

Review

# Restoring the Unrestored: Strategies for Restoring Global Land during the UN Decade on Ecosystem Restoration (UN-DER)

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**Abstract:** Restoring the health of degraded land is critical for overall human development as land is a vital life-supporting system, directly or indirectly influencing the attainment of the UN Sustainable Development Goals (UN-SDGs). However, more than 33% of the global land is degraded and thereby affecting the livelihood of billions of people worldwide. Realizing this fact, the 73rd session of the UN Assembly has formally adopted a resolution to celebrate 2021–2030 as the UN Decade on Ecosystem Restoration (UN-DER), for preventing, halting, and reversing degradation of ecosystems worldwide. While this move is historic and beneficial for both people and the planet, restoration of degraded land at different scales and levels requires a paradigm shift in existing restoration approaches, fueled by the application of applied science to citizen/community-based science, and tapping of indigenous and local knowledge to advanced technological breakthroughs. In addition, there is a need of strong political will and positive behavioral changes to strengthen restoration initiatives at the grassroot level and involvement of people from all walks of life (i.e., from politicians to peasants and social workers to scientists) are essential for achieving the targets of the UN-DER. Similarly, financing restoration on the ground by the collective contribution of individuals (crowd funding) and institutions (institutional funding) are critical for maintaining the momentum. Private companies can earmark lion-share of their corporate social responsibility fund (CSR fund) exclusively for restoration. The adoption of suitable bioeconomy models is crucial for maintaining the perpetuity of the restoration by exploring co-benefits, and also for ensuring stakeholder involvements during and after the restoration. This review underpins various challenges and plausible solutions to avoid, reduce, and reverse global land degradation as envisioned during the UN-DER, while fulfilling the objectives of other ongoing initiatives like the Bonn Challenge and the UN-SDGs.



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## 1. Land as a Vital Resource for Sustainable Development

Land is a complex biophysical system providing vital ecosystem services for human wellbeing and a good quality of life [1–4]. It supports primary production for feeding a rapidly growing human population and livestock, maintaining biodiversity and resultant ecological complexities (i.e., from species to ecosystems, and landscapes to biomes) [5–7] and plays a central role in cycling of nutrients [8] (i.e., C, N, P), water [9], and other critical elements [3–6]; and regulating the emission of trace gases (i.e., CH<sub>4</sub>, CO<sub>2</sub>, N<sub>2</sub>O, NO) and the earth's climate [2–11]. Moreover, land is perceived as an important production factor (as an economic resource) for overall human development [10] ([www.undp.org](http://www.undp.org)), and also has enormous social, biocultural, and religious significance [1–3,11].

Maintaining the vitality of land resources is therefore essential for environmental sustainability and also for the realization of various global goals [11–13] pronounced in the UN Sustainable Development Goals (UN-SDGs) ([www.sdg.un.org](http://www.sdg.un.org)). As depicted in Figure 1, the attainment of various SDGs such as no poverty (Goal No.1), zero hunger (Goal

No.2), good health and wellbeing (Goal No.3), gender equality (Goal No. 5), clean water and sanitation (Goal No.6), affordable and clean energy (Goal No. 7), decent work and economic growth (Goal No. 8), reduced inequalities (Goal No.10), responsible consumption and production (Goal No. 12), climate action (Goal No. 13), are directly or indirectly depends upon the quality of land, whereas the realization of the Goal No. 15, i.e., life on land (*‘protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss’*) and associated SDG targets are exclusively dependent on land resource ([www.un.org](http://www.un.org)). Hence, regaining the productivity of land is crucial for the realization of various objectives envisioned for the United Nations Decade on Ecosystem Restoration (UN-DER) [11–13], and also, for attaining land degradation neutrality (LDN), as well as various other developmental agendas put forth by the respective nations [14–16].



**Figure 1.** Pictorial depiction of land’s contributions to human well-being and a good quality of life [1–4]. There is a strong and positive interconnectedness between land system, human development, and the UN-SDGs ([www.sdg.un.org](http://www.sdg.un.org)). Land is a vital system for overall human development and also regulates critical planetary functions [1,7–10,15]. Therefore, protecting land system is essential for protecting our own future.

Unfortunately, more than 33% of the global land resources is already degraded due to various direct and indirect drivers of changes [1–4,15–21] including pollution due to rapid agriculturalization [5,6,10], urbanization, and industrialization; unsustainable land use practices [15], deforestation [18], salinization [17], desertification, natural and human induced fires, soil erosion, overexploitation of groundwater and other critical natural resources, mining activities, invasive alien plants, climate change, poor land governance and policy measures, behavioral changes, etc. [7,15–21]. According to Stocking [22], land degradation is defined as the “temporary or permanent decline in the productive capacity of the land, and the diminution of the productive potential, including its major land uses (e.g., rain-fed arable, irrigation, forests), its farming systems (e.g., smallholder subsistence), and its value as an economic resource” [22].

