REGENERATIVE FORESTRY AND AGRICULTURE PRACTICES: A RESPONSE TO THE CLIMATE EMERGENCY AND BIODIVERSITY DECLINE IN DEVELOPING NATIONS

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Abstract

This study examines the critical significance of regenerative forestry and agriculture techniques as a tactical response to the growing climate emergency and biodiversity loss in developing countries. Land use changes, pollution, and habitat degradation are cited as direct consequences of agricultural operations that contribute to biodiversity loss. Climate change concurrently affects biodiversity and agricultural productivity dramatically, driven by both natural and human forces. The study explores the effects of agriculture on biodiversity, the environment, and climate, highlighting the need for a sustainable strategy and acknowledging the urgent need for nature-based solutions to climate change and biodiversity loss. Agriculture must implement mitigation techniques for climate change since it poses a global hazard to food, the environment, and human security. This study is based on research that highlights the detrimental effects of climate change on the human population and the environment, in addition to the necessity of addressing these effects through nature-based solutions. It also examines the widespread and escalating threat that climate change poses to ecosystems and biodiversity, emphasising the pressing need for an all-encompassing solution, this study discusses the various effects of climate change on developing countries, such as reduced resources for forestry and agriculture, water scarcity, and food and people insecurity. It highlights regenerative forestry and agriculture methods as viable solutions that help restore biodiversity while simultaneously reducing the impacts of climate change and biodiversity loss. By combining knowledge from these various sources, the study offers a thorough summary of how regenerative approaches might improve sustainability and resilience in underdeveloped countries' environmental discourse.

Keywords: *Regenerative Forestry and Agriculture practices, climate change, biodiversity*

Introduction

Climate change and biodiversity decline represent two of the world's most urgent environmental issues at the moment. These issues are particularly acute in developing nations, where the impacts of climate change are often most severe, and where biodiversity loss can have devastating effects on ecosystems and human communities. Regenerative forestry and agriculture practices offer a promising response to these challenges. By focusing on restoration and sustainable management, these methods can improve biodiversity, lessen the effects of climate change, and strengthen food security and resilience in developing countries.

Understanding Regenerative Forestry and Agriculture

Regenerative forestry focuses on sustainable forest management practices that promote natural regeneration, biodiversity, and soil health. Techniques include selective logging, controlled burns, and reforestation with native species to maintain ecological balance and enhance forest resilience.[1] Both fields aim to create resilient ecosystems that support both environmental and human well-being by mitigating climate change impacts, restoring degraded lands, and promoting sustainable resource use.[2]

Regenerative agriculture, on the other hand, is an approach to farming and land management that aims to restore and enhance the health of ecosystems,[3] it is a collection of concepts, strategies, and goals intended to improve ecosystem function, biodiversity, soil health, climate resilience, and socioeconomic benefits.[4] The goal of regenerative agriculture is to improve and restore the health of ecosystems through farming and land management. This includes improving soil health, increasing biodiversity, and enhancing water cycles, all while reducing carbon emissions and promoting resilience to climate change.[5] Key practices include crop rotation, reduced tillage, cover cropping, and the integration of livestock into farming systems.[6]

Historical Context and Evolution

The concept of *regenerative forestry and agriculture* has evolved from traditional farming and forest management practices that indigenous and local communities have employed for centuries.[7] These communities have long recognized the importance of maintaining the health and balance of their natural environments.[8] It is argued that modern regenerative practices build on these traditional methods, integrating contemporary scientific understanding of ecology, soil biology, and climate science. In recent years, *regenerative forestry and agriculture* have drawn a lot of interest as sustainable methods to meet

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[1] JF Ponge and others, 'The Forest Regeneration Puzzle' (1998) 48 (7) BioScience 523-530: RL Chazdon and others, 'Fostering Natural Forest Regeneration on Former Agricultural Land Through Economic and Policy Interventions' (2020) 15 (4) Environmental Research Letters 043002.

[2] RL Chazdon and others, 'Fostering Natural Forest Regeneration on Former Agricultural Land Through Economic and Policy Interventions' (2020) 15 (4) Environmental Research Letters 043002: E Toensmeier, '*The Carbon Farming Solution: A Global Toolkit of Perennial Crops and Regenerative Agriculture Practices For Climate Change Mitigation And Food Security* (Chelsea Green Publishing 2016).

[3] P Newton and others, 'What Is Regenerative Agriculture? A Review of Scholar and Practitioner Definitions Based on Processes and Outcomes' (2020) 4 Frontiers in Sustainable Food Systems 577723.

[4] B Sands and others, 'Moving Towards an Anti-Colonial Definition for Regenerative Agriculture' (2023) 40 (4) Agriculture and Human Values 1697-1716: RR Harwood, 'A History of Sustainable Agriculture' in *Sustainable Agricultural Systems* (CRC Press 2020) 3-19: E Gordon, F Davila and C Riedy, 'Transforming Landscapes and Mindscapes Through Regenerative Agriculture' (2022) 39 (2) Agriculture and Human Values 809-26.

[5] R Khangura and others, 'Regenerative Agriculture—A Literature Review on the Practices and Mechanisms Used to Improve Soil Health' (2023) 15(3) Sustainability 2338.

[6] Newton and others (n 3).

[7] U Etemire and NU Sobere, 'Improving Public Compliance with Modern Environmental Laws in Nigeria: Looking to Traditional African Norms and Practices' (2020) 38 (3) Journal of Energy & Natural Resources Law 305, 308.

[8] MO Agada, VA Otene and SO Adikwu, 'Usage of Indigenous Production and Preservation Practices by Maize farmers in Ugbokolo, Benue State, Nigeria' (2020) 8(3) World Journal of Advanced Research and Reviews 52, 57.

human needs while improving biodiversity and recovering ecosystems.[9] These customs have their roots in a historical progression that takes into account modifications to farming methods, environmental consciousness, and scientific discoveries.[10]

The Evolution of Agriculture

Humanity made the shift from roving hunter-gatherers to permanent farming communities, which is when agriculture began. Agricultural techniques began with the domestication of animals like sheep, goats, and cattle, as well as plants like wheat, barley, and legumes. In the early stages of agriculture, simple equipment and methods were used. Simple plant cultivation and animal domestication were the mainstays of early agricultural activities. Farmers were able to regulate the flow of water thanks to irrigation systems. With the advancement of irrigation, crop rotation, and the employment of animal labour, these practices changed over time, resulting in higher agricultural output and the emergence of complex societies.[11]This increased agricultural production and supported greater populations.

