

## Organic Farming and Soil Biodiversity

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Organic farming is a comprehensive agricultural method that maintains soil health, ecological equilibrium, and biodiversity without the use of synthetic fertilisers, pesticides, or genetically modified organisms. Soil biodiversity, encompassing the range of species within soil ecosystems, is crucial for nutrient cycling, soil structure development, disease control, and sustained productivity. Modern agricultural methods have significantly improved global food output. This advancement has often resulted in soil degradation, reduced biodiversity, and disruption of the environment. In reaction to these issues, organic farming has emerged as a sustainable method that emphasizes natural ecological processes and biological interactions.

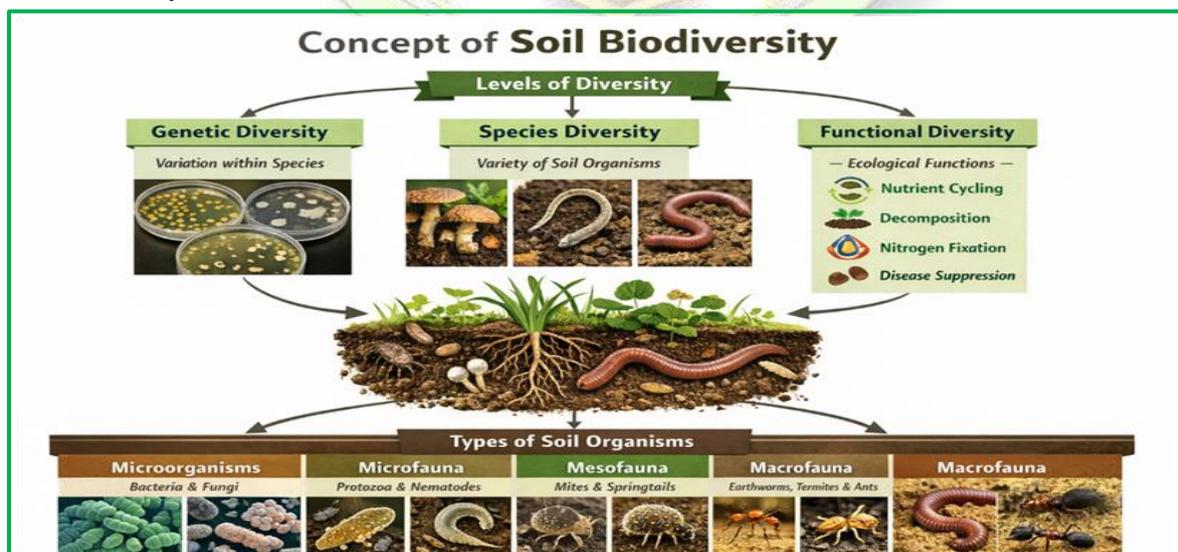
The International Federation of Organic Agriculture Movements (IFOAM) delineates four fundamental principles of organic agriculture: health, environment, justice, and caring. Soil biodiversity denotes the broad range of organisms living in soil, including bacteria, fungi, protozoa, nematodes, arthropods, earthworms, and plant roots. These organisms engage in complex food webs that control vital environmental functions.

### Concept of Soil Biodiversity

The diversity of life belowground, including microorganisms, fauna, plant roots, and their ecological interactions that regulate soil processes and ecosystem services. Soil organisms are categorized based on size and function.

### Microflora

- Bacteria (e.g., nitrogen-fixing and phosphate-solubilizing bacteria)
- Fungi (including arbuscular mycorrhizal fungi)
- Actinomycetes



## Microfauna

- Protozoa
- Nematodes

## Mesofauna and Macrofauna

- Mites
- Collembola
- Earthworms
- Termites

These organisms contribute to decomposition, humus formation, aggregation, nutrient mineralisation, and suppression of soil-borne pathogens.

## Levels of Soil Biodiversity

- **Genetic Diversity** – Variation within species (e.g., different strains of nitrogen-fixing bacteria).
- **Species Diversity** – Number and abundance of different organisms in soil.
- **Functional Diversity** – Variety of biological functions performed (decomposition, nitrogen fixation, predation, etc.).