In simple terms, land degradation refers to “many processes that drive the decline of biodiversity, ecosystem functions or ecosystem services” [15]. As a result, the degradation nega-

tively impacts the ecosystem services provided by the land system for human wellbeing, including social, economic, and cultural dimensions of human development (Figure 2) [22]. Recent studies of various inter-governmental agencies like the United Nations Convention to Combat Desertification (UNCCD) ([www.unccd.int](http://www.unccd.int)), the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services of the United Nations (IPBES) ([www.ipbes.net](http://www.ipbes.net)), the United Nations Development Program (UNDP) ([www.undp.org](http://www.undp.org)), and the Intergovernmental Panel on Climate Change (IPCC) ([www.ipcc.ch](http://www.ipcc.ch)), reported that the global land degradation directly affects billions of people worldwide (i.e., land degradation affects the livelihood of almost 74% of the poor people) and causing an economic damage amounting to US\$6.3 trillion per annum [7,15]. For example, forest degradation directly affects ~1.6 billion people, including 70 million indigenous peoples who are solely dependent on the forest system for their survival [2,3,7,15]. Similarly, it has been estimated that almost 52% of the global agricultural lands are degraded (i.e., moderately or severely), and thereby affecting the livelihood of almost 2.6 billion people, those who are directly dependent on the agriculture for their sustenance ([www.undp.org](http://www.undp.org)).



**Figure 2.** While soil erosion, deforestation, pollution, climate change, and unscientific land use are the major drivers of land degradation [1–4], land ownership (i.e., public or private) also affects land health. Figure shows an abandoned public land prone to erosion and pollution in Rajagarh, Mirzapur, UP, India.

Therefore, the timely restoration of degraded land is essential for ecosystem resilience, and also for ensuring food and nutritional security of the growing human population [6]. Apart from averting the negative effects on socio-economic system, restoration of degraded land is also pivotal for regaining ecological complexities mediated by land system [23]. In this way, the recent international initiatives such as the Bonn Challenge, the New York Declaration on Forests (NYDF), the UN-SDGs, and the UN-DER, are historic and highly commendable, since all of these initiatives are exclusively or majorly targeted for restoring degraded land for sustainable development. The present review is aimed to highlight the challenges of land restoration for sustainable development and provide inventive measures to avoid, reduce, and reverse global land degradation during the UN-DER (i.e., 2021–2030) and even beyond that.

## 2. The Challenges of Restoring Degraded Land within the Target Period

While land restoration is a slow process [4], the mounting pressure exerted by a growing human population on finite land resources necessitate easy and immediate ways of restoration. However, the success of land restoration greatly depends upon (i) the time, and also on other important factors such as (ii) the nature and extent of the degradation, (iii) the biodiversity of the area, (iv) the history of the land use pattern, (v) the edaphic and climatic conditions, (vi) the availability of resources, people's support, and involvement, and importantly, (vii) the effectiveness of the restoration technologies employed [2–4,20,21].

Therefore, in strict sense, the objectives of land restoration cannot be completely attained within a short-stipulated time frame, and therefore, restoration activities must be extended for a very long period of time (at least for 50 years) with distinct, and defined short-term (i.e., decadal) as well as long-term restoration targets. Though it may not be possible to restore all of the ecological, economic, and socio-cultural services offered by land in a single go, the combination of short-term as well as long-term efforts will facilitate the attainment of one or more services in a stepwise manner. Therefore, investing ample time is one of the greatest challenges of global land restoration.

The lack of accurate information regarding the extent of land degradation (i.e., the total area of degraded land under different land-use) is another major hurdle for planning sustainable restoration initiatives and also for allocating time, and money incurred for the restoration programs accordingly [20,21,24–27]. While several agencies have already acknowledged the worsening impact of worldwide land degradation on ecological and economic systems [1,4,15,28,29], the actual level of degradation (by area wise and land use wise) is yet to be quantified. According to the FAO, more than one-third (i.e., 33%) of the global land is degraded ([www.fao.org](http://www.fao.org)). However, in reality, the actual land area undergoing degradation may be more than this estimate, because it is difficult to quantify the severity of land degradation under various land use. For instance, the IPBES global assessment on land degradation and restoration indicates that 75% of the global land area has been significantly modified, whereas 90% of the total land is predicted to be significantly altered by 2050 [15,29]. These postulations clearly show the alarming trend of anthropogenic pressures on our finite land system and the need of attaining LDN for environmental sustainability.