Animal domestication and breeding produced reliable food supplies as well as labour for field preparation and transportation. This mutually beneficial coexistence of people and animals promoted the growth of agriculture. The growth of commercial agriculture and the fall of subsistence farming were facilitated by the consolidation of small farms throughout this time into larger, more productive units.[12] The Green Revolution of the 20th century saw the introduction of chemical fertilisers, herbicides, high-yielding variety (HYV) seeds, and sophisticated irrigation methods. These discoveries significantly increased food output, especially in developing nations, which reduced hunger and food shortages.[13]

However, the Green Revolution also had negative effects on the environment, such as chemical contamination, soil deterioration, and water depletion.[14]

With developments in biotechnology, precision farming, and sustainable methods, agriculture is still changing today.[15] Drones, artificial intelligence, and genetically modified organisms (GMOs) are revolutionising agriculture by increasing productivity.[16] It is argued that the world is becoming more aware

[9] BP Oberč and SA Arroyo, '*Approaches to Sustainable Agriculture: Exploring the Pathways* (IUCN, Brussels, Belgium 2020) 25, 47: SH Muhie, 'Novel Approaches And Practices To Sustainable Agriculture' (2022) 10 Journal of Agriculture and Food Research 100446: KE Giller and others, 'Regenerative Agriculture: An Agronomic Perspective' (2021) 50 (1) Outlook on Agriculture 13-25: AS Mori, KP Lertzman and L Gustafsson, 'Biodiversity and Ecosystem Services in Forest Ecosystems: A Research Agenda for Applied Forest Ecology' 54 (1) (2017) Journal of Applied Ecology 12-27.

[10] A Leu, 'An Overview of Global Organic and Regenerative Agriculture Movements' in *Organic Food Systems: Meeting the Needs of Southern Africa* (Wallingford UK: CABI 2020) 21-31.

[11] U Sekaran and others, 'Role of Integrated Crop-Livestock Systems in Improving Agriculture Production and Addressing Food Security: A Review' (2021) 5 Journal of Agriculture and Food Research 100190.

[12] JR Harlan and P Gepts, (eds), *Biodiversity in Agriculture: Domestication, Evolution, and Sustainability* (Cambridge University Press 2012) 23.

[13] P Fitzgerald-Moore and BJ Parai, *The Green Revolution* (University of Calgary 1996) 1-7.

[14] RE Evenson, *From the Green Revolution to the Gene Revolution* (CABI Publishing 2002) 1–16.

[15] J Clapp and SL Ruder, 'Precision Technologies for Agriculture: Digital Farming, Gene-Edited Crops, and the Politics of Sustainability' (2020) 20 (3) Global Environmental Politics 49-69.

[16] ibid 51.

of sustainable agriculture, which emphasises soil health, ecological balance, and resource conservation in response to climate change and the need for food security.[17] The development of agriculture is evidence of human resourcefulness and flexibility and agriculture has continuously changed to satisfy the shifting demands of society, starting with the early domestication of plants and animals and continuing with contemporary technological advancements. The task ahead, therefore, will be to create sustainable farming methods that can feed the world's expanding population such as chemical contamination, soil deterioration, and water depletion.[18]

Development of Regenerative Agriculture

Regenerative agriculture emerged in response to concerns about soil erosion and degradation.[19] Established as a comprehensive farming approach, it emphasises biodiversity, soil health, and sustainable agricultural methods. Its origins can be traced to conventional farming practices that prioritised ecological balance.[20] In response to the negative social and environmental effects of industrial agriculture, contemporary regenerative agriculture emerged and has served to advance sustainable agriculture. Growing awareness of climate change and the need for sustainable food systems has given the movement a boost in recent years. To enhance soil health and lower erosion, this strategy placed a strong emphasis on crop rotations, stubble retention, multispecies cover crops, permanent soil cover, rotational grazing and minimum soil disturbance.[21] What would eventually be referred to as regenerative agriculture was founded on the ideas of conservation agriculture.[22]

Evolution of Forestry

The history of forestry as both a practice and a science, can be traced back to the dawn of human civilization when early humans relied on forests for survival. Initially, forests were primarily a source of fuel, building materials, and food.[23] The relationship between humans and forests was largely exploitative, with little understanding of sustainable forestry practices.[24] Ancient civilizations began to recognize the importance of forests and implemented early forms of forest management. These early efforts were often driven by the need to ensure a stable supply of wood for construction, fuel, and other uses. However, it wasn't until the medieval period in Europe that more systematic forest management practices began to emerge.[25] During

[17] N Khan and others, 'Current Progress and Future Prospects of Agriculture Technology: Gateway to Sustainable Agriculture' (2021) 13 (9) Sustainability 4883.
[18] BN Floye and IJ Ekpoh, 'Transforming Traditional Agriculture: Historical Background to Modern Agricultural Development in Nigeria' (2007) 6 (2) Global Journal of Social Sciences 97-102.
[19] KW Butzer, 'Environmental History in the Mediterranean World: Cross-Disciplinary Investigation of Cause-and-Effect for Degradation and Soil Erosion' (2005) 32 (12) Journal of Archaeological Science 1773-800.
[20] Khangura and others (n 5).
[21] Livelihood Funds, 'Regenerative Agriculture: From the Key Principles to the Practice' https://livelihoods.eu/regenerative-agriculture-from-key-principles-to-practice/ accessed 25 June 2024.
[22] KE Giller and J Sumberg, 'Regenerative Agriculture: An Agronomic Perspective' (2021) 50 (1) Outlook on Agriculture 13-25.
[23] P Dauvergne and KJ Neville, 'Forests, Food, and Fuel in the Tropics: The Uneven Social and Ecological Consequences of the Emerging Political Economy of Biofuels' in *The Politics of Biofuels, Land and Agrarian Change* (Routledge 2013) 57-86.
[24] ibid.
[25] BE Fernow, *A Brief History of Forestry: In Europe, the United States and Other Countries* (DigiCat 2022) 29.

