



Regenerative Agriculture: Pathways to Climate-Resilient Farming Systems

*Anik Chandel¹ and Sharul²

¹Research Scholar, Division of Environmental Sciences, ICAR-Indian Agricultural Research Institute, New Delhi, India

²Research Scholar, University School of Environment Management (USEM), Guru Gobind Singh Indraprastha University, Dwarka, Delhi, India

Corresponding Author's email: anikchandel8@gmail.com

Agriculture today stands at a turning point. Decades of intensive cultivation, excessive fertilizer use, monoculture farming, and continuous soil disturbance have increased yields but simultaneously weakened the ecological foundation of food production. Soil fertility decline, groundwater depletion, increasing greenhouse gas emissions, and reduced biodiversity now threaten global food security. Regenerative agriculture has emerged as a transformative solution to these interconnected crises. Rather than simply minimizing environmental damage, regenerative farming actively restores soil health, ecological balance, and biological productivity. The approach integrates ecological principles with modern scientific understanding to create resilient farming systems capable of adapting to climate variability. The growing interest in regenerative agriculture reflects a broader shift toward farming systems that not only sustain production but also improve ecosystem services such as carbon sequestration, water retention, nutrient recycling, and biodiversity conservation.

Core Principles of Regenerative Agriculture

Regenerative agriculture is not a single farming practice but a framework built upon multiple interconnected principles that collectively improve ecosystem functioning.

- Minimal Soil Disturbance:** Conservation tillage and no-till farming help preserve soil aggregates, microbial communities, and fungal networks essential for nutrient cycling and water infiltration. Reduced soil disturbance also lowers carbon losses from the soil to the atmosphere.
- Permanent Soil Cover:** Cover crops and crop residues protect soil from erosion caused by wind and rainfall. Organic mulches also regulate soil temperature, suppress weeds, and provide food for beneficial soil organisms.
- Crop Diversity:** Crop rotation, intercropping, and agroforestry systems increase biodiversity both above and below ground. Diverse systems reduce pest outbreaks naturally and improve nutrient-use efficiency.
- Living Roots Throughout the Year:** Maintaining living roots in the soil for extended periods enhances microbial activity and facilitates continuous carbon transfer from plants into the soil ecosystem.
- Livestock Integration:** Managed grazing systems contribute organic matter through manure deposition, stimulate plant regrowth, and accelerate nutrient cycling.



Key Principles of Regenerative Agriculture

Major Regenerative Practices and Their Ecological Benefits

S.No.	Regenerative Practice	Ecological Benefit
1	Cover Cropping	Nitrogen fixation, weed suppression, carbon addition
2	Composting & Vermicomposting	Improves soil fertility and microbial activity
3	Conservation Tillage	Reduces erosion and preserves soil structure
4	Agroforestry	Enhances biodiversity and carbon sequestration
5	Crop Rotation	Breaks pest cycles and improves nutrient balance
6	Water Harvesting	Enhances water availability during drought periods
7	Integrated Livestock Systems	Accelerates nutrient cycling and organic matter buildup

Challenges in the Adoption of Regenerative Agriculture

Despite its ecological and economic benefits, large-scale adoption of regenerative agriculture faces several challenges:

- Limited farmer awareness and technical knowledge about regenerative practices.
- Temporary yield fluctuations during the transition period.
- Dependence on chemical fertilizers and conventional farming systems.
- Lack of policy support and financial incentives for farmers.
- Limited access to carbon credit and ecosystem payment programs.
- Insufficient extension services, training, and demonstration programs.
- Market barriers and lack of premium pricing for regenerative products.
- Financial constraints among smallholder farmers.
- Lack of long-term scientific research and region-specific data.

Conclusion

Regenerative agriculture offers a scientifically grounded and practically accessible pathway to farming systems that produce food while restoring the ecological systems that underpin long-term productivity. By rebuilding soil organic matter, enhancing biodiversity, and closing on-farm nutrient cycles, regenerative practices simultaneously reduce greenhouse gas emissions and increase farm resilience to drought, flood, and temperature extremes. India, with its rich tradition of ecological farming knowledge and its vast smallholder sector, is well-positioned to integrate regenerative principles at scale provided that policy frameworks, research investments, and extension services align to support the transition. The future of food security may well depend on our ability to farm not just sustainably, but regeneratively.

References

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