Since it is comparatively easy to identify the extent of degradation in vegetated system, [30] mainly by assessing the canopy cover (i.e., >75% of canopy cover for the intact forests whereas, <75% for the degraded forest) and biomass (i.e., >75% of aboveground biomass for intact forest) by remote sensing, and also by using other proxy-indicators of degradation such as linear intrusions (i.e., the presence of logging roads, rails etc.), and human settlements etc. [31,32]; there are no well-defined indicators for assessing the extent and severity of degradation in non-forested areas like agroecosystems [6,33] and other land use. In the latter one, the ecological profiling of soil, including physical, chemical, and microbiological profiling is the only way to understand the level of degradation [5,24]. Hence, it will require a considerable amount of time, labor, and other resources for undertaking the soil quality profiling of non-forested areas at a global scale for ascertaining the extent of land quality degradation. Thus, developing simplified protocols for assessing the overall quality of land is essential for devising sustainable management strategies for restoration [5].

Although restoration of degraded land is essential to reduce or reverse the detrimental effects done by humans to nature ([www.iis-rio.org](http://www.iis-rio.org)), identifying priority areas for immediate restoration is another serious challenge [34–37]. Since it is not possible to initiate restoration of all degraded land under different land use (i.e., forest, grassland, crop land, marginal, and waste land, etc.) in one go, identifying priority areas are utmost important for the immediate initiation of the UN-DER [35,36]. Though the cost of land degradation is higher than the cost of conservation and restoration, land restoration at the global level requires a considerable amount of resources and commitments [37–39]. Therefore, mobilizing financial resources for global land restoration (~US\$ 300 to 400 billion per year) is another point of concern [40,41]. As mentioned earlier, identifying priority areas for restoration is a challenging task, because such prioritization must be balanced and based on ecological, economic, and biocultural considerations of the local people. According to Strassburg et al. [34], restoration initiatives in 15% of the converted lands in priority areas of the global South will reduce species extinction by 60%, while sequestering ~ 30% of the atmospheric CO<sub>2</sub> (299 gigatons of CO<sub>2</sub>) [34]. The study also finds that optimizing spatial planning based on multicriteria analysis will reduce the cost of restoration while further improving biodiversity gains by almost 91%, and climate change mitigation by

82% [34–37]. Since most of the forest conversion has happened for food production (as of 2014, >1.5 billion hectares of natural ecosystems had been converted to croplands [29]), the re-conversion of cropland to forest may jeopardize food security of the growing human population. Hence, land restoration initiatives must be balanced and targeted for both ecological and socio-economic gains.

Last but not least, restoration of polluted land under changing climatic condition is another serious concern, especially for plant and microbial-assisted restoration, because the changing climatic conditions can alter the growth and survival of plant species and associated rhizospheric and soil microorganisms [5,10,21]. The changing climatic conditions can also alter the fate and behavior of pollutants in soil-plant systems including the bioavailability of pollutants [10,24,25]. Moreover, we do not have proper scientific understanding regarding the role of emerging pollutants like micro- and nanoplastics [42], nanoparticles [43], etc., on land degradation. Therefore, deploying site-specific and pollutant-specific strategies are essential for restoring vast stretches of polluted land [5].

### 3. Ten-Point Action Plan for Global Land Restoration

The 10-point strategies suggested by the UN ([www.deacdeonrestoration.org](http://www.deacdeonrestoration.org)) for action during the 10-year period of the UN-DER (2021 to 2030) is depicted in Figure 3. The ensuing subsections critically analyze the global implications of these action plans over the UN-DER period.



**Figure 3.** Ten-point action plan for restoring the vitality of the global ecosystem during the UN-DER (2021–2030). While these strategies are broadly aimed to create a global movement and solidarity for restoring degraded ecosystem for regaining ecological complexities, there are also co-benefits associated with land restoration such as creating new job avenues, and fighting against climate change, biodiversity loss, and climate-induced disasters ([www.deacdeonrestoration.org](http://www.deacdeonrestoration.org)). Therefore, the timely adoption of these strategies will have far reaching implications on global ecosystem restoration and also for the timely realization of the UN-SDGs.