this time, regulations were introduced to control the use of forest resources and designated forest officers were appointed to enforce these rules.[26]

The modern science of forestry began to take shape in the 18th and 19th centuries.[27] The need for a reliable timber supply for shipbuilding and other industries led to the development of formal forestry education and research institutions laying the groundwork for sustainable forest management practices and emphasising the importance of balancing timber production with forest conservation. The concept of multi-use forestry, which considers forests for their multiple benefits beyond timber, such as wildlife habitat, water conservation, and recreation, gained prominence in the 20th century.[28] This holistic approach was driven by a growing awareness of environmental issues and the recognition of the vital ecosystem services that forests provide. The establishment of national parks and protected areas also highlighted the need to preserve forests for biodiversity and ecological health.[29]

In the 1970s, the global perspective on forestry began to shift significantly due to increasing awareness of deforestation and its impacts on climate change, biodiversity, and indigenous communities. International organizations such as the Food and Agriculture Organization (FAO) and various environmental NGOs started to play a crucial role in promoting sustainable forest management practices. Policies began to incorporate the needs and rights of local communities, recognizing that sustainable forestry must also address social and economic dimensions.[30]

Technological advancements in the late 20th and early 21st centuries such as Geographic Information Systems (GIS), remote sensing, and other digital tools have enabled more precise and efficient forest management.[31] These technologies allow for better monitoring of forest health, more accurate assessment of forest resources, and improved planning for conservation and sustainable use. Currently, forestry encompasses a broad range of activities and objectives. Modern forestry practices aim to balance the economic benefits of timber production with the ecological and social functions of forests. Sustainable forest management seeks to ensure that forest resources are available for future generations while maintaining the health and diversity of forest ecosystems. This approach is increasingly vital as forests play a crucial role in mitigating climate change, preserving biodiversity, and supporting the livelihoods of millions of people worldwide.

[26] R Sands, (ed), *Forestry in a Global Context* (CABI 2013) 12.
[27] T Związek and others, 'Addressing Multiple Perspectives in Studying Environmental Changes in Forest Landscapes During the Modernization Period (18th–19th Centuries)' (2023) 30 The Anthropocene Review 6.
[28] ibid.
[29] E Kula, (ed), *The Economics of Forestry: Modern Theory and Practice* (Springer Science & Business Media 2012).
[30] K Kumar, SN Phukon and H Singh, 'The Role of Communities in Sustainable Land and Forest Management' in *Forest Resources Resilience and Conflicts* (Elsevier 2021) 305-318.
[31] SA Nitoslawski and others, *The Digital Forest: Mapping A Decade of Knowledge on Technological Applications for Forest Ecosystems* (2021) 9 (8) Earth's Future 10.

The history of forestry has always followed the growth of agriculture. Early forestry management techniques were used by ancient civilizations, to guarantee a consistent supply of wood and other forest products. Cultural, economic, and environmental influences have shaped these practices over centuries. The detrimental effects of industrial agriculture, such as soil erosion, biodiversity loss, and chemical contamination, gave rise to regenerative agriculture. By adding new methods targeted at improving and restoring the general health of agricultural ecosystems, it expands on conservation agriculture. Cover crops, low tillage, varied crop rotations, and livestock integration are important regenerative agriculture techniques.[32] As global challenges such as climate change and biodiversity loss intensify, the role of forestry in ensuring a sustainable future becomes ever more critical.

Emergence of Regenerative Forestry

Regenerative forestry is a progressive method of managing forests which seeks to improve and restore the productivity, biodiversity, and overall health of forest ecosystems. It aims to establish sustainable systems that benefit human communities as well as the environment, as opposed to traditional forestry which frequently concentrates on the short-term financial rewards from timber extraction.[33] As a concept, regenerative forestry places a strong emphasis on cultivating resilience against climate change and actively restoring ecological processes. These techniques are achieved by applying two methods; assisted natural regeneration (where human intervention supports the process by doing things like keeping young trees from grazing or planting native species in degraded areas)[34] and natural regeneration (which uses the forest's seeds and resources to grow new trees).[35]

Large-scale restoration is one of the main advantages of regenerative forestry. Cost-effective natural regeneration can restore ecosystem services including carbon sequestration, water filtering, and wildlife habitat provision. Furthermore, it enhances ecosystem resilience by supporting the survival of a wide range of plant and animal species, thereby promoting biodiversity.[36]

Additionally, in line with the concepts of ecosystem services, regenerative forestry makes sure that forests offer advantages beyond just timber. In addition to non-timber forest products like berries and mushrooms, these also include recreational areas and cultural values. Regenerative forestry promotes a comprehensive method of land management by combining these many goals.[37]

Practically speaking, nations have instituted laws and procedures that promote forest regeneration via both natural and artificial means.[38] Among these methods are Using seeds or planting procedures to restore

[32] Giller and Sumberg (n 22).
[33] CE Prescott, 'Perspectives: Regenerative Forestry–Managing Forests for Soil Life' (2024) 554 Forest Ecology and Management 121674.
[34] L Ciccarese and others, *Ecosystem Services from Forest Restoration: Thinking Ahead* (New Forests 2012) 43, 547.
[35] ibid.
[36] LV Rasmussen and others, 'Forest Regrowth Improves People's Dietary Quality in Nigeria' (2023) 1(1) Sustainable Agriculture 3.
[37] Ciccarese and others, (n 34).
[38] J Sayer and others, 'The Restoration of Forest Biodiversity and Ecological Values' (2004) 201 (1) Forest Ecology and Management 3-11.

forests after felling operations are carefully planned. In doing so, the ecological equilibrium is preserved and the perpetual replenishment of forest resources is guaranteed.[39]

A relatively recent idea, regenerative forestry expands on the ideals of ecological and sustainable forestry. Replanting with a variety of native species, restoring the soil, conducting controlled burns to replicate natural fire cycles, and participation of the community in forest management. These methods aim to build forests that can offer a variety of ecosystem services and are more resistant to climate change and Biodiversity loss. Regenerative forestry, therefore, signifies a radical change in the way forest ecosystems are engaged with and managed.

