between land sharing and sparing approaches, helps in forest and landscape restoration (FLR) (Meli *et al*., 2019). Moreover, capacity development based on stakeholder requirements, knowledge extracted from various sources, skill sets, and the inclusion of social, financial, and legal subjects, along with technical and ecological themes, effectively supports the planning and implementation of FLR (Bloomfield *et al*., 2019).

Sustainable Land Management (SLM)

Sustainable land management (SLM) is a key to reducing land degradation, preventing desertification, and restoring degraded lands (Eekhout and de Vent, 2022). SLM is a broad concept and multidisciplinary in nature, beneficial for land users, researchers, and other stakeholders who have been working on issues concerning land degradation and SLM practices. Global SLM database studies reveal that dry, sub-humid countries along with countries with medium scores on the Human Development Index (HDI) have shown better SLM dissemination compared to humid countries with low HDI values (Haregeweyn *et al*., 2023).

Land degradation and desertification has shown significant impact on forest and agricultural lands. Agriculture sectors requires a concrete solution involving land use planning, and acquisition of sustainable land and water management, and food security through the establishment of a regional platform to facilitate dialogue; knowledge management and sharing; provision of tools to scale-out sustainable land and water management options; public and private investment opportunities; and conducive policies and strategies (Ziadat *et al*., 2022). Land degradation is causing an adverse impact on the income of the agricultural population; therefore, the adoption of SLM technologies can provide better access to markets, credit, extension, and land tenure security to poor agricultural households (Mirzabaev, 2016). The development and exploration of economic instruments like Payments for Ecosystem Services will help ecosystem services along with reorienting degraded rangeland and supporting livelihood systems (Reed *et al*., 2015). Thus, there is a need for documenting and sharing knowledge for better land use management in various environments.

Agroforestry to restore degraded lands

The restoration of degraded land through agroforestry has been emphasized by various international agencies to address forest sustainability and global deforestation crises. 'Agroforestry' the term used for the first time by J. Russell Smith in 1929 in the book Tree Crops: A Permanent Agriculture, aimed at providing an important solution to the destructive erosion due to the cultivation of sloping lands, has also emerged as an important means to restore degraded lands. According to available information, 71 countries reported 45.4 million ha of the area under agroforestry, with Asia accounting for the maximum (31.2 million ha), followed by Africa (12.8 million ha), and North and Central America both accounting for 1.28 million ha of area under agroforestry (FAO, 2022). Depending on the local environmental conditions, agroforestry systems have the potential to achieve 50–80 per cent of the local biodiversity, along with enhancing food security, nutrition, and crop productivity. The restoration of degraded land and expansion of agroforestry provide benefits, increased in tree cover, enhanced agricultural productivity, and balancing the amount of CO_2 in the atmosphere (FAO, 2022).

The restoration of degraded lands should be given priority by providing agroforestry or climate-smart agriculture through the practice of agrisilviculture, sand dune stabilization or alley cropping, silvipastoral systems, urban or peri-urban forestry, social forestry, and home gardens. With a better understanding of soil properties and land use, an effective and best-practice agroforestry system can be designed that supports sustainable land productivity, biodiversity, and ecosystems at plot and landscape scales (Gupta *et al*., 2020). Agroforestry helps in resolving water and soil erosion, soil fertility and rehabilitation of degraded lands, along with repercussions of climate change, natural resource sustainability and food security (Tomar *et al*., 2021). Agroforestry applied to degraded peatlands, besides producing forest areas, also helps in generating other useful areas, along with optimization of land, crop diversification, and enhancing carbon stocks. The selection of trees for agroforestry and their management becomes important for the physical, economic, social, and environmental systems (Maftu'ah *et al*., 2021).