### 3.1. Empower A Global Movement

Restoration of degraded land across the globe is not possible with the mere involvement of few individuals and institutions, and therefore, creating a momentum for global solidarity is crucial for the overall success of this mammoth task. Since the ultimate aim of the UN-DER is to halt and reverse the global degradation, it needs the expertise and experience of people from all walks of life (such as policy makers, local peoples, regulatory experts, scientist and technical experts, lawyers, gardeners, engineers, architects, designers, religious leaders, politicians, farmers, women and children, etc.), as well as the collaboration and cooperation of private and public institutions, non-governmental organizations, community/citizen groups, etc. [8,21]. As suggested by the UN ([www.deacdeonrestoration.org](http://www.deacdeonrestoration.org)), it is important to connect and empower the actions of various national, regional, and global initiatives targeted for halting land degradation such as the UN-SDGS ([www.sdgs.un.org](http://www.sdgs.un.org); as detailed earlier, the Goal No.15 is exclusively for land management, apart from that, several other SDGs and SDG targets are directly or indirectly related to land restoration); the Paris Agreement ([www.unfccc.int](http://www.unfccc.int); the Article 5 (2) of the Paris Agreement underlines the need of ‘policy approaches and positive incentives for activities relating to reducing emissions from deforestation and forest degradation, and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries’); the Bonn Challenge ([www.bonnchallenge.org](http://www.bonnchallenge.org); aimed to restore 350 million hectares of global degraded land by the year 2030); the New York Declaration on Forest ([www.forestdeclaration.org](http://www.forestdeclaration.org); ‘a voluntary and non-binding international declaration to take action to halt global deforestation’); The Global Partnership of Forest and Landscape Restoration ([www.forestlandscaperestoration.org](http://www.forestlandscaperestoration.org); an ongoing global initiative by the International Union for Conservation of Nature for restoring degraded forest and landscapes); the Global Restoration Initiative ([www.wri.org](http://www.wri.org); an ongoing initiative by the World Resources Institute targeted for the restoration of forest and degraded lands in 17 different landscapes in 50 countries, spanning over three regions, i.e., Asia Pacific, Africa, and Latin America and Caribbean); The Great Green Wall Initiative ([www.greatgreenwall.org](http://www.greatgreenwall.org); an African-led initiative to grow an 8000 km green wall across the entire width of Africa); the AFR100 ([www.afr100.org](http://www.afr100.org); the African Forest Landscape Restoration Initiative, ‘a country-led effort to bring 100 million hectares of land in Africa into restoration by 2030’); the Initiative 20x20 ([www.initiative20x20.org](http://www.initiative20x20.org); a country-lead initiative to reduce land degradation in Latin America and the Caribbean); etc., to strengthen the objectives of the UN-DER.

### 3.2. Finance Restoration on the Ground

Though there are many international initiatives targeted to restore degraded land across the world and several local and regional organizations/communities are willing to carry forward the ethos of restoration, land restoration on the ground needs considerable amounts of resources including financial support [37–41]. Even though the economic benefit of restoration is several folds higher than the cost of restoration (almost 7 to 30-fold, i.e., every US\$1 expenditure on land restoration will provide an economic return of US\$7–30) [39], huge investments are required for implementing land restoration at the global scale [43,44]. Therefore, restoration on the ground is not possible without financial contributions and active support of all players ([www.deacdeonrestoration.org](http://www.deacdeonrestoration.org)) including government bodies; global lenders such as the International Monetary Fund (IMF), the World Bank (WB), the Asian Development Bank (ADB), the African Development Bank (AFD) etc.; and international development agencies such as the United States Agency for International Development (USAID), the Foreign, Commonwealth and Development Office, UK (FCDO), the Swedish International Development Agency (SIDA), the Canadian International Development Agency (CIDA), the Japan International Cooperation Agency (JICA), the Norwegian Agency for Development Corporation (Norad), the Danish International Development Agency (DANIDA), the French Development Agency (AFD), the Australian Aid (AA), the Federal Ministry of Economic Cooperation and Development, Germany (BMZ), etc., to name a few.

While individuals can support restoration initiatives by generous funding and even through crowd funding, private companies can finance local, regional, or global land restoration initiatives through their 'Corporate Social Responsibility Funds' (CSR Funds). Moreover, there is a need to create an exclusive fund for restoration named the 'Global Restoration Fund' (GRF), like in the case of the 'Global Environment Fund' (GEF) created in 1990 for investing in low carbon initiatives, cleaner and renewable energy-based production, as well as for promoting resources saving industrial operations ([www.globalenvironmentfund.com](http://www.globalenvironmentfund.com)). The national and state government can also allocate a special fund for restoration, as in the case of the Queensland Government's Land Restoration Fund (LRF) established by the Govt. of Queensland, Australia ([www.gld.gov.au](http://www.gld.gov.au)) for mobilizing land restoration activities [44]. Furthermore, as recommended by the FAO, integrating land restoration into national accounting is one of the best strategies to garner proper attention of policy makers, and also to allocate adequate funds for land restoration at the national level [45]. The innovative strategies suggested by the WRI [39] for unlocking restoration finance such as (i) diverting revenue generated from carbon taxes (mainly obtained through the Nationally Determined Contributions) for land restoration, (ii) providing robust risk management measures to private players for ensuring their confidence and involvement in restoration projects, (iii) integrating restoration initiatives into the business portfolios of all concerned ministries for better coordination and governance, and importantly, and. (iv) quantifying the actual benefits of land restoration and informing the overall benefits to one and all is essential, so that the general public and other prospective actors can come forward for this common cause [39].