Synergies Between Regenerative Forestry and Agriculture

Regenerative Forestry and Agriculture share many core concepts and goals, such as improving soil health, increasing biodiversity, and growing ecosystem services. When these techniques are combined, positive synergies can be produced for the forest and agricultural areas. For example, agroforestry, which cultivates both trees and crops on the same plot of land, can improve agricultural productivity, biodiversity, and soil health. In contrast, silvopasture, or the coexistence of livestock with trees, has the potential to improve carbon sequestration, improve animal welfare, and provide additional sources of income.[40]

By incorporating trees into agricultural systems, *regenerative forestry and agriculture* work together to improve resilience, biodiversity, and ecosystem services. Planting trees in agricultural environments to maximise land use, minimise erosion, improve soil fertility, and sequester carbon is commonly referred to as agroforestry.[41] Agroforestry techniques foster the advancement of sustainable agricultural systems that support crop production as well as the preservation of forests, supporting several Sustainable Development Goals (SDGs) and encouraging a comprehensive approach to land management.[42]

The Role of Indigenous Knowledge

Regenerative Forestry and Agriculture have been practised by Indigenous peoples for a long time, employing methods including natural insect control, controlled burning, and polyculture.[43] More people are realising the benefits of these age-old methods for sustainable land management. The effectiveness of regenerative techniques can be improved, and more inclusive and equitable land management can be promoted, by fusing indigenous knowledge with contemporary scientific methods. Indigenous knowledge is essential to regenerative agriculture because it offers time-tested, environmentally friendly methods that improve ecosystem resilience, biodiversity, and soil health. These age-old practices, have their roots in

[39] ibid, 5.
[40] MV Noordwijk, 'Agroforestry as Nexus of Sustainable Development Goals' in *IOP Conference Series: Earth and Environmental Science* 449 (1) (IOP Publishing 2020) 012001.
[41] CR Elevitch, DN Mazaroli and D Ragone, 'Agroforestry Standards for Regenerative Agriculture' (2018) 10 (9) Sustainability 3337.
[42] MV Noordwijk and others, 'SDG Synergy Between Agriculture and Forestry in the Food, Energy, Water and Income Nexus: Reinventing Agroforestry? (2018) 34 Current Opinion in Environmental Sustainability 33-42.
[43] 'The Indigenous Roots of Regenerative Agriculture' https://www.rainforest-alliance.org/insights/the-indigenous-roots-of-regenerative-agriculture/#:~:text=While%20a%20new%20wave%20of,than%20a%20thousand%20years%20ago. accessed 25 June 2024.

centuries of observation and modification and strongly correspond with the tenets of regenerative agriculture.[44] Some of these roles are discussed below,

Soil Health and Fertility: Crop rotation, intercropping, and the application of organic fertilisers are examples of indigenous practices that enhance soil fertility and structure. As an example, it has been demonstrated that the Amazonian tribes' usage of biochar, or "terra preta," greatly improves the nutrient content and retention of soil.[45]

Biodiversity: Diverse plant species are frequently incorporated into indigenous farming systems, aiding in the management of pests and diseases as well as fostering ecosystem stability. By imitating natural ecosystems, this polyculture strategy increases resistance to environmental stressors.[46]

Water Management: Conventional methods of managing water, such as terracing and building catchments, are efficient in preserving water and halting soil erosion. These techniques are especially important in dry and semi-arid areas where a major problem is a lack of water.[47]

Climate Adaptation: Communities can create adaptable plans for climate fluctuation thanks to indigenous knowledge, which includes a thorough awareness of regional climates and ecosystems. To protect against extreme weather events, this can involve choosing crops resistant to drought or putting in place agroforestry techniques.[48]

Cultural Integration: By incorporating indigenous cultural practices and beliefs, regenerative agriculture promotes a sense of responsibility and a connection to the land. Long-term sustainability and community well-being are supported by this all-encompassing viewpoint.[49]

Knowledge Sharing and Innovation: Creative solutions for sustainable food production are produced through the combination of contemporary regenerative techniques with indigenous knowledge. New methods that are both culturally and scientifically suitable may result from this partnership.[50]

Regenerative forestry and agriculture may improve the efficacy and sustainability of agricultural systems

[44] M Cairns, (ed) *Voices from the Forest: Integrating Indigenous Knowledge into Sustainable Upland Farming* (Taylor & Francis 2010).
[45] 'Why Indigenous Traditional Knowledge is Key for Adopting Regenerative Agriculture' https://www.renature.co/articles/indigenous-traditional-knowledge-regenerative-agriculture/ accessed 25 June 2024.
[46] 'The Indigenous Roots of Regenerative Agriculture' https://www.rainforest-alliance.org/insights/the-indigenous-roots-of-regenerative-agriculture/ accessed 25 June 2024.
[47] BH Moyo, *The Use and Role of Indigenous Knowledge in Small-Scale Agricultural Systems in Africa: The Case of Farmers in Northern Malawi* (Doctoral Dissertation, University of Glasgow 2010).
[48] 'Harnessing the Power of Indigenous Knowledge in Regenerative Agriculture' https://ecolonomics.org/harnessing-the-power-of-indigenous-knowledge-in-regenerative-agriculture/ accessed 25 June 2024.
[49] H Arledge, 'Discover the Roots of Regenerative Agriculture in Indigenous Cultures' https://plantwithpurpose.org/indigenous-regenerative-agriculture/ accessed 25 June 2024.
[50] M Manshanden and others, *Regenerative Agriculture in Europe: An Overview Paper on the State of Knowledge and Innovation in Europe* (Wageningen Economic Research 2023); A French, 'Regenerative Agriculture and Knowledge Sharing' https://www.agritecture.com/blog/2019/1/29/regenerative-agriculture-and-knowledge-sharing accessed 25 June 2024.

and guarantee their productivity and resilience for future generations by acknowledging and utilising indigenous knowledge.