Resolving land degradation through Agroforestry in Indian Himalayan Agro-climatic zones

The biodiversity in the Indian Himalayan region is under extreme pressure due to an increasing human population, unplanned settlement, deforestation, agricultural expansion, and alteration in land use and land cover, resulting in an increase in forest fragmentation, barren lands, and a decrease in forest area and ecosystem services (Mondal and Zhang, 2018). Agroforestry has emerged as a better solution to rehabilitate degraded lands by arresting deforestation, soil erosion, and rangeland degradation, at various scales, starting from the plot to the landscape level (Gupta *et al*., 2020). Myriad publications are available on Agri-Silviculture, Agri-Silviculture-Pastoral, Agri-Silviculture-Horticulture modeling, supporting the improvement of soil nutrients and physical properties, enhancing biomass, fertility, and soil and water conservation in Indian Himalayan regions (Sharma *et al*., 2007; Kumar *et al*., 2018; Nath *et al*., 2021; Negi *et al*., 2022).

The analysis of some of the relevant literature revealed that the adoption of agroforestry in hilly areas not only helps to restore degraded lands but could also provide food, fodder, fuel wood, timber, and medicine, supporting livelihoods and environmental health (Table 1). There are nine types of agroforestry systems described in the Indian Himalayan region: forest/timber trees and farm woodlots throughout the Himalaya; crop grasses with fruit trees in Jammu-Kashmir and Himachal; seasonal grazing in the Western Himalayas; woodlots and soil conservation in sloppy and land-slide prone areas; live hedges and boundary plantations in terrace areas; shelterbelts and windbreaks in alpine regions; and Taungya and Shaded perennial systems with plantation crops in the Eastern Himalaya (Palsaniya and Ghosh, 2016). In summary, temperate agroforestry in the western Himalayas (Kumar *et al.,* 2018), and traditional agroforestry in the central and eastern Himalayas (Maikhuri *et al.,* 2000; Sharma *et al.,* 2007; Yadav *et al.,* 2018) show great promise for meeting all household and ecological needs. These systems help regulate environmental services; including soil and water conservation, carbon sequestration, and climate change mitigation.

Table 1: Trees-Crops combination suitable for degraded lands in Himalayan Agro-climatic Zones in India.

S. No.	Trees	Ecological significance of the trees	Best crop/plant combination	Economic uses of the trees	References
Western Himalayan Region					
1	*Salix alba*	Sustainable land management, enhance soil nutrients, carbon storage	Maize, Sorghum	Leaf- Fodder Wood- Fuel wood Timber- Cricket bat	(Bhat *et al*., 2019)
2	*Albizia lebbek*	Nitrogen fixation, Wasteland restoration	Wheat ,Maize , Pulses, Aromatic and Medicinal plants	Wood- Fuelwood Fodder	(Negi and Dhyani, 2014).
3	*Dalbergia sissoo*,	Nitrogen fixation, Wasteland restoration	Wheat ,Maize , Pulses, Aromatic Medicinal plants and *Chrysopogon fulvus* (Fodder)	Wood- Timber, Fuelwood Fodder	(Dadhwal *et al*., 2012; Negi and Dhyani, 2014).
4	*Melia azederach*	Restoration of wasteland	Wheat ,Maize , Pulses, Aromatic Medicinal plants	Wood- Timber, Fuelwood	(Bijalwan, 2011; Kumar *et al*., 2018)
5	*Quercus leucotrichophora* (Himalayan Banj Oak)	Wasteland restoration, soil water conservation, carbon sequestration	Wheat	Wood- Fuelwood Fodder	(Negi and Dhyani, 2014; Kumar *et al*., 2020; Negi *et al*., 2022)
6	*Prunus armeniaca* (Apricot)	soil improvement of eroded areas, atmospheric carbon storage	Soybean, Barley, Peas, Mustard, Cowpea, and Vegetables	Fruit- source of fibres, minerals and vitamins.	(Arunachalam *et al*., 2019)
7	*Prunus persica* (Peach)	Carbon sequestration, maintain green cover of the soil	Beans, pulses vegetables,	Fruits- edible control diabetes obesity, and cardiovascular diseases	(Arunachalam *et al*., 2019)
8	*Celtis australis* (Celtis)	Land rehabilitation, Carbon sequestration	*Cenchrus ciliaris, Digitaria decumbens, Dicanthium annualatum, Dactylis glomerata*, beans, wheat, rice, soybean and Pulses	Fodder- Stall feeding animals Wood- small timber, fuel, agricultural equipment, and frames Fruit- Edible	(Rawat *et al*., 2017; Arunachalam *et al*.,2019)
9	*Grewia optiva* (Bhimal)	Reduces soil loss and Carbon sequestration	*Eleusine coracana, Echinochloa frumentaceae,* , Rice, Wheat, Soybean and Vegetable Beans	Wood- Fuel Fodder Branches- Fibers and ropes	(Dhyani and Handa, 2013; Arunachalam *et al*., 2019; Tariyal *et al*., 2022)

