AgroPedia
e - Publication for Agriculture Popular Articles
Volume: 03, Issue: 07 (July, 2026)
Available online at: https://www.agropedia.co.in
ISSN: 3048-6580

Understanding the Soil Food Web: The Unappreciated Workforce Under Our Feet

Dhara Hareesh[1*], **Tirtharaj Patra**[2] and **Narayanan Mani**[3]
[1&2]School of Natural Resource Management, College of Post Graduate Studies in Agricultural Sciences, CAU(I), Umiam, Meghalaya – 793 103
[3]School of Crop Improvement, College of Post Graduate Studies in Agricultural Sciences, CAU(I), Umiam, Meghalaya – 793 103
*Corresponding author - dharahareesh1997@gmail.com

Introduction

Beneath every field, garden, forest, and grassland lies a vast living community of organisms that continuously maintain soil fertility and ecosystem health. Known as the soil food web, this hidden community is one of the most powerful contributors to agricultural productivity. While farmers often focus on fertilizers, irrigation, improved varieties, or pest control, soil is biologically active habitats on Earth. A single teaspoon of healthy soil contains billions of bacteria, fungal hyphae, protozoa, nematodes, and numerous arthropods that collectively regulate organic matter decomposition, nutrient cycling, soil structure, plant growth, and climate-related processes (Moore, 1994; Lejoly *et al.,* 2026). Understanding this hidden ecosystem is essential for improving soil health, enhancing agricultural productivity, and promoting environmental sustainability.

Did You Know?

A single teaspoon of healthy soil may contain billions of bacteria, thousands of protozoa, hundreds of nematodes, and countless microscopic arthropods making it one of the most biologically diverse habitats on Earth.

What Is the Soil Food Web?

The soil food web is the network of organisms living in the soil and the feeding relationships that connect them. A comparable network functions beneath the soil's surface, just as food webs do in rivers, forests, and seas (Moore, 1994). Plants form the foundation of the soil food web. Plants use photosynthesis to transform sunlight into molecules that are high in energy. A significant portion of this energy is transferred belowground through crop residues, fallen leaves, roots, root exudates, and other organic materials. Soil organisms use these elements as their main food source (Lejoly *et al.,* 2026).

The first living things to use these resources are bacteria and fungi. They break down organic constituents and simplify complicated molecules. Larger organisms like protozoa, nematodes, mites, and springtails then eat these microbes. The soil ecology has several trophic levels because predatory creatures feed on these smaller consumers. The soil food web is much more intricate than a straightforward food chain. Energy moves through various channels at once, and many organisms have multiple feeding responsibilities. Because of its intricacy, the soil food web is incredibly durable and efficient, allowing it to carry out a variety of ecological tasks (Moore, 1994; Lejoly *et al.,* 2026). Together, these organisms interact through complex feeding relationships that drive many of the ecosystem services provided by healthy soils.

The Key Players Beneath the Soil Surface

The soil food web consists of a diverse array of organisms, each contributing in unique ways to soil functioning.

Bacteria: The Microscopic Recyclers

Bacteria are among the most abundant organisms in soil. They rapidly decompose fresh organic matter and release nutrients essential for plant growth. Some bacteria carry out specific farm duties like nitrogen fixation, which transforms atmospheric nitrogen into available forms to plants (Lin *et al*., 2025). Bacteria are important for nutrient cycling and soil fertility because they react rapidly to environmental changes.

Fungi: Nature's Underground Network

Fungi are equally important members of the soil community. Unlike bacteria, they are particularly effective at decomposing complex compounds such as lignin and cellulose found in plant residues. Many fungi form mycorrhizal associations with plant roots, improving nutrient and water uptake while receiving carbohydrates in return. These fungal networks can connect multiple plants underground, creating what scientists often describe as a "wood-wide web" (Lin *et al*., 2025; Lejoly *et al*., 2026).

Protozoa and Nematodes: The Nutrient Regulators

Protozoa and nematodes are microscopic animals that primarily feed on bacteria and fungi. Their grazing activity stimulates microbial turnover and accelerates nutrient release. Nematodes occupy several trophic levels within the soil food web; some feed on bacteria and fungi, while predatory species consume smaller soil organisms. Because they respond rapidly to environmental changes, nematodes are widely used as indicators of soil health and ecosystem functioning (Moore, 1994; Lin *et al*., 2025; Ferris *et al*., 2001).