Core Components of Regenerative Practices

Soil Health: Recognising that healthy soil is the cornerstone of resilient and productive ecosystems, regenerative methods place a high priority on its restoration. Techniques like no-till farming, cover crops, and the use of organic composts have the advantage of increasing soil organic matter, improving soil structure, improving water retention, and increasing nutrient availability.[51]

Biodiversity: Enhancing biodiversity is a fundamental objective of regenerative methods. Increased biodiversity promotes ecosystem resilience and health. This is achieved through a variety of farming practices, including varied crops, polycultures, agroforestry systems, and the incorporation of animals.[52]

Water Management: Managing water resources well is essential to keeping ecosystems robust. By utilising techniques like contour ploughing, swales, and riparian buffer zones, regenerative practices seek to increase soil water infiltration and retention, decrease runoff and erosion, and restore natural water cycles.[53]

Carbon Sequestration: Given that regenerative methods store carbon in soils and biomass, they assist in slowing down the impact of climate change. Reforestation, afforestation, and the use of biochar are examples of practices that help absorb and store carbon from the atmosphere, lowering the concentrations of greenhouse gases.[54]

The Climate Emergency and Biodiversity Decline

Long-term changes in Earth's temperature, precipitation, and other atmospheric factors are referred to as climate change. The primary reason for these alterations is human actions that increase the levels of greenhouse gases in the atmosphere, including the combustion of fossil fuels, deforestation, and industrial operations. These reasons exacerbate naturally occurring events such as prevailing winds, ocean currents, land and water distributions, atmospheric temperature etc. Some of the numerous detrimental effects of climate change include rising global temperatures, an increase in the frequency and intensity of extreme weather events, a rise in sea level, and disruptions to ecosystems and human civilizations.[55]

[51] Newton and others (n 3).
[52] LV Gibbons, 'Regenerative—The New Sustainable?' (2020) 12 Sustainability (13) 3.
[53] DP Loucks, 'Sustainable Water Resources Management' (2000) 25 (1) Water International 3-10.
[54] Ciccarese and others (n 34).
[55] KR Shivanna, 'Climate Change and Its Impact on Biodiversity and Human Welfare' Proceedings of the Indian National Science Academy Part A, (2022) 88 (2) Physical Sciences 160-171.

Biodiversity is the term used to describe the diversity of life on Earth, including species, ecosystems, and genetic variation within species. Biodiversity is vital to ecosystems because it performs tasks including pollination, pest control, nutrient cycling, and climate management, basically, biodiversity ensures that the cycle of life continues as it facilitates the function of each aspect of nature which depends on each other to sustain the existence of nature.[56] However, biodiversity is decreasing at an alarming rate due to invasive species, pollution, overexploitation, habitat loss, and climate change. This loss has a major influence on both the health of the environment and human well-being.[57]

Intersectionality of Climate Change and Biodiversity

There is a close connection between climate change and declining biodiversity. By disrupting ecosystems, changing ecological balances, and raising the frequency and intensity of catastrophic weather events, climate change exacerbates biodiversity loss.[58] In contrast, ecosystems' capacity to store carbon and control the temperature is diminished by biodiversity loss, which causes a feedback loop that contributes to both crises.[59] In other words, climate change undermines the ability of ecosystems to function at the capacity required to sustain their natural function of maintaining the cycle of life effectively. Some of the ways in which climate change and biodiversity decline intersect are briefly discussed below.

Impact on species and ecosystems: Individual species are greatly impacted by climate change, which modifies their interactions, habitats, reproduction rate and style and rates of survival. The disruption of ecosystem structures and functions resulting from these changes leads to a decline in ecosystem services and a loss of biodiversity.[60]

Differential Vulnerability: Due to their distinct traits and ecological responsibilities, different species and ecosystems react to climate change in different ways, according to an intersectional approach. These reaction to climate change are mostly negative, resulting in biodiversity decline. By adopting regenerative strategies, the most vulnerable groups can be identified and conservation activities can be prioritised appropriately.[61]

Socio-ecological Interconnections: Beyond its effects on the environment, intersectionality takes into account how social constructs like gender, class, and cultural background affect how people interact with

[56] T Elmqvist and others, 'Biodiversity, Ecosystems and Ecosystem Services. In *The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations* (Routledge 2012) 41-111; DS Maier, *What's So Good about Biodiversity?* (Springer 2012) 71; U Rawat and NK Agarwal, 'Biodiversity: Concept, Threats and Conservation' (2015) 16 (3) Environment Conservation Journal 19-28.

[57] Syngenta Group, 'Regenerative Agriculture: Where Innovation Meets Tradition' https://www.syngentagroup.com/regenerative-agriculture accessed 26 June 2024.

[58] A Arneth and others, 'Post-2020 Biodiversity Targets Need to Embrace Climate Change' (2020) 117 (49) Proceedings of The National Academy of Sciences 91.

[59] ibid.

[60] SR Weiskopf and others, 'Climate Change Effects on Biodiversity, Ecosystems, Ecosystem Services, and Natural Resource Management in the United States (2020) 733 Science of the Total Environment 3-5.

[61] A Kaijser and A Kronsell, 'Climate Change through the Lens of Intersectionality' (2013) Environmental Politics 1 -14.

biodiversity. This all-encompassing perspective is essential for creating inclusive and successful climate adaptation plans. Intersectionality, climate change, and women are possible references.[62]
From the fore-going therefore, climate change actions which bring about high concentration of Greenhouse gases, rising global temperature, frequent and severe weather events, increase in sea level and ecosystem alteration, affect Biodiversity. This becomes evident in the migration of invasive species, pollution, overexploitation, habitat loss etc. and causes ecosystem disruption, ecological imbalance and more severe and catastrophic weather events.

Regenerative Practices as a Response to climate change and biodiversity decline

A promising way to resolve the twin crises of declining biodiversity and climate change is through regenerative practices. The natural mechanisms that sustain soil health, carbon sequestration, and ecosystem resilience are restored and enhanced by these approaches.[63] Regenerative agriculture uses practices including crop rotation, cover crops, and reduced tillage to increase soil fertility, water retention, and biodiversity. This contrasts with conventional agricultural methods, which frequently degrade soil and decrease biodiversity.[64] Regenerative methods promote agricultural output and mitigate climate change by collecting atmospheric carbon and improving ecosystem services. They also foster diverse plant and microbial life and increase organic matter.[65] As the world looks for long-term answers to environmental problems, regenerative agriculture stands out as a practical tactic to fight climate change and safeguard biodiversity. Therefore, regenerative practices create positive responses as discussed below.