Deriving co-benefits such as bioproducts or phytoproducts during various stages of restoration is considered as an innovative way for supporting a bio-based economy [1,21,46–49] while maintaining the continuity of restoration and also for ensuring stakeholder involvements [21]. A recent assessment done by the International Resource Panel (IRP) of the UNEP on linking land restoration with the SDGs has clearly articulated the possible co-benefits associated with land restoration while concurrently achieving other SDG targets also. These co-benefits are mainly economic (income generation), social (improving the livelihood opportunities by providing employment in restoration sector), and biocultural (regaining biocultural significance of land) in nature and are directly or indirectly obtainable during or after the land restoration programs. For instance, land restoration with multipurpose plant species (like biomass and biofuel crops) provides an opportunity for extracting phytoproducts i.e., biomass [1], bioplastics, bioethanol, biochar, fuel wood, etc., during restoration for supporting a bio-based enterprise [43]. Land restoration also provides additional revenue generation through carbon crediting, and also by converting degraded landscapes to parks and heritage sites/cultural landscape etc. As depicted in Table 1, well planned and targeted restoration programs will facilitate the attainment of various SDG targets related to social and economic development such as no poverty, zero hunger, good health and wellbeing, gender equality, clean water and sanitation, affordable energy production (mainly through biomass), decent work and economic growth, reduced inequalities, etc. For example, land restoration helps in ending discrimination against women up to a certain extent by providing equal employment opportunities in restoration sector which in turn creates better opportunities for education to their children including girls ([www.foreststreesagroforestry.org](http://www.foreststreesagroforestry.org)) [47–49]. Restoration initiatives will also result in poverty alleviation by improving financial conditions of the women and also by converting degraded lands into agroforestry-based food production systems [50]. In a nutshell, the benefits of land restoration are enormous and inclusive restoration programs will directly or indirectly support the realization of other SDG targets also [2].

**Table 1.** Land restoration will not only help in the realization of several SDG targets, but also provide an opportunity for deriving additional benefits (co-benefits) [2,3,7] during or after the restoration stage (i.e., by the end of the UN-DER) [2]. An indicative list of SDG targets (related to land restoration) for which co-benefits are possible or likely obtainable reported by the International Resource Panel (IRP) of the UNEP [2]. The opportunity to harness co-benefits will further encourage world-wide restoration initiatives.



Related SDGs	Concerned SDG Targets	Possible Co-Benefits from Land Restoration	
		Restoration (Ongoing)	Restored (2030)
	1.1. By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than \$1.25 a day	x	
	1.2. By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions	x	
	1.4. By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership, and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance	x	x
	1.5. By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters		x
	2.1. By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants		x
	2.2. By 2030, end all forms of malnutrition, including achieving by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons.		x
	2.3. By 2030, double agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment	x	x
	2.4. By 2030, ensure sustainable production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality	x	x
	2.5. By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed	x	x



Table 1. Cont.


Related SDGs	Concerned SDG Targets	Possible Co-Benefits from Land Restoration	
		Restoration (Ongoing)	Restored (2030)
	3.1. By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births		x
	3.2. By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1000 live births and under-5 mortality to at least as low as 25 per 1000 live births.		x
	3.3. By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases		x
	3.4. By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and wellbeing	x	x
	3.9. By 2030, substantially reduce the number of deaths and illness from hazardous chemicals in air, water and soil pollution and contamination		x
	5.1. End all forms of discrimination against all women and girls everywhere	x	x
	5.5. Ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life	x	x
	5.a. Undertake reforms to give women equal rights to economic resources, as well as access to ownership and control over land and other forms of property, financial services, inheritance and natural resources, in accordance with national laws		x
	5.b. Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women		x
	6.3. By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally		x
	6.4. By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and sustainability reduce the number of people suffering from water scarcity		x
	6.5. By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate.		x
	6.6. By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes		x
	6.a. By 2030, expand international cooperation and capacity-building support to developing countries in water and sanitation-related activities and programs, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies	x	
	6.b. Support and strengthen the participation of local communities in improving water and sanitation management	x	

Table 1. Cont.


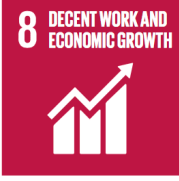
Related SDGs	Concerned SDG Targets	Possible Co-Benefits from Land Restoration	
		Restoration (Ongoing)	Restored (2030)
	7.1. By 2030, ensure universal access to affordable, reliable and modern energy services		x
	7.2. By 2030, increase substantially the share of renewable energy in the global energy mix	x	x
	7.a. By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficient and advanced cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology	x	x
	7.b. By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land-locked developing countries, in accordance with their respective programs of support		x
	8.1. Sustain the per capita economic growth in accordance with national circumstances and, in particular, at least 7% GDP growth per annum in the least developed countries	x	x
	8.2. Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labor-intensive sectors	x	x
	8.3. Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small-and medium-sized enterprises, including through access to financial services	x	x
	8.4. Improve progressively, through 2030, global resource efficiency in consumption and production and endeavor to decouple economic growth from environmental degradation, in accordance with the 10-year programs on sustainable consumption and production, with developed countries taking the lead		x
	8.5. By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equally pay for work of equal value	x	x
	8.6. By 2020, substantially reduce the proportion of youth not in employment, education or training	x	
	8.7. Take immediate and effective measures to eradicate forced labour, and modern slavery and human trafficking and secure the prohibition and elimination of the worst forms of child labour, including recruitment and use of child soldiers, and by 2025 end child labour in all its forms	x	x
	8.9. By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products.		x
	8.10. Strengthen the capacity of domestic financial institutions to encourage and expand access to banking, insurance and financial services for all	x	

