

Harnessing natural farming for sustainable agro-ecosystems and SDG advancement in India

Velmurugan A.^{1*}, N. Ravisankar², T.P. Swarnam² and J.K. Thakur³

¹Indian Council of Agricultural Research, New Delhi 110 012

²ICAR-Indian Institute of Farming Systems Research, Modipuram, Uttar Pradesh 250 110

³ICAR-Indian Institute of Soil Science, Bhopal, Madhya Pradesh 462 038

Natural farming represents a synthesis of traditional wisdom and modern agroecological science, offering a viable pathway for sustainable, climate-resilient, and inclusive agricultural development in India. This article realigns scientific evidence, field-level experiences, and large-scale programme in addressing the twin challenges of farm income stress and environmental degradation. Natural farming functions as an integrated agroecological solution that simultaneously enhances farm livelihoods, restores natural resources, and supports India's commitments to the SDGs. This popular article synthesises the scientific rationale, methodological framework, and empirical evidence from research trials and farmers' fields across diverse agro-ecological regions of India. It highlights the relevance of natural farming for different farming communities, its role in environmental sustainability and climate adaptation, and outlines future trends for scaling and mainstreaming natural farming within Indian agriculture.

Keywords: Agro-ecosystem sustainability, Climate resilience, System productivity, Sustainable development goals

INDIAN agriculture, while achieving remarkable gains in food production since the Green Revolution, is increasingly constrained by soil degradation, declining factor productivity, rising input costs, and vulnerability to climate variability. Excessive dependence on synthetic fertilisers and pesticides has resulted in nutrient imbalances, loss of soil organic carbon, biodiversity erosion, and pollution of water bodies. These challenges are particularly acute for small and marginal farmers, who constitute more than 85% of operational holdings and are highly exposed to input price volatility and climatic risks.

Natural farming (NF) has gained prominence as a response to these challenges by advocating 'farming in harmony with nature'. It seeks to restore ecological processes within the farm by minimising external inputs and maximising biological interactions. The renewed policy focuses through initiatives such as Bharatiya Prakritik Krishi Paddhati and the National Mission on Natural Farming which reflects growing recognition of NF as a viable pathway for sustainable and inclusive

agricultural development.

The scientific foundation of NF lies in agroecology, soil biology and ecosystem services. Core principles include continuous soil cover, minimal soil disturbance, diversified cropping systems, integration of livestock, and reliance on biological inputs prepared from locally available resources. Preparations such as *beejamrit* and *jeevamrit* act as microbial inoculants, enhancing soil microbial biomass, enzymatic activity, and nutrient mobilisation. Mulching and intercropping promote soil moisture conservation, carbon sequestration, and biological nitrogen fixation. It has been found that NF improves soil organic carbon by 0.2–0.4% within three to five years, enhances microbial biomass by 30–60%, and significantly increases earthworm populations. These changes strengthen nutrient cycling, soil structure, and resilience against droughts and heavy rainfall events. Ecological pest management using botanical extracts (e.g. *Neemastra*, *Brahmastra*, *Dashparni ark*) reduces pest incidence while conserving beneficial insects and pollinators.

Natural farming for Indian conditions

NF is particularly suited to Indian conditions due to its adaptability across agro-climatic zones and its compatibility with smallholder farming systems. In rainfed, hilly and tribal regions, where access to external inputs is limited, NF leverages traditional knowledge and locally available biomass to sustain productivity. For irrigated and semi-arid regions, crop diversification, residue recycling, and soil moisture management enhance system stability and reduce production risks. Different farming communities benefit differently: small and marginal farmers gain from reduced cultivation costs and debt dependence; women farmers and self-help groups play a central role in preparation of bio-inputs and knowledge dissemination; and livestock-owning households strengthen crop-livestock integration. Thus, NF aligns ecological sustainability with social inclusion and livelihood resilience.