Mitigating Climate Change

Regenerative forestry and agriculture techniques can improve ecosystem resilience, lower greenhouse gas emissions, and sequester carbon, all of which can greatly aid in the mitigation of climate change. While no-till farming, cover crops, and the use of organic amendments aid in preserving and enhancing soil health and improve soil carbon sequestration, practices like afforestation, reforestation, and agroforestry boost the storage of carbon in plants and soils.[66] In order to minimise soil erosion and reduce the need for irrigation, healthy soils retain more water and store more carbon. Furthermore, including trees in agricultural practices enhances soil structure, biodiversity, and carbon sequestration. In absorbing CO2 and storing it in biomass and soil, trees function as carbon sinks. It is trite that eliminating synthetic pesticides and fertilisers and adopting organic farming lowers emissions of nitrous oxide. Regenerative forestry and agriculture techniques concentrate on restoring plant life and soil, which increases the amount of carbon dioxide that

[62] ibid.
[63] G Cusworth and T Garnett, *What is Regenerative Agriculture?* (TABLE, University of Oxford, Swedish University of Agricultural Sciences and Wageningen University and Research 2023) 3.
[64] P Rovný, P Barát and K Bírová, 'Opportunities and Obstacles of Regenerative Agriculture 120', being a presentation at the Sustainable, Resilient and Fair Food Systems in the EU and Globally International Scientific Symposium, Bratislava – Nitra, October 6-7, 2022; T Gomiero, D Pimentel and MG Paoletti, 'Environmental Impact of Different Agricultural Management Practices: Conventional vs Organic Agriculture' (2011) 30 (1-2) Critical Reviews in Plant Sciences 95-124.
[65] Q Soomro, 'Regenerative Agriculture' https://medium.com/@qasim__soomro/regenerative-agriculture-333a32f97551 accessed 25 June 2024; 'Regenerative Agriculture Practices' https://albertawater.com/wc1-regenerative-agriculture-practices/ accessed 25 June 2024.
[66] Ciccarese and others (n 34).

is drawn from the atmosphere and lowers greenhouse gas (GHG) emissions. This can play significant roles in the global effort to reduce the impact of climate change by implementing these regenerative methods

Enhancing Biodiversity

Regenerative agriculture and forestry increase biodiversity by using methods that support a variety of plant and animal life, strengthen and maintain ecosystems, and improve soil health.[67] These methods are intended to build productive, resilient landscapes that can tolerate changes in the surrounding environment. Through the creation of robust and varied ecosystems, regenerative practices support biodiversity. Ecosystems are stabilised and function better when a diversity of animal and plant species is sustained through polycultures, agroforestry systems, and integrated livestock operations. Reforestation, habitat restoration, and the establishment of wildlife corridors are methods of restoring degraded areas that contribute to ecosystem health and biodiversity preservation.[68] Keeping forests diverse in terms of species and ages of trees encourages structural complexity and gives wildlife a variety of habitats. To preserve this diversity, methods such as selective logging and spontaneous regeneration can be adopted.

These regenerative methods improve soil health by raising soil organic matter, strengthening soil structure, and boosting microbial diversity thereby fostering a greater variety of plant and animal life. In the inclusion of trees and shrubs in agricultural landscapes, habitats for a variety of species are created, carbon sequestration is increased, and ecosystems are stabilised. Pollinator habitats are improved, pest and disease outbreaks are decreased, and overall ecosystem health is improved by planting a diversity of crops and using polycultures. Creating wildlife corridors inside of agricultural areas permits the safe migration of species and the interchange of genetic material, both of which are essential to the preservation of robust populations. In addition to improving total biodiversity, these corridors link disparate habitats and enhances ecosystem resilience and biodiversity. These regenerative methods are intended to build productive, resilient landscapes that can tolerate changes in the surrounding environment.

Improving Food Security

By boosting crop yields, enhancing crop resilience to climate change, and promoting soil health, fostering sustainable agricultural methods, and building resilient ecosystems, regenerative agriculture can greatly improve food security. Higher and more consistent crop yields are supported by high amounts of organic matter in healthy soils, which also boost water and nutrient retention and productivity. Crop failure is less likely in diverse farming systems because they are more resistant to pests, illnesses, and extreme weather.[69]

[67] B Levin, 'Regenerative Agriculture as Biodiversity Islands' in *Biodiversity Islands: Strategies for Conservation in Human-Dominated Environments* (Cham: Springer International Publishing 2022) 61-88
[68] Newton and others (n 3).
[69] Syngenta Group (n 57).

Therefore, sustainable food production depends on the restoration of natural processes and biodiversity, which is the main goal of these approaches.

Case Studies from Developing Nations

This section takes a cursory look at some countries that have adopted regenerative practices in response to climate change and biodiversity decline arising from agricultural activities.

Nigeria

In Nigeria, regenerative agriculture aims to improve water management, biodiversity, and soil health. This method relies heavily on techniques like agroforestry, crop rotation, low tillage, and cover crops. Crop rotation aids in disrupting insect cycles and enhancing soil fertility, whereas cover cropping is planting particular crops to preserve and improve the soil.[70] By minimising soil disturbance, minimal tillage preserves soil structure and carbon sequestration. Agroforestry increases biodiversity and gives farmers extra revenue sources by incorporating trees and shrubs into agricultural settings.[71]

Initiatives by the Nigerian government and groups like *Babbangona* seek to advance these methods to stop land degradation and increase food security. These initiatives are vital because they strengthen farming systems' resilience while also addressing environmental issues.[72] These initiatives are vital because they strengthen farming systems' resistance to climate change while simultaneously addressing environmental issues.[73] Regenerative agriculture offers a way forward for sustainable development in Nigeria by promoting sustainable farming practices and restoring soil health, thereby supporting ecological balance and agricultural productivity.[74]

Kenya: Agroforestry and Sustainable Agriculture

Agroforestry practices have been successfully integrated into Kenyan agricultural systems to increase food security, improve soil health, and increase biodiversity.[75] The Movement for Green Belts, founded by Nobel laureate Wangari Maathai, supported planting trees and sustainable land management techniques. In