Table 1. Cont.






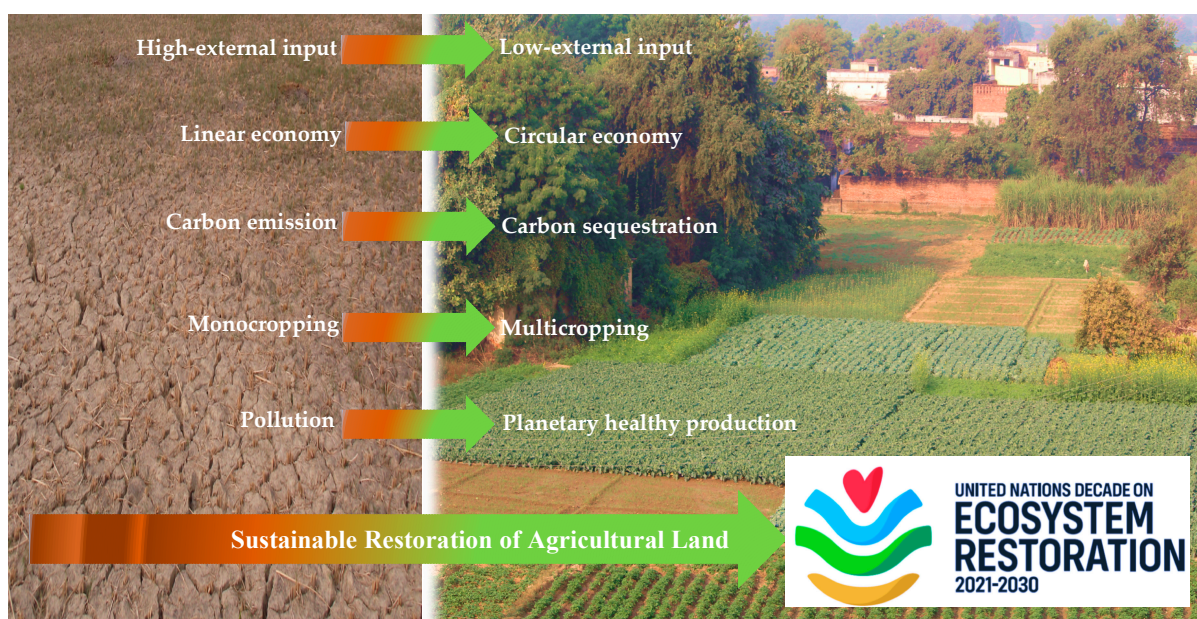
Related SDGs	Concerned SDG Targets	Possible Co-Benefits from Land Restoration	
		Restoration (Ongoing)	Restored (2030)
	10.1. By 2030, progressively achieve and sustain income growth of the bottom of 40 percent of the population at a rate higher than the national average	x	x
	10.2. By 2030, empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion, or economic or other status.	x	
	10.7. Facilitate orderly, safe, regular and responsible migration and mobility of people, including through the implementation of planned and well managed migration policies.		x
	11.3. By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries.	x	x
	11.4. Strengthen efforts to protect and safeguard the world's cultural and natural heritage		x
	11.5. By 2030, significantly reduce the number of death and number of people affected and substantially decrease the direct economic losses relative to global GDP caused by disasters, the number of deaths and the number of people, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations		x
	11.6. By 2030, reduce the adverse per capital environmental impacts of the cities, including by paying special attention to air quality and municipal and other waste management		x
	11.7. By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older person and person with disabilities		x
	11.a. Support positive economic, social and environmental links between urban, peri-urban, and rural areas by strengthening national and regional development planning	x	
	12.2. By 2030, achieve the sustainable management and efficient use of natural resources	x	x
	12.4. By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment	x	
	12.5. By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.		x
	12.6. Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle		x
	12.8. By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature	x	x

Table 1. Cont.