Evidence linking natural farming to SDGs

Scientific evaluation of NF in India emphasises system-level analysis rather than single-crop responses, recognising the integrated nature of NF. Cropping systems involving cereals, pulses, oilseeds, horticultural crops, and fodders have been evaluated under diverse pedo-climatic conditions. Multi-location trials indicated that NF can sustain or enhance productivity in legume-based and diversified cropping systems, while yields in high-input cereal systems may show a temporary decline during initial transition years. On average, NF reduces paid-out costs by 25–40%, primarily through elimination of synthetic fertilisers and pesticides. In several cases, net returns and returns per rupee invested are higher under NF despite comparable or slightly lower yields.

Soil health improvements are a consistent outcome, with higher soil organic carbon, improved aggregate stability, greater microbial activity, and enhanced



Natural farming model farm

water-holding capacity. Energy use and greenhouse gas emissions are reduced by 15–25% due to lower reliance on fossil fuel-based inputs.

Farmers' experiences

Large-scale initiatives such as the Andhra Pradesh Community Managed Natural Farming programme demonstrate the scalability of NF through community-based extension models. Farmers reported improved soil moisture retention, reduced pest pressure over time, and greater income stability, particularly during climatic stress events. The establishment of village-level green input shops and farmer resource persons has strengthened access to inputs and knowledge.

Experiences from hill states such as Himachal Pradesh highlight significant reductions in cost of cultivation in horticultural crops, while rainfed regions show enhanced resilience due to diversified cropping and mulching. However, variability in practices across regions underscores the need for area- and crop-specific standardisation of NF packages.

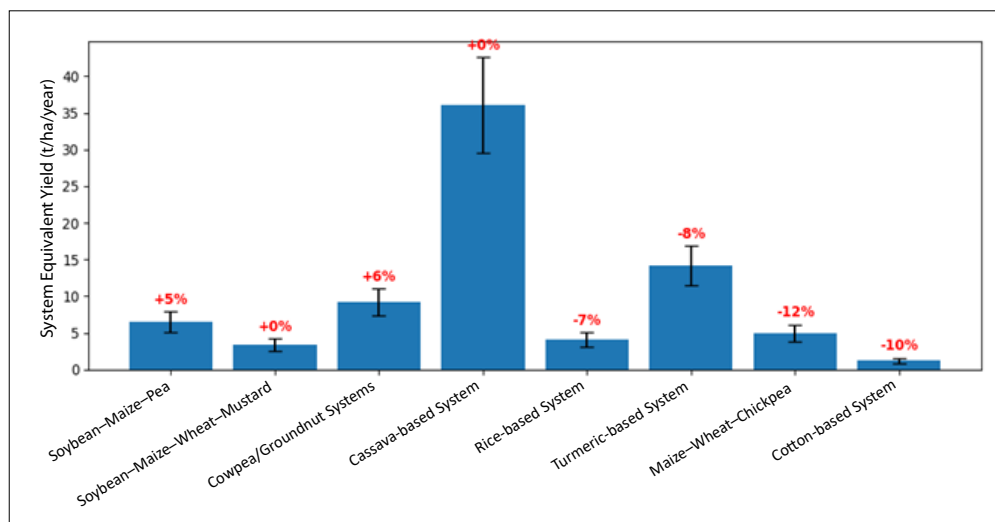
Natural farming as a driver of SDGs

Contribution to environmental sustainability: It contributes to environmental sustainability by restoring soil health, conserving biodiversity, and reducing

Table 1. Effect of natural farming practices on sustainability and linkages with SDG

Natural farming practice/ Innovation	Key environmental and livelihood outcomes	Indicative evidence*	SDGs advanced*
<i>Jeevamrit</i> and <i>beejamrit</i> (bio-inoculants)	Enhanced soil microbial activity, improved nutrient cycling, reduced chemical fertilizer use	Microbial biomass ↑ 30–60%; external N input ↓ 25–40%	SDG 2, SDG 12, SDG 15
Mulching and continuous soil cover	Improved soil moisture, increased soil organic carbon, reduced erosion	Soil organic carbon ↑ 0.2–0.4% in 3–5 years; soil moisture retention ↑ 15–25%	SDG 13, SDG 15
Crop diversification and intercropping	Enhanced biodiversity, yield stability, pest suppression	Pest incidence ↓ 20–35%; yield variability ↓ 10–20%	SDG 2, SDG 15
Botanical pest management	Reduced pesticide residues, protection of beneficial insects	Synthetic pesticide use ↓ 70–100%; pollinator abundance ↑ 40–60%	SDG 6, SDG 12
On-farm resource recycling	Circular nutrient use, lower cultivation cost, income stability	Paid-out cost ↓ 25–40%; net returns ↑ 10–30%	SDG 12, SDG 2
Water-efficient practices (<i>Whapasa</i> , mulching)	Reduced irrigation demand, drought resilience	Irrigation requirement ↓ 20–30% in cereals and pulses	SDG 6, SDG 13
System-based natural farming adoption	Stable productivity, reduced climate risk, enhanced resilience	GHG emissions ↓ 15–25%; crop failure risk ↓ under climate stress	SDG 2, SDG 13