S. No.	Trees	Ecological significance of the trees	Best crop/plant combination	Economic uses of the trees	References
10	*Morus alba* (Mulberry)	Reduces soil loss and enhance soil nutrients, wasteland restoration	Wheat, Rice, Soybean, vegetables	Wood- Hockey sticks, Badminton and Tennis rackets, Fodder Leaf- Silk worm for silk production Fruit- Edible	(Negi and Dhyani, 2014; Arunachalam *et al*., 2019)
11	*Populus alba* (Poplar)	Leaf litter helps in soil carbon sequestration	Turmeric, Mustard, Ginger, Barley, Beans, Pulses, and Vegetables	Wood- hardboards, plywood, packing cases, matches and crates.	(Arunachalam *et al*., 2019)
12	*Bauhinia purpurea*	Nitrogen fixation, restoration of degraded land.	Rice, Wheat, Maize	Fodder, Timber, Medicine, Fuel,	(Pateria *et al*., 2003; Yadav and Bisht 2013)
13	*Hippophae rhamnoides* (Seabuckthorn)	Land reclamation, soil erosion control, used as fence	Barley, Wheat, Potato, Buckwheat	Fruits- Fruit juice is rich in organic acids, sugar, amino acids, and best source of Vitamin C	(Sanwal and Pandey, 2018; Arunachalam *et al*., 2019; Malik *et al*., 2021)
14	*Rubia wallichiana*	Land restoration	*Chloris gayana, Dactylis glomerata, Setaria anceps*, Hy. Napier, Poa sp., Red clover, White clover, *Stylosanthes hamata*	Wood – Furniture and construction, Medicinal uses	(Pateria *et al*., 2003)
15	*Ulmus wallichiana* (Himalayan elm)	Land restoration	Maize, Pea, Oatsmung, Bean	Bark- Fibre Wood- Construction, planking	(Pateria *et al*., 2003)
Eastern Himalayan Region					
1	*Aquilaria malaccensis* (Agarwood)	Restoration of Shifting and cultivated area	Patchouli (*Pogostemon cablin*), Brahmi (*Brahmi indica*), Sarpagandha (*Withania somnifera*), Mohavingaraj (*Wedelia calendulacea*), Mosundary (Houttuynia cordata), Narasingha*(Murraya koenigii)*, Ashwyagandh (*Withania somnifera*), Kalmegh (*Andrographis paniculata*), Black pepper Ginger, Pineapple, and Turmeric	Resin- incense and perfume, Medicinal material, Paper pulp	(Singh and Dwivedi, 2017; Arunachalam *et al*., 2019)
2	*Alnus nepalensis (*Himalayan alder*)*	Nitrogen fixation, enhances soil fertility, and microbial activity, increases carbon stocks, improves landslides affected sites	*Eleusine coracana, Amomum subulatum* (Large cardamom)	Fodder, wood- fuel and timber	(Bhatt and Todaria, 1990; Maikhuri *et al*., 2000; Sharma *et al*., 2007; Negi and Dhyani, 2014; Giri *et al.,* 2018; Arunachalam *et al*., 2019)
3	*Albizia lebbeck*	Nitrogen fixation, enhance soil fertility, Restore degraded land	Turmeric, ginger, taro, cowpea, maize, upland paddy and millets	Fuel, Fodder, Timber	(Singh *et al*., 1997; Nath *et al*., 2020)
4	*Bauhinia variegata*	Nitrogen fixation, enhance soil fertility, Restore degraded land	Maize, *Cowpea, Vigna unguiculata*.	Fuel, Fodder, Timber	(Bhatt *et al*., 2001; Nath *et al*., 2020)