Related SDGs	Concerned SDG Targets	Possible Co-Benefits from Land Restoration	
		Restoration (Ongoing)	Restored (2030)
	13.1. Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries	x	x
	13.2. Integrate climate change measures into national policies, strategies and planning	x	
	13.3. Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning	x	
	14.1. By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution	x	x
	14.2. Sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take actions for their restoration in order to achieve healthy and productive oceans	x	x

### 3.3. Set the Right Incentives

Though the profitability index i.e., the benefit–cost ratio (BCR) of restoration is very high, it will take years to reap the monetary benefits out of land restoration. Therefore, introducing suitable market-based incentives (MBI) like subsidies or loans are essential for attracting more players into land restoration ventures, whereas imposing disincentives such as penalties, taxes, permits, etc., will restrict or penalize the activities which further leads to land degradation [39,51,52]. For instance, a study on the role of MBI for landscape restoration in Shinyanga, Tanzania proved that incentives worked best for privately owned land, whereas disincentives played well for restoring community or public land. As suggested by Chapman and Lindernmayer [53], introducing alternate MBI like revenue-contingent loan (RCL) is suitable for attracting public sector engagement with agricultural land restoration as ‘it has subsidy-reducing properties for government budgets’ [53] as well as flexible repayment opportunities i.e., repayment normally starts with the revenue generation or ‘financial assistance repaid contingent on a farm’s capacity to pay’ [54]. In addition, there is a need to change the way existing incentives are allocated, especially for agricultural activities. Since agrochemicals constitute the major budgetary outlay for marginal and subsistence farmers in developing countries, providing subsidies for fertilizers is often viewed as an economic support to the farmer’s endeavors [55]. Unfortunately, the subsidized price often leads to over-application of fertilizers (due to higher purchasing power of farmers), and subsequent environmental pollution [55]. It has been estimated that synthetic fertilizers (e.g., nitrogenous fertilizers) are one of the major drivers of land degradation and the rampant use of synthetic fertilizers have already crossed the planetary boundaries [56–58]. Therefore, setting the right incentives for the right activities is of paramount significance for preventing future land degradation, while diverting the subsidies for activities that facilitate/support land restoration [39]. In this context, the incentives must be set for biofertilizers/organic/sustainable agricultural practices, instead of existing incentives for synthetic/mineral fertilizers (Figure 4).



**Figure 4.** Setting the right incentives are imperative for promoting planetary healthy food production while reducing pollution from agroecosystems [6,59–62]. Moreover, good cultivation practices based on circular economy principles will protect agricultural land from further degradation. Therefore, incentives must be provided for framing practices based on low-external input as well as resource conserving practices (mainly replacing synthetic fertilizers by organic and biofertilizers [60,63–67], sustainable utilization of agro-residues), improving soil carbon pool, and also based on multiple cropping patterns targeted to maintain agrobiodiversity for ecological resilience, and food and nutritional security [6].

### 3.4. Celebrate Leadership

Though there are many national, regional, and multilateral agreements and commitments (both binding and non-binding) are operational across the world and several countries/organizations are committed to restore degraded landscape back to life [68,69], restoration at a global scale needs more leadership and political will, and also the engagement of peoples from various sectors across the world. Therefore, new commitments are essential for strengthening ongoing efforts [69]. So, it is the right time to celebrate leadership, foster commitments, and encourage others to come forward. In this way, the initiative taken by the G-20 countries (i.e., Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Republic of Korea, Mexico, Russia, Saudi Arabia, South Africa, Turkey, United Kingdom, United States, and the European Union) named the ‘*Global Initiative on Reducing Land Degradation and Enhancing Conservation of Terrestrial Habitats*’ to restore a 50% of degraded land by 2040, on a voluntary basis, is a welcome step forward [70]. Similarly, other international forums/organizations such as the Common Wealth of Nations, the European Union, the Asia Pacific Economic Cooperation, the Association of Southeast Asian Nations, the SAARC, the BRICS, the South Asia Sub-regional Economic Cooperation, the Organization of the Petroleum Exporting Countries, the Organization for Economic Co-operation and Development, etc., can also start similar initiatives in line with the G-20 countries for land restoration ([www.g20riyadhsummit.org](http://www.g20riyadhsummit.org)) and formulate explicit financial packages for promoting land restoration activities in their respective regions/member states.

### 3.5. Shift Behaviors

Shifting behaviors are important for restoration narratives [71]. While land degradation is a local issue, the drivers of land degradation are often connected to the global market system (due to global production and use of goods and services) [71,72]. Therefore, land restoration not only requires money, resources, and technology, but also needs behavioral changes, especially a pragmatic change in the way we manage our land resources as well as

the way we produce and consume. Therefore, the behavioral shift towards planet-friendly ways of industrial and agricultural production, green transportation, and consumption patterns (including the consumption of restoration-based products) based on circular economy principles rather than linear economy will prevent future degradation of our landscapes, while supporting regional initiatives for restoration [71–75]. Most importantly, the transition towards a planetarily healthy diet (based on a plant-based diet with flexible amount of fish/animal protein) will enable us to sustainably manage agricultural system while protecting our natural landscapes from further degradation [76].