Functional diversity is especially important in agriculture because it directly influences soil fertility and crop productivity.

## Principles of Organic Farming

Organic farming is guided by four fundamental principles formulated by the International Federation of Organic Agriculture Movements (IFOAM). These principles provide the ethical and ecological foundation for organic agriculture worldwide.

### Principle of Health

Organic agriculture should sustain and enhance the health of soil, plants, animals, humans, and the planet as one and indivisible system.

- Maintains soil biological activity
- Promotes safe and nutritious food
- Avoids harmful synthetic chemicals
- Protects ecosystem and human health

Healthy soil → Healthy crops → Healthy livestock → Healthy people.

### Principle of Ecology

Organic farming should be based on living ecological systems and cycles, working with them rather than against them.

- Enhances soil biodiversity
- Encourages nutrient recycling
- Promotes crop rotations and mixed farming
- Conserves water and natural resources

### Principle of Fairness

Organic agriculture should build relationships that ensure fairness with regard to the common environment and life opportunities.

- Fair treatment of farmers and workers
- Ethical animal welfare
- Equitable trade practices
- Respect for environmental justice

### Principle of Care

Organic farming should be managed in a precautionary and responsible manner to protect the health and well-being of present and future generations.

- Avoids risky technologies
- Promotes sustainable resource use
- Encourages long-term ecological balance
- Supports climate resilience

## Impact of Organic Farming on Soil Biodiversity

**Enhancement of Microbial Biomass:** Organic amendments increase soil organic matter (SOM), which serves as a substrate for microbial growth. Studies show higher microbial biomass carbon and nitrogen under organic systems compared to conventional systems.

**Improved Soil Structure:** Earthworms and fungi enhance soil aggregation. Organic systems often show better aggregate stability due to increased biological activity.

**Nutrient Cycling Efficiency:** Microbial communities in organic systems enhance nitrogen fixation, phosphorus solubilization, and organic matter mineralization.

**Disease Suppression:** Diverse microbial populations compete with or antagonize pathogens, reducing disease incidence naturally.

**Increased Functional Diversity:** Functional groups such as decomposers, mutualists, and predators maintain ecological balance in soil ecosystems

## Mechanisms Linking Organic Farming and Soil Biodiversity

- **Carbon Input Enhancement** – Compost and crop residues increase organic carbon pools.
- **Reduced Chemical Disturbance** – Absence of synthetic pesticides preserves beneficial organisms.
- **Habitat Diversification** – Crop rotations and mixed cropping increase ecological niches.
- **Biological Interactions** – Symbiotic associations such as mycorrhizae improve nutrient uptake.

## Comparative Perspective: Organic vs Conventional Systems

Parameter	Organic Farming	Conventional Farming
Microbial Biomass	High	Moderate to Low
Earthworm Population	Abundant	Often Reduced
Soil Organic Matter	Higher	Often Declining
Biodiversity Index	Greater	Lower

Numerous long-term field experiments worldwide have demonstrated improved soil biological indicators under organic systems.

## Environmental and Agronomic Benefits

- Enhanced soil fertility and resilience
- Improved water retention and infiltration
- Reduced greenhouse gas emissions through carbon sequestration
- Increased long-term sustainability

Organic soils are generally more resilient to drought and climate stress due to higher organic matter and biological activity.

## Limitations

- Transition period yield reduction
- Limited nutrient availability in early years
- Need for skilled management
- Certification costs

## Future Perspectives

- Metagenomic analysis of soil microbial communities
- Functional biodiversity assessment
- Integration of organic practices with precision agriculture
- Climate-resilient soil management strategies

Advances in molecular biology and soil ecology will further clarify the mechanisms linking organic practices and biodiversity enhancement.

## Conclusion

Organic farming significantly enhances soil biodiversity by increasing organic matter, reducing chemical disruption, and promoting natural biological interactions within the soil ecosystem. Soil biodiversity is more than a single component of soil health; it underpins the proper functioning of the entire soil system. Consequently, sustainable farming practices should value biological integrity as highly as they value crop yield. By promoting soil biodiversity through organic methods, agriculture can secure long-term food production, protect environmental quality, and improve the resilience of agro-ecosystems.