[70] MA Ibe and others, 'Agriculture, Forestry and Climate Change: An Imperative for Sustainable Development' (2023) 21 (2) Journal of Agriculture and Food Sciences 13-24.
[71] OP Agboola and others, 'Built Environment Transformation in Nigeria: The Effects of A Regenerative Framework' (2024) 23(2) Journal of Asian Architecture and Building Engineering 789-812.
[72] B Dougherty, 'Regenerative Agriculture: The Path to Healing Agroecosystems and Feeding the World in the 21st Century' *A Report for Nuffield International Farming Scholars* (Nuffield International Project 2019 Sep) (1801) 45.
[73] Ibe and others (n 70).
[74] A Adeite, 'All You Should Know About Regenerative Agriculture' https://babbangona.com/all-you-need-to-know-about-regenerative-agriculture/ accessed 3 June 2024.
[75] S Ndung'u and others, 'Adoption of Agroforestry as a Climate Smart Agriculture Practice Among Smallholder Farmers in Kakamega County, Kenya' (2023) 4 (2) African Journal of Empirical Research 1169.

addition to improving agricultural output and restoring degraded areas, these initiatives have also significantly reduced carbon emissions, which helps to mitigate climate change.[76]

India: Regenerative Agriculture for Climate Resilience

Regenerative agricultural techniques, like crop diversification, zero-till farming, and the application of organic amendments, have been adopted in India to improve soil health and increase climate change resilience.[77] These methods have helped farmers maintain and boost crop yields despite difficult weather conditions, and they have been especially helpful in areas vulnerable to drought and soil degradation.[78] The potential of regenerative agriculture to enhance food security and promote sustainable development has been shown by the advocacy of these methods by groups like the Deccan Development Society.[79]

Brazil: Sustainable Forest Management

Regenerative forestry has been implemented as part of Brazil's efforts to minimise deforestation and promote sustainable forest management. Reforestation, forest conservation, and the sustainable use of forest resources have been aided by initiatives like the Amazon Fund and the Bolsa Floresta Programme.[80] Regenerative forestry can address environmental concerns in underdeveloped countries, as seen by these efforts that have helped restore damaged lands, preserve biodiversity, and reduce greenhouse gas emissions.[81]

Regenerative Forestry and Agriculture: Challenges and Opportunities

Barriers to Implementation

Lack of Awareness and Knowledge: Many farmers and land managers especially in developing nations may not be familiar with regenerative practices or lack the knowledge and skills to implement them effectively.[82] This includes understanding the benefits and the specific techniques needed, which vary by region and ecosystem. The adoption of regenerative techniques is hampered by the lack of easily understandable

[76] L Erdős, 'A Passion for Trees–Wangari Maathai and the Green Belt Movement' in *Green Heroes: From Buddha to Leonardo DiCaprio* (Springer 2019) 181-5.
[77] S Olsson and others, 'Framework for a Collective Definition of Regenerative Agriculture in India' (2022) 5 (1) Ecology, Economy and Society–the INSEE Journal 23-30.
[78] A Begam and others, 'Combating the Effects of Climate Change through Regenerative Organic Agriculture' in *Regenerative Agriculture* (CRC Press 2024) 180-192.
[79] Newton and others (n 3).
[80] U Flossmann-Kraus, *The Political Economy of Climate Finance in Brazil: How Actors and Their Ideas Shape Institutions. the Case of the Amazon Fund and the ABC Programme for Low-Carbon Agriculture* (LIT Verlag Münster 2023) 348; J Börner and others, *Promoting Forest Stewardship in The Bolsa Floresta Programme: Local Livelihood Strategies and Preliminary Impacts* (Centre for International Forestry Research 2013).
[81] RAL da Silva and others, 'Brazilian Forest-Based Sector Perceptions and Contributions to the Sustainable Development Goals (SDGs)—Developing Strategies Using the Strategic Options Development and Analysis (SODA) Approach. (2024) 15 (1) Forests 198.
[82] LA Schulte and others, 'Meeting Global Challenges with Regenerative Agriculture Producing Food and Energy' (2021) 5 (5) Nature Sustainability 384.

information about them. Farmers sometimes rely on conventional, less sustainable practices because they lack the resources to learn about new ones. This could create uncertainty as to how to apply regenerative practices successfully due to the variety of certification alternatives and the lack of standardised criteria.

Lack of training options and educational programmes could worsen the chances of the effective implementation of regenerative techniques. Farmers that lack the necessary knowledge are less likely to implement regenerative agricultural practices because they are unable to completely comprehend or believe in the advantages of these techniques. To successfully implement regenerative forestry and agriculture, addressing these issues calls for coordinated efforts to raise awareness, standardise procedures, and offer farmers strong support networks.

Financial Constraints: Implementing regenerative practices often requires initial investments in training, equipment, and inputs, which can be a barrier for resource-constrained farmers.[83] Many farmers need assistance to finance the significant initial investments in new equipment, training, and infrastructure that the switch to regenerative techniques frequently necessitates. Lack of access to funding, obtaining loans or grants to fund regenerative initiatives is a challenge for many farms. Investments in activities viewed as high-risk or having erratic returns are sometimes met with resistance from financial institutions. This is usually attributed to market uncertainty as not all farmers have consistent access to or reliability in the voluntary carbon market, which offers financial incentives through the selling of carbon offsets. Farmers may find it challenging to plan and commit to long-term regeneration techniques because of this unpredictability. Furthermore, as farmers desire quick financial returns on their land, financial crises and unstable economies can cause deforestation and unsustainable farming practices. To overcome these financial obstacles, supportive financial tools including grants, subsidies, and low-interest loans must be created. Without sufficient funding or incentives, adopting these methods can be financially difficult for farmers and landowners as they frequently come with large upfront expenditures. Additionally, market incentives that promote the adoption of regenerative practices must be created.

