

Soil biology for resilient, healthy soil

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What is a resilient, healthy soil? A resilient soil is capable of recovering from or adapting to stress and the health of the living/ biological component of the soil is crucial for soil resiliency. Soil health is tightly coupled with the concept of soil quality and the terms are frequently used interchangeably.

The living component of soil or soil biota represents a small fraction (<0.05% dry weight) but is essential to many soil functions that affect overall soil quality and thus are the foundation for agricultural production systems that sustain the human population.

Table 1 Services provided by soil biota and related processes and benefits.

| Soil functions/properties | Processes involved | Agronomic services | Environmental services |
|--|--|---------------------------------|--------------------------------|
| Biogeochemical regulation, nutrient retention and delivery | Carbon, nitrogen, and phosphorus cycles | Provide plant nutrients | Mitigate atmospheric gases |
| | Redox reactions | | Sequester carbon |
| | Decomposition/humification | | Maintain/improve water quality |
| Symbiotic and compensatory associations | Nitrogen fixation (bacteria) | Provide plant nutrients | Maintain/improve water quality |
| | Nutrient uptake via mycorrhizae (fungi) | Enhance water acquisition | |
| Biodegradation/bioremediation of wastes, pollutants, and agrochemicals | Microbial degradation | Reduce pesticide legacy impacts | Maintain/improve water quality |
| Pathogen dynamics | Host-pathogen interactions (regulation and competition) | Suppress disease | Maintain/improve water quality |
| Soil structure and stability | Soil aggregation/porosity | Increase aeration | Reduce erosion risks |
| | Build soil organic matter | Reduce compaction | Mitigate flood and drought |
| | | Improve water infiltration | Sequester carbon |
| | | Increase water holding capacity | |
| Weed dynamics | Germination and growth | Suppress weed germination, | Maintain/improve water quality |

The rapidly increasing human population is expanding the demand for food, fiber, feed, and fuel, which is stretching the capacity of the soil resource and contributing to soil degradation. Soil degradation decreases a soil's production capacity to directly supply human demands and decreases a soil's functional capacity to perform numerous critical services, which are valued in trillions of US dollars. The ability to reverse degradation of soil resources and improve soil services is intimately related to the ability to promote the biological functioning or health of the soil.

Although this report primarily considers soil microorganisms, we fully acknowledge the importance of higher soil organisms to the maintenance of soil health and provision of soil services, but leave those phyla to future discourse.

Emerging tools and technologies have become available to dramatically advance our understanding of microscopic soil biota and provide the foundation to manage soil organisms to enhance primary productivity, provide multiple ecological services, rejuvenate soil resilience, and sustain long-term soil resource quality.

Lehman, R.M., Acosta-Martinez, V., Buyer, J.S., Cambardella, C.A., Collins, H.P., Ducey, T.F., Halvorson, J.J., Jin, V.L., Johnson, J.M., and Kremer R.J. *Soil biology for resilient, healthy soil. Journal of Soil and Water Conservation* 70:12A-18A. 2015.