S. No.	Trees	Ecological significance of the trees	Best crop/plant combination	Economic uses of the trees	References
5	*Bambusa balcooa*, *Dendrocalamus hamiltonii* (Bamboo)	Carbon storage	Turmeric, Ginger, large cardamom, Banana, Pineapple, Papaya, Lime Upland Paddy and Maize	House construction, Pulp, Farm fencing, Agricultural implements, Mats, Basket, Wall plate, Agarbatti stick, Ladders and Scaffolding.	(Pateria *et al*., 2003; Arunachalam *et al*., 2019)
6	*Dalbergia sissoo*	Soil organic carbon, carbon sequestration	Pineapple	Timber, Fodder	(Maikhuri *et al*., 2000; Yadav *et al*., 2021)
7	*Gmelina arborea*	Restoration of degraded land, carbon sequestration	Paddy, Linseed	Wood- timber, fuel wood, paper and pulp and other forest-based industries	(Das *et al*., 2016; Verma *et al*., 2017; Tamang *et al*., 2021)
8	*Hardwickia binata* (Anjan)	Restoration of degraded land	*Pennisetum pedicellatum* (grass)	Fodder,	(Das *et al*., 2016)
9	*Litsea glutinosa* (Litsea)	Restoration of degraded land	Bean, Groundnut, Legumes, Turmeric, Ginger, and Pine apple	Plant used as binding agent as plasters for fractured limbs, incense-stick industry, tablet formulations Seed- Aromatic oil for making soaps and candles	(Arunachalam *et al*., 2019)
10	*Acacia auriculiformis*	Restoration of land due to shifting cultivation	*Thysanolaena maxima*	Timber, Fuelwood	(Bhatt *et al*., 2010)
11	*Paraserianthes falcataria*	Restoration of degraded land, Nitrogen efficiency of soil	Soybean Linseed Groundnut, Mustard (*Brassica Campestris*)	Wood- Timber, fuelwood	(Dhyani and Tripathi, 1999)
12	*Parkia timoriana*	Restoration of slash-and-burn land	Paddy, mustard, maize, Colocasia, pea, cabbage, potato, turmeric	Pods- Medicinal and nutritional properties	(Singh *et al*., 2010; Palsaniya and Ghosh, 2016; Roy *et al*., 2016)
13	*Leucaena leucocephala*	Nitrogen fixation, Restoration of degraded land	Cowpea, Turmeric, Pineapple	Fuelwood, timber, fodder	(Bhatt *et al*., 2001; Ishihara *et al*., 2018)

Conclusion

Land degradation is a significant global crisis caused by deforestation, soil and water erosion, unplanned agricultural activities, and climate change, and is affecting food security and ecosystem functioning. The issue needs to be addressed by integrating a holistic approach through restoration, management, and SLM practices. The Indian Himalayan ecosystem, enriched in biodiversity, is under threat of biodiversity loss and degradation due to human-induced activities and natural disasters and requires immediate remediation. In the Indian Himalayan agro-climatic zone, land degradation is highest in the forest, followed by grassland, and land with scrub, and is arising due to vegetation degradation. Wind erosion is responsible for the degradation of irrigated and non-irrigated agricultural land. These impacts are dominant in the western Himalayas as compared to the eastern Himalayas. Further, water bodies and drainage account for alterations in land physico-chemical properties in the Eastern Himalayas.

