



POPULAR ARTICLE

Natural farming: A pathway towards sustainable and resilient agriculture

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Intricacies of the subject

Agricultural production faces severe challenges, including soil degradation, biodiversity loss, water scarcity, rising costs, and climate variability. To address these issues, natural farming which emphasizes ecological processes, soil health, crop diversification and local plant bioformulations inputs has gained significant traction highlighted by India's National Mission on Natural Farming (NMNF) in 2024. Research and state-level implementations such as Zero Budget Natural Farming in Andhra Pradesh demonstrate that natural farming can match conventional yields while boosting farm profitability, enhancing soil biodiversity and improving microbial activity. Furthermore, integrating natural farming with host plant resistance, biological control and scientific pest monitoring offers a strong framework for sustainable crop protection. However, challenges regarding input standardization, long-term yield stability, labor demands and context-specific performance remain. A successful transition requires an adaptive, evidence-based approach that combines traditional ecological knowledge with modern agricultural and scientific disciplines.

Introduction

Ecological processes interacting across soil, plants, microorganisms, water and climate form the foundation of agriculture. While 20th-century intensification boosted yields through synthetic inputs, mechanization and irrigation, excessive reliance on external inputs has led to soil degradation, biodiversity loss, water contamination, pesticide resistance and rising costs (Altieri, 1995; Kogan, 1998). To balance modern demands food security, environmental sustainability, climate resilience and economic viability agro-ecological approaches like natural farming have gained traction. Natural farming emphasizes minimal external inputs, ecological pest control, soil cover, crop diversification and livestock integration (Duddigan et al., 2023; Berger et al., 2025). In India, the National Mission on Natural Farming (NMNF) has scaled this approach to 18.78 lakh hectares across 18,786 clusters, enrolling 18.19 lakh farmers (Government of India, 2026). However, because agricultural responses vary by climate, soil type, crop variety and socioeconomic context, natural farming is not a uniform technology, highlighting the need for rigorous, site-specific scientific evaluation.

Concept and Core Components

Natural farming is an agro-ecological farm-



management approach rather than a standardized technology or single input that relies on farm-derived biological resources and ecological processes (Duddigan et al., 2023; Berger et al., 2025). Unlike certified organic farming, which follows strict regulatory standards and permitted input lists, natural farming emphasizes local resource self-reliance. Its four primary components include:

- **Beejamrit:** Seed treatment using local biological formulations.
- **Jeevamrit / Ghanjeevamrit:** Inoculants applied to enhance soil microbial life.
- **Acchadana (Mulching):** Soil-cover management to retain moisture and organic matter.
- **Whapasa:** Soil aeration and moisture-balance management.

In practice, these are integrated with broader ecological practices like crop diversification, cover cropping, bird perches and livestock integration (Berger et al., 2025). The core principles of natural farming can be categorized into three major ecological pillars.

Maintaining Soil Biological Activity

Soil biological activity refers to the biological processes driven by organisms living within the soil matrix including bacteria, fungi, actinomycetes, protozoa, nematodes, earthworms and micro-arthropods. The primary drivers and mechanisms include, Soil organisms break down complex organic matter into plant-available nutrients (mineralization), such as ammonium, nitrate, phosphate, and sulfate. Practices like applying biological formulations (e.g., Jeevamrit, Ghanjeevamrit, compost teas) introduce diverse beneficial microbes and stimulate native populations. Regular addition of organic inputs (crop residues, farmyard manure, green manure) serves as the primary energy and carbon source for heterotrophic soil biota. Fungal

hyphae and glomalin (a glycoprotein produced by mycorrhizal fungi) along with earthworm mucilage, bind soil particles into stable micro and macro-aggregates. This improves pore space, aeration and root penetration.

Conserving Soil Cover (Mulching and Surface Management)

Soil cover management (Acchadana or mulching) involves keeping the soil surface continuously protected by living crop canopy, crop residues or organic mulches. This is primarily achieved through the following techniques, applying plant residues directly to the soil surface to create a physical barrier between the atmosphere and the topsoil. Growing non-harvested or secondary cover crops (e.g., legumes, grasses) during fallow periods or alongside main crops. Reducing mechanical disruption to leave previous crop residues intact on the field surface.

Preserving Beneficial Organisms

Agricultural ecosystems host a vast array of beneficial organisms categorized into soil fauna, natural enemies of pests and plant mutualists. Important functional groups includes, earthworms, millipedes, and woodlice decompose coarse organic matter and create macropores that enhance aeration and water infiltration. Arbuscular Mycorrhizal Fungi (AMF) extend root surface areas for phosphorus and water uptake Rhizobium and Azospirillum fix atmospheric nitrogen into plant-usable forms. Ladybird beetles, lacewings, predatory mites, spiders, parasitoid wasps (*Trichogramma* spp.) and entomopathogenic nematodes regulate pest populations. Wild bees, solitary wasps, butterflies and syrphid flies improve seed set and yield in insect-pollinated crops.

Ecological Benefits

Mulch significantly reduces evaporative water



loss, maintains favorable soil moisture levels, and buffers against extreme temperature fluctuations that harm roots and soil life. Surface cover dissipates the kinetic energy of raindrops, preventing surface crusting, detachment of soil particles and run-off erosion. Physical shading blocks light transmission to light-sensitive weed seeds, reducing weed germination and reliance on chemical herbicides or labor-intensive weeding. Decomposing surface mulch provides continuous food and shelter for epigenic earthworms and surface-dwelling beneficial invertebrates. Rapid turnover and biological cycling of essential macro- and micronutrients reduce leaching losses. Active biological conversion converts plant biomass into stable humus forms, locking carbon in the

soil profile. Natural farming offers a sustainable path forward by promoting soil biological activity, biodiversity, and ecological pest regulation while reducing reliance on synthetic inputs (Duddigan et al., 2023; Berger et al., 2025). Evidence from initiatives like Andhra Pradesh ZBNF program shows it can maintain competitive yields, increase farm profitability and improve soil microbial health. However, because performance varies across climates, soil types and crops successful implementation relies on scientific validation, farmer participation and local adaptation. Ultimately, natural farming is more than the absence of synthetic chemicals, it is an integrated strategy to build resilient, economically viable and ecologically balanced agricultural systems.

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