Mites and Springtails: The Organic Matter Processors

Tiny arthropods that play a major role in decomposition processes are mites and springtails. They increase the surface area available for microbial activity by breaking up organic wastes into smaller particles (Lejoly *et al*., 2026). In spite of their small size, these organisms play a vital role in maintaining soil biological activity and nutrient recycling.

Earthworms: The Ecosystem Engineers

Through their burrowing activities, earthworms improve soil structure. They increase root penetration, water infiltration, and aeration through their tunnels. Earthworm casts are rich in nutrients and beneficial microorganisms that enhance soil fertility. According to Lejoly *et al.* (2026), earthworm casts enhance biological activity and soil fertility, and their abundance is seen as an indication of healthy soil in many agricultural systems.

How the Soil Food Web Supports Plant Growth

The soil food web functions as a natural nutrient-recycling system. Microorganisms decompose organic residues and incorporate nutrients into their biomass. When nematodes, protozoa, and other grazers consume these microbes, nutrients are released into plant-available forms, supporting crop growth (Sackett *et al*., 2010).

Current studies show that soils with more diverse and complex food webs exhibit higher nutrient availability, greater microbial biomass, improved soil fertility, and enhanced soybean growth. These findings indicate that belowground biodiversity is not merely a consequence of healthy soil but a key driver of agricultural productivity (Lin *et al*., 2025).

Soil Food Webs as Indicators of Soil Health

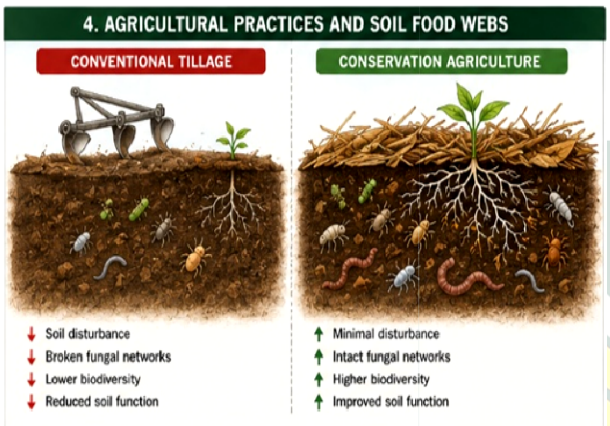
Soil health has gained global attention as concerns about degradation continue to grow. Healthy soil is characterized not only by its physical and chemical properties but also by its biological activity. Because soil organisms respond quickly to management practices and environmental changes, they provide valuable insights into soil condition. Among these indicators, nematodes are particularly useful because their abundance and feeding habits reflect nutrient cycling pathways and ecosystem stability. Scientists have developed integrated approaches that use nematode communities to generate soil health scores, providing a more comprehensive assessment of soil condition and ecosystem functioning (Ferris *et al*., 2001).

The Impact of Agricultural Practices on Soil Food Webs

Agricultural management practices strongly influence soil food web structure and function.

Intensive Tillage

Conventional tillage disrupts soil structure, damages fungal networks, and exposes soil organisms to environmental stress. Frequent disturbance reduces biological diversity and often shifts decomposition toward bacterial-dominated pathways at the expense of fungal channels (Moore, 1994).



Conservation Agriculture

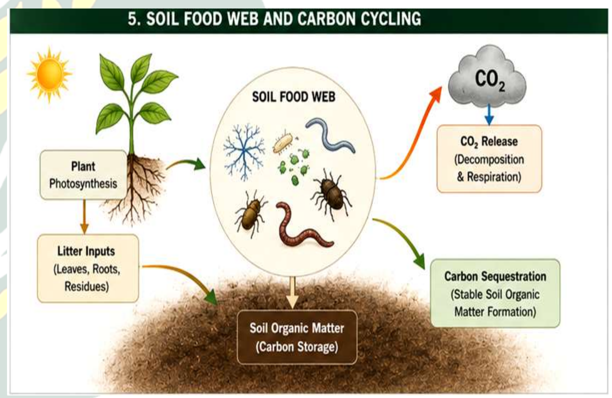
Practices such as reduced tillage, residue retention, cover cropping, and crop diversification help maintain habitat for soil organisms and support more stable food webs. These systems typically enhance fungal communities, nutrient retention, biological activity, and ecosystem resilience (Moore, 1994).