*Indicative values synthesised from multi-location research trials, farmers' field observations, expert assessments, and model natural farming demonstrations across India.



System productivity under natural farming

pollution. Avoidance of synthetic agrochemicals minimises contamination of soil and water resources, while enhanced biomass recycling promotes circular nutrient flows. Increased soil carbon sequestration under NF supports climate mitigation efforts and improves long-term soil fertility.

Climate adaptation and resilience: NF enhances climate resilience through improved soil moisture conservation, diversified production systems, and reduced dependence on external inputs vulnerable to market and supply shocks. Practices such as mulching, intercropping, and *whapasa* (soil air-water balance) enable crops to withstand droughts and erratic rainfall. Reduced greenhouse gas emissions and energy use further position NF as a climate-smart agricultural approach.

System productivity under natural farming: Natural farming is a system-based approach that simultaneously improves soil health, biodiversity, and efficient use of water and nutrients while reducing dependence on chemical inputs. These changes directly support SDG 12 (Responsible Consumption and Production) and SDG 6 (Clean Water and Sanitation) by lowering pollution and resource wastage. Improved soil organic carbon, diversified cropping, and reduced climate risk strengthen farm resilience and stable food production, contributing to SDG 2 (Zero Hunger) and SDG 13 (Climate Action). By restoring agro-ecosystem functions and enhancing long-term productivity, natural farming also advances SDG 15 (Life on Land), positioning it as a practical pathway for sustainable farming system transformation.

Natural farming can achieve yield parity or advantage in diversified and legume-based systems, while some intensive systems show temporary yield

penalties during the initial transition years. The large error bars in the figure indicate substantial variability across locations and seasons, reflecting differences in soil condition, management intensity, and stage of transition. These trends underscore the need for long-term, system-based research and adaptive management to reduce variability, close initial yield gaps, and attain stable productivity under natural farming.

Future trajectories of NF in India will depend on strengthening scientific validation, developing standardised yet flexible packages of practices, and integrating NF into broader farming system approaches. Key priorities include long-term trials on nutrient balance, yield stability, and climate resilience; development of market linkages and certification mechanisms; and convergence with digital tools and farmer producer organisations.

SUMMARY

Natural farming (NF) is increasingly recognised as a key innovation for advancing environmental sustainability and multiple Sustainable Development Goals (SDGs) in India. Drawing upon traditional wisdom, field-level experiences, and multi-location scientific evidence generated during the last decade, NF emphasises the use of on-farm biological resources, crop diversification, soil cover, and ecological pest management. By minimising dependence on synthetic inputs, NF directly contributes to SDGs related to food security, water quality, climate action, responsible production, and terrestrial ecosystem health. It strengthens ecological processes and promotes circular use of on-farm resources. Evidence from research trials and farmers' fields demonstrates its potential to reduce input costs, improve soil health, enhance resilience, and support livelihoods, particularly of small and marginal farmers. While challenges remain in standardisation, yield stability during transition, and market integration, continued research, policy support, and community-based approaches can unlock the full potential of natural farming in shaping the future of Indian agriculture.

*Corresponding author email: velu2171@gmail.com

! Attention !

Want to try your hands at the ICAR textbooks released recently! No Worries! We got you covered. Now shop the latest textbook collection of ICAR online from the convenience of your home.

SCAN QR Code