Sustainable land management practices have a greater potential for climate change mitigation because they are based on the sharing of knowledge and technology, generate income for local communities, and ensure the proper functioning of ecosystems and food security. The present endeavor gave special emphasis on practicing agroforestry in Western and Eastern Indian Himalayan agro-climatic zones and explored several past studies that recommended a suitable combination of trees and crops to ensure land restoration, soil nutrition and health, carbon sequestration, enhanced biomass, and economic significance to the local practitioners. Thus, climate-smart agriculture with proper planning of tree intercrop selection will be the best technique to restore land and ecosystem integrity in the most diversified Indian Himalayan agro-climatic zones.

INDIAN FORESTER

भूमि निम्नीकरण : भारतीय हिमालयी कृषि-जलवायु क्षेत्रों में कृषि वानिकी के माध्यम से समाधान खोजना

संदीप पाण्डेय

सारांश

दुनिया भर में नीति निर्माताओं, पर्यावरण हितधारकों और वन वासियों के लिए भूमि क्षरण एक बड़ी चुनौती बनकर उभरा है। भूमि उत्पादकता की पुनः स्थापना, या ''भूमि क्षरण तटस्थता'', सेवाओं का समर्थन करने और पारिस्थितिक तंत्र के कामकाज के साथ-साथ खाद्य सुरक्षा सुनिश्चित करने के लिए सतत् विकास के लिए एक महत्वपूर्ण लक्ष्य बन गया है। भारत दुनिया का दूसरा सबसे अधिक आबादी वाला और मेगा-विविधता वाला देश है, भूमि क्षरण निश्चित रूप से एक बड़ी समस्या है। भारत को कृषि-जलवायु क्षेत्रों के आधार पर देखते हुए, प्रत्येक राज्य ने एक अलग भौगोलिक और वन पैटर्न और एक अलग कृषि मॉडल के साथ भूमि और वन आवरण का शोषण किया है, इसे निम्नीकृत, बंजर या खंडित भूमि में परिवर्तित कर दिया है। भारतीय हिमालय के कृषि-जलवायु क्षेत्र, पश्चिमी और पूर्वी हिमालय के रूप में वर्गीकृत, पारिस्थितिक कार्य प्रणाली और जलवायु विज्ञान की एक अलग तस्वीर पेश करते हैं। अधिकांश क्षेत्र पर पारंपरिक मानव बस्तियों के साथ-साथ ग्लेशियर, गहरी घाटियों, घाटियों और ऊंची चोटियों वाली पर्वत श्रृंखलाओं का कब्जा है। निरंतर विकासात्मक गतिविधियों, अनियोजित कृषि पद्धतियों, मैदानी इलाकों में प्रवास और प्राकृतिक संसाधनों के अत्यधिक दोहन के कारण इस क्षेत्र में भूमि क्षरण की दर उच्च हुई है। इन परिस्थितियों में, आजीविका, खाद्य सुरक्षा और एक स्वस्थ पर्यावरण प्रणाली सुनिश्चित करने के लिए प्रबंधन प्रथाओं को अपनाकर स्वर्गरूपी इस विशाल पारिस्थितिकी तंत्र को पुर्नस्थापित करना आवश्यक हो गया है। बहुमुखी दृष्टिकोण के साथ जलवायु-स्मार्ट कृषि ने संकट को कम करने और भारतीय हिमालयी पारिस्थितिकी तंत्र की पारिस्थितिक गिरावट को रोकने के लिए अधिक क्षमता का प्रदर्शन किया है। यह समीक्षा भारत में भूमि क्षरण पर केंद्रित है, जिसमें भारतीय हिमालयी क्षेत्रों पर विशेष जोर दिया गया है, और स्थायी भूमि उपयोग और प्रबंधन के लिए उपयुक्त कृषि वानिकी प्रथाओं को अपनाकर भूमि की बहाली की गई है।

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