Organic Amendments

Compost, manure, mulches, and crop residues provide energy sources for soil organisms, stimulating microbial activity and promoting diverse biological communities. In essence, organic matter serves as food for the soil food web.

Soil Food Webs and Carbon Cycling

Soil food webs play a crucial role in global carbon cycling and climate regulation. Soils contain higher carbon than the atmosphere and vegetation combined, and soil organisms strongly influence whether this carbon is stored or released. Detritivores, microbivores, predators, and ecosystem engineers regulate decomposition, nutrient cycling, and soil organic matter formation, making soil fauna important drivers of carbon sequestration and ecosystem functioning (Lejoly *et al*., 2026). Their activities influence both the movement of carbon through ecosystems and the long-term storage of carbon in soils, highlighting their importance in climate change mitigation.



Different Ecosystems, Different Food Webs

Soil food webs vary considerably across ecosystems. Climate, vegetation, soil type, and land management influence the composition and functioning of soil communities. Higher energy fluxes and higher rates of predation are typical of tropical ecosystems. They support higher percentages of macrofauna and are more dependent on plant-based energy routes. In contrast, temperate ecosystems rely more heavily on energy routes derived from fungi and detritus

(Potapov *et al.,* 2026). These variations highlight the soil food webs' extraordinary flexibility. Soil communities change in response to local environmental conditions rather than adhering to a single uniform pattern. This discovery has significant consequences for land management. It's possible that methods that support soil health in one ecosystem won't work in another. Therefore, a context-specific understanding of biological processes is necessary for sustainable soil management.

The Future of Sustainable Agriculture Lies Underground

The importance of soil biology is increasingly being recognized as agriculture faces growing challenges from climate change, land degradation, biodiversity loss and population growth. In the past, external inputs like synthetic fertilizers and pesticides were crucial to agricultural intensification. Although these technologies made a significant contribution to food production, they frequently ignored the biological processes that naturally promote soil fertility. Soil food webs can be strengthened and ecosystem services enhanced by practices such as conservation agriculture, crop diversity, organic matter recycling, integrated nutrient management, and less disturbance (Moore, 1994; Lin *et al.,* 2025; Lejoly *et al*., 2026). Nutrient cycling, productivity, water-use efficiency, carbon sequestration, and long-term agricultural sustainability are all improved by healthy soil food webs (Sackett et al., 2010; Lejoly *et al*., 2026).

The fact that soil biodiversity and soil health are inextricably linked is perhaps the most important lesson to be learned from soil food web research. The innumerable organisms that reside beneath our feet are more than just soil occupants; they actively contribute to the processes that keep life on Earth going.

Conclusion

The soil food web is one of nature's most remarkable yet overlooked ecosystems. Beneath the surface, countless organisms work together to recycle nutrients, build soil structure, support plant growth, and regulate carbon cycling. Research increasingly demonstrates that soil food web diversity is closely linked to soil fertility, agricultural productivity, environmental resilience, and climate regulation. By adopting practices that protect and nourish soil biodiversity, farmers can improve both productivity and sustainability. Ultimately, every healthy crop and resilient ecosystem depends on the hidden workforce beneath our feet.

References

Ferris, H., Bongers, T., & de Goede, R. G. (2001). A framework for soil food web diagnostics: extension of the nematode faunal analysis concept. *Applied soil ecology*, *18*(1), 13-29.

Lejoly, J. D., Mason-Jones, K., & Veen, G. C. (2026). A soil food web approach to integrate soil fauna into multitrophic biogeochemistry. *Communications Earth & Environment*.

Lin, Y., Yi, Q., Gao, D., Li, J., Zhang, W., Wang, K., ... & Zhao, J. (2025). Soil micro-food web composition determines soil fertility and crop growth. *Soil Ecology Letters*, *7*(1), 240264.

Moore, J. C. (1994). Impact of agricultural practices on soil food web structure: theory and application. *Agriculture, ecosystems & environment*, *51*(1-2), 239-247.

Potapov, A. M., Semenyuk, I., Bluhm, S. L., Krashevska, V., Kudrin, A., Migunova, V., ... & Tiunov, A. V. (2026). Energy and biomass distribution in soil food webs of temperate and tropical forests. *Nature Communications*.

Sackett, T. E., Classen, A. T., & Sanders, N. J. (2010). Linking soil food web structure to above-and belowground ecosystem processes: a meta-analysis. *Oikos*, *119*(12), 1984-1992.