

Brief Report

Agroecological innovations for sustainable farming in post-industrial landscapes

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Post-industrial landscapes, shaped by decades of intensive extraction, urbanization and industrial activities, are characterized by degraded soils, pollution, biodiversity loss and disrupted ecosystems. As global societies confront the dual challenge of food insecurity and environmental degradation, agroecology emerges as a transformative paradigm for restoring ecological balance while ensuring agricultural productivity. Agroecological innovations, ranging from regenerative soil practices, integrated pest management and diversified cropping systems to circular bioeconomy models, offer pathways toward sustainability in regions where traditional farming is constrained by ecological damage. It argues that agroecological innovations not only rehabilitate degraded ecosystems but also reconfigure food systems to be more equitable, climate-resilient and community-centered. By linking ecological science, traditional knowledge and modern technology, agroecology provides an integrative solution for sustainable agriculture in an era defined by environmental stress and post-industrial challenge.

Keywords: Agroecology, Sustainable farming, Post-industrial landscapes, Regenerative agriculture, Soil restoration, biodiversity, Circular bioeconomy, Food security, Climate resilience, Ecological innovation.

Introduction

Industrialization has profoundly reshaped human landscapes, generating economic growth and technological progress but simultaneously leaving behind ecological scars. Post-industrial regions, often defined by abandoned mines, contaminated soils, urban sprawl, deforestation and disrupted hydrological cycles, present one of the greatest challenges for sustainable development. These landscapes are marked by reduced fertility, high levels of pollutants, diminished biodiversity and weakened ecosystem services—all of which compromise agricultural productivity and food security. Conventional industrial farming methods, reliant on chemical inputs, monocultures and mechanization, exacerbate these challenges by further degrading soil health, polluting water systems and undermining resilience to climate variability (Page MJ, et al. 2021).

In response, agroecology has emerged as a holistic framework for sustainable farming that integrates ecological principles, traditional practices and modern innovations. Unlike conventional agriculture, which treats nature as a resource to be exploited, agroecology emphasizes co-creation with natural systems, harnessing biodiversity, nutrient cycling and ecological interactions to sustain production. Agroecological innovations are particularly crucial in post-industrial landscapes where ecological degradation is acute and where farming must simultaneously serve the goals of ecosystem restoration, climate adaptation and socio-economic revitalization (Gu D, et al. 2017).

Description

Agroecology is rooted in the integration of ecology and agriculture, viewing farms as ecosystems embedded in larger socio-ecological systems. Its principles include recycling of nutrients, enhancing biodiversity, minimizing external inputs, strengthening ecological resilience and promoting social equity. In post-industrial landscapes, where soils are depleted, ecosystems fragmented and communities often economically marginalized, agroecology offers both ecological repair and socio-economic renewal. The strength of agroecology lies in its systemic approach: rather than focusing solely on yields, it evaluates farming systems based on their capacity to regenerate natural resources, support biodiversity and empower local communities. Soil degradation is the most pressing constraint in post-industrial landscapes. Decades of mining, industrial emissions and unsustainable farming practices often result in compaction, erosion, nutrient depletion and heavy metal contamination. Agroecological innovations in soil restoration include the application of organic amendments (compost, biochar, green manures), reduced or zero tillage, crop residue recycling and the establishment of cover crops (Liu Y, et al. 2022). These practices increase soil organic matter, enhance microbial activity, improve structure and restore nutrient cycling. Biochar, in particular, has shown promise in immobilizing heavy metals and improving soil fertility in contaminated soils.

Monocultures dominate conventional agriculture but are particularly unsuited to post-industrial landscapes, which require resilience against ecological instability. Agroecological innovations emphasize diversification through polycultures, agroforestry, intercropping and integrated livestock-crop systems. Diversified systems not only spread risk but also enhance soil fertility, suppress pests and create synergies that mimic natural ecosystems. For example, legume intercropping improves nitrogen availability, while agroforestry systems combine trees with crops to stabilize soils, sequester carbon and provide shade and microclimatic regulation. In post-industrial contexts where biodiversity has been diminished, these practices reintroduce ecological complexity, attracting pollinators, natural predators and beneficial soil organisms (Adebiyi JA, et al. 2022). This contributes not only to farm productivity but also to the broader ecological restoration of landscapes. Habitat strips, hedgerows and wetland buffers further enhance biodiversity while providing ecosystem services such as water purification and erosion control.

Post-industrial landscapes often suffer from altered hydrological regimes, including polluted water sources, reduced infiltration and increased vulnerability to drought or flooding. Agroecological innovations in water management include rainwater harvesting, contour farming, mulching and the construction of small-scale reservoirs or wetlands that restore water balance. Practices such as conservation agriculture increase soil water retention, while agroforestry reduces runoff and erosion. These interventions enhance resilience to climate variability, making farming systems more adaptive in degraded landscapes. One of the defining challenges of post-industrial regions is resource inefficiency. Agroecology introduces circular bioeconomy approaches that recycle nutrients and energy within farming systems. Organic waste from urban areas, food industries and livestock operations can be composted and returned to soils (Rust NA, et al. 2022). Biogas technologies convert agricultural residues into renewable energy while producing nutrient-rich slurry for fields. Such innovations close nutrient loops, reduce dependency on synthetic inputs and mitigate waste disposal challenges.

Conclusion

Agroecological innovations hold immense promise for sustainable farming in post-industrial landscapes, where ecological degradation and social disruption converge. By applying ecological principles to restore soils, diversify cropping systems, enhance biodiversity and recycle resources, agroecology transforms degraded environments into resilient agroecosystems. Its emphasis on social participation, local knowledge and community empowerment ensures that sustainability is not only ecological but also socio-economic. While challenges remain in scaling and institutionalizing agroecology, its integrative approach offers a pathway to reconcile agricultural productivity with ecological restoration and social justice. In an era defined by environmental crises and post-industrial challenges, agroecology provides not merely an alternative but a necessary paradigm shift toward sustainable food systems. The resilience of post-industrial landscapes depends on our ability to innovate within ecological limits and agroecology stands at the forefront of this transformation.

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Conflict of Interest

The authors declare no conflict of interest.

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