*Policy and Institutional Barriers***:** Inadequate policies and institutional support can hinder the adoption of regenerative practices. This includes a lack of incentives for sustainable land management and insufficient integration of regenerative practices into national and regional development plans.[84] The promotion and support of regenerative techniques is frequently neglected in favour of conventional wood production and traditional forest management.[85] Getting the required permits, following rules, and getting access to markets come at a high cost, which prevents agroforestry from being widely adopted. Agricultural policies in some areas may conflict with environmental objectives, leading to misunderstandings and decreasing the efficacy

[83] Syngenta Group (n 57).
[84] Schulte and others (n 82).
[85] P Weston and others, 'Farmer-Managed Natural Regeneration Enhances Rural Livelihoods in Dryland West Africa' (2015) 55 (6) Environmental Management 1402-17.

of regenerative techniques.[86] The promotion of sustainable methods, for instance, may be hampered by subsidies and incentives for conventional agriculture. Strong institutional support, including extension services and knowledge sharing, is necessary for the effective implementation of regenerative techniques. Farmers' capacity to implement these methods is hampered by the lack of reliable consulting services and region-specific information. Farmers may be discouraged from using regenerative methods due to the possibility that they won't be able to sell their goods profitably. To overcome these obstacles, regenerative forestry and agriculture practices must be promoted through targeted support, improved institutional frameworks, and thorough dependable policy reform.[87]

Technical Challenges: Regenerative practice implementation might be difficult and need specialised technical knowledge and abilities.[88] One of the biggest obstacles to regenerative agriculture can be the absence of extension services and research tailored to the needs of the local farmers.[89] Without the right guidance and assistance, many farmers may find it challenging to apply regenerative techniques, which call for a thorough understanding of ecosystem interactions. A lot of farmers, particularly those in developing nations, do not have access to the cutting-edge instruments and technologies required to properly monitor and oversee regenerative practices.[90] Farmers' adoption of regenerative practices is hampered by a general lack of knowledge and comprehension of these techniques. Without depending on traditional chemical inputs, regenerative agriculture has difficulties controlling pests, illnesses, and invasive species. Sturdy mechanisms for tracking and confirming environmental effects are necessary for the successful use of regenerative methods. These systems can be resource- and technically-intensive. To help farmers implement and maintain regenerative forestry and agricultural practices, improving training programmes, expanding access to technology, and fortifying support networks are imperative in addressing these technical obstacles.[91]

Opportunities for Scaling Up

As much as there are challenges to the implementation of regenerative forestry and agriculture practices, there are also ample opportunities to take advantage of these promising strategies to regain control of land and agricultural resources. Some of these opportunities are outlined below.

Capacity Building and Education: The broad implementation of regenerative methods can be aided by raising awareness and knowledge of them through training initiatives, extension services, and farmer-to-farmer learning.

[86] N Schaller, 'The Concept of Agricultural Sustainability' (1993) 46 (1-4) Agriculture, Ecosystems & Environment 89-97; K Oltmer, *Agricultural Policy, Land Use and Environmental Effects* (Studies in Quantitative Research Synthesis 2003) 55.
[87] MS Ashton and MJ Kelty, *The Practice of Silviculture: Applied Forest Ecology* (John Wiley & Sons 2018) 101.
[88] P Rovný, P Barát and K Bírová, 'Opportunities and Obstacles of Regenerative Agriculture 123, being a presentation at the Sustainable, Resilient and Fair Food Systems in the EU and Globally International Scientific Symposium, Bratislava – Nitra, October 6-7, 2022.
[89] Schulte and others (n 82).
[90] SH Muhie, 'Novel Approaches and Practices to Sustainable Agriculture' (2022) 10 Journal of Agriculture and Food Research 6.
[91] S Lockie and others, *The Future of Agricultural Technologies* (Australian Council of Learned Academies (ACOLA) (2020)) 26.

Financial Support and Incentives: Grants, subsidies, and loan availability are examples of financial incentives that can assist farmers and land managers in covering the upfront expenses associated with implementing regenerative methods.[92]

Policy and Institutional Support: Adoption of these practices can be aided by the creation of institutions and policies that are supportive of them, such as regenerative practice integration into national development plans and incentives for sustainable land management.[93]

Research and Innovation: Regenerative practices can be developed and tailored to local conditions by funding research and innovation, which will increase their efficacy and encourage adoption. This involves creating methods, tools, and systems for regenerative forestry and agriculture that are suitable for the local environment.

Conclusion

Regenerative forestry and agriculture techniques present a viable solution to the dual problems of climate change and declining biodiversity in developing countries. Sustainable development and improved food security can be achieved through these techniques, which also promote biodiversity, strengthen resistance to climate change, and restore soil health. However, for them to be widely used, several obstacles must be removed because despite the potential benefits, regenerative forestry and agriculture face several challenges. These include restrictions on policy, illiteracy and ignorance, and financial barriers.[94] Making the transition to regenerative practices can be challenging and often requires an initial financial commitment for small-scale farmers and foresters. It is also essential to have laws and incentives that promote regenerative practices and recognise their long-term benefits.[95] Developing countries may leverage the potential of regenerative techniques to establish resilient and sustainable landscapes through investments in research and innovation, financial incentives, capacity building, and supportive legislation.

Regenerative forestry and agriculture in the future would require greater research and innovation, better integration of traditional and scientific knowledge, and more policy support. Regenerative approaches can potentially be more effective because of technological advancements like precision agriculture and remote sensing. Collaboration between farmers, foresters, academics, lawmakers, and communities will ultimately be necessary for regenerative forestry and agriculture.[96] Overall, the history and evolution of regenerative forestry and agriculture demonstrate a growing awareness of the need for sustainable and restorative methods of land management. These efforts, from the earliest days of forestry and agriculture to the modern

[92] Syngenta Group (n 57).
[93] Newton and others (n 3).
[94] M Jastrzębska and M Kostrzewska and A Saeid, 'Sustainable Agriculture: A Challenge for the Future' in *Smart Agrochemicals for Sustainable Agriculture* (Academic Press 2022) 29-56.
[95] ibid, 32.
[96] Giller and Sumberg (n 22).

concepts of regeneration, have evolved in response to societal demands and environmental challenges such as climate change and biodiversity decline. Along with incorporating traditional practices and integrating ecological understanding, regenerative agriculture and forestry and other approaches build upon the principles of conservation.