### 3.6. Invest in Research

Investing in land restoration research is essential for developing site-specific restoration packages [13,25,75]. Though the drivers of restoration may be common for various land use, successful restoration needs site-specific, and customized efforts [76,77]. Since restoration is a complex processes, it needs scientific advancements of various disciplines such as ecology, agriculture, plant science, forestry, agroforestry, microbiology, zoology, geology, geography, remote sensing, landscape designing, engineering, modelling, economics, planning, sociology, anthropology, law, governance, business management, etc., as well as the sustainable utilization of traditional and indigenous knowledge (including biocultural knowledge) of the concerned people, and also the adoption of citizens science/community science. As mentioned earlier, restoration under changing climatic conditions is a challenging task, and therefore optimizing restoration practices for diverse edaphic and agrometeorological conditions under futuristic climate is a herculean task [25–27]. Identifying suitable plant species for revegetation and optimizing their agronomic practices for large-scale cultivation in degraded landscapes needs robust research inputs. Moreover, redesigning of the degraded landscapes are essential for maintaining the biocultural significance of the concerned land. Therefore, coordinating land restoration research at various scales and levels are imperative for developing practical and actionable restoration packages corroborated by nature-based solutions, and ecosystem-based strategies for implementing a successful restoration decade.

### 3.7. Build up Capacity

While thousands of land restoration programs are already underway ([www.deacdeonrestoration.org](http://www.deacdeonrestoration.org)), involving immediate sufferers of land degradation (especially, women and youth) in restoration ventures and building capacity of such marginalized people [78] to successfully steering restoration during the UN decade is essential for executing restoration on the ground ([www.iufro.org](http://www.iufro.org)). Capacity building will not only empower and educate such groups for this common cause, but also facilitate a platform for networking of like-minded people [79]. Such platforms will also help in imparting awareness regarding ecological, economic, and socio-cultural significance of ecosystem restoration, conducting training on best restoration practices, knowledge and experience sharing, and also for sharing information regarding mobilization of financial resources [80], etc. Therefore, creating a network of interested people, and thereby properly utilizing their expertise, experience, and enthusiasm is essential for the success of land restoration.

### 3.8. Celebrate a Culture of Restoration

Land restoration is neither a time bound nor an easy target. It needs considerable years of time and efforts to restore a degraded land back to normalcy. For a successful restoration, the support of all players including common people are essential [81]. Therefore, as a global citizen, it is the responsibility of each and every individual to inspire and motivate others to take part in land restoration ventures. Importantly, adopting a culture of restoration in our daily life itself is one of the best strategies to keep the ball rolling [82,83]. Learning the biocultural practices of indigenous and local people from diverse parts of the world is essential to understand the relevance of implying cultural practices for land

restoration [81,83] and also for attaining multi-level sustainability goals in a time-bound manner [84].

### 3.9. Build up the Next Generation

As the consequences of land degradation will greatly impact the youth and future generations, honing the soft and hard skills of the next generation is essential for leading restoration drive forward and also for creating ‘sustainable job opportunities based on a restoration economy’ ([www.deacdeonrestoration.org](http://www.deacdeonrestoration.org)) for their wellbeing. Education for restoration can be imparted through various formal (i.e., specific courses and training programs/field work for School and University students, and also through Massive Online Open Courses (MOOC) etc.) and also through various informal ways (e.g., through mobile apps) [85]. As highlighted by the UN, “education for restoration will turn today’s children into ecosystem ambassadors, provide skills for sustainable jobs and ensure that the UN Decade’s achievements far outlive its timeframe” ([www.deacdeonrestoration.org](http://www.deacdeonrestoration.org)).

### 3.10. Listen and Learn

Listening and learning from each other and building a culture of sharing knowledge, resources, and expertise for caring land resources is imperative for the success of the UN decade. Respecting others and learning from the success [86] and failures of previous and ongoing land restoration ventures [87] will provide an opportunity for necessary course corrections. Furthermore, it is the high time to re-embrace the forgotten concept of ‘land ethic’ proposed by ‘Aldo Leopold’ [88] and we must change our attitude towards land as a ‘living entity’ rather than a ‘fictitious commodity’. Together, by collective efforts, we can fulfill the ambitious goals of the UN-DER and also other ongoing initiatives targeted for land restoration.

## 4. Conclusions

Land degradation is one of the major impediments for sustainable development and causing economic damage amounting to US \$6.3 trillion per annum. Devising sustainable strategies for restoring degraded land at the local, national, regional, and global level is imperative for the timely realization of the UN-SDGs. The UN-DER opens the floodgates of opportunities for restoring degraded land for the benefit of both people and the planet. However, individuals and institutions must come forward to grab this golden opportunity to restore the health of our dying land for a sustainable future.

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