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Advancing Horticulture through Organic and Natural Farming: Status and Opportunities

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Horticultural crops, which include fruits, vegetables, plantation crops, spices, medicinal and aromatic plants, and ornamentals, play a crucial role in ensuring food and nutritional security, income generation, and employment opportunities in both rural and peri-urban regions. India, being one of the largest producers of fruits and vegetables in the world, has witnessed tremendous growth in the horticulture sector during the last two decades. However, this growth has come at a cost. The intensive use of chemical fertilizers, pesticides, fungicides, and growth regulators has led to soil degradation, groundwater contamination, loss of biodiversity, and residue hazards in food products (Bhattacharyya *et al*., 2015). Growing consumer awareness about food safety and environmental sustainability, there has been a global shift towards ecologically sound farming approaches such as organic farming and natural farming. These systems aim to reduce external chemical input dependence, restore soil health, conserve natural resources, and produce safe, residue-free horticultural produce. These systems emphasize ecological balance, resource recycling, and minimal external input use. This article explores the principles, practices, status, opportunities, challenges, and future prospects of organic and natural farming in horticultural crops.

Importance of Sustainable Farming in Horticulture

The horticulture sector contributes over 33% of India's agricultural GDP from just 13.1% of the gross cropped area (NHB, 2023). This high-value nature makes horticultural crops particularly sensitive to input use and market preferences.

Key reasons for shifting towards sustainable practices:

Soil Health Concerns: Continuous use of chemical fertilizers reduces organic carbon and disrupts soil microbial balance.

Food Safety Issues: Residues of pesticides and fungicides in fruits and vegetables pose risks to human health.

Export Market Demand: International markets increasingly demand certified organic produce.

Climate Change Mitigation: Sustainable practices enhance soil carbon sequestration and reduce greenhouse gas emissions.

Organic Farming in Horticultural Crops

❖ **Definition and Principles**

The International Federation of Organic Agriculture Movements (IFOAM) defines organic farming as a "production system that sustains the health of soils, ecosystems, and people by relying on ecological processes, biodiversity, and cycles adapted to local conditions, rather than the use of inputs with adverse effects."

The principles of organic farming are:

Health: Maintaining soil, plant, animal, and human health.

Ecology: Emulating natural ecological cycles.

Fairness: Ensuring equity and justice among stakeholders.

Care: Managing resources responsibly for future generations (IFOAM, 2020).

❖ **Soil Fertility Management**

Organic farming improves soil fertility in horticultural systems by enhancing its physical, biological, and chemical characteristics. Physically, it strengthens soil structure, boosts water-holding capacity, and ensures better aeration. Biologically, it fosters beneficial microorganisms, enriches biodiversity, and supports a balanced soil ecosystem. Chemically, it supplies nutrients through organic inputs such as compost while also stabilizing soil pH. Practices like crop rotation, cover cropping, mulching, and the application of organic manures significantly increase soil organic matter (Mekonen, 2023). This organic matter plays a vital role in retaining water and nutrients, while simultaneously sustaining a thriving soil environment essential for healthy plant growth such as:

Farmyard Manure (FYM) and Compost: Rich in organic matter, they improve soil structure, water-holding capacity, and microbial activity.

Vermicompost: Provides humus, plant nutrients, and growth-promoting substances.

Green Manures: Crops like Sesbania and Sunnhemp enrich soil nitrogen.

Biofertilizers: Microbial inoculants such as *Azotobacter*, *Azospirillum*, *Rhizobium*, and phosphate-solubilizing bacteria (PSB) enhance nutrient availability.

❖ **Pest and Disease Management**

Organic farming helps prevent pests and diseases in horticultural crops by creating a balanced and resilient ecosystem. This is achieved through practices that enhance soil health, increase biodiversity, and incorporate cultural techniques such as crop rotation and the use of resistant varieties. When pest or disease issues occur, organic systems rely on integrated approaches rather than synthetic chemicals. These include biological control using natural predators, application of botanicals such as neem oil, deployment of physical barriers, and mechanical methods like trapping or hand-picking. Together, these strategies maintain crop health while supporting ecological sustainability (Sharma *et al*., 2024).

Botanicals: Neem oil, garlic extract, and chili solutions act as repellents and biopesticides.

Biological Control Agents: *Pseudomonas fluorescens*, *Trichoderma spp*. suppresses fungal pathogens; *Bacillus thuringiensis* controls lepidopteran pests.

Cultural Practices: Crop rotation, resistant varieties, trap crops, and sanitation reduce pest buildup.

❖ **Weed Management**

Organic farming manages weeds through preventive measures, cultural practices such as crop rotation and mulching, and mechanical control, focusing on keeping weed populations at economically manageable levels rather than total eradication. The primary objective is to build a healthy soil ecosystem and establish a vigorous crop stand that naturally suppresses weed growth. This approach requires an understanding of weed biology and the adoption of integrated, preventive practices aimed at reducing the soil seed bank and limiting weed reproduction (Finney and Creamer, 2008).

- Mulching with straw, plastic, or crop residues.
- Mechanical weeding with inter-cultivation.
- Biological weed control using allelopathic plants.

❖ **Certification and Post-Harvest Handling**

Certification under the National Programme for Organic Production (NPOP) or international standards (EU, USDA) ensures traceability and market access. Participatory Guarantee Systems (PGS) are also promoted for smallholder farmers. Post-harvest handling in organic horticulture emphasizes residue-free packaging, cold storage, and eco-friendly transport (Narayan, 2005).

Natural Farming in Horticultural Crops

❖ **Concept and Philosophy**

Natural farming, popularized in India by **Subhash Palekar** through Zero Budget Natural Farming (ZBNF), emphasizes farming without external inputs neither synthetic chemicals nor purchased organic inputs. It seeks to harness natural processes for crop growth, reducing dependence on the market (Palekar, 2016).

❖ **Core Practices**

- **Beejamrit:** A microbial seed treatment prepared from cow dung, cow urine, lime, and soil from the farm bund.
- **Jeevamrit:** A microbial inoculant made with cow dung, cow urine, jaggery, pulse flour, and water; enhances soil microbial activity.
- **Mulching:** Retaining crop residues, dry leaves, or cover crops on soil surface to conserve moisture and add organic matter.
- **Waaphasa:** Managing soil aeration by applying only need-based irrigation, ensuring balance between soil moisture and air.

❖ **Role in Soil and Biodiversity Conservation**

Natural farming plays a crucial role in conserving soil and biodiversity by eliminating the use of chemical inputs, thereby allowing soil biology to flourish. This approach increases soil organic carbon and enhances soil structure, creating a more resilient ecosystem. Through practices such as diverse crop rotations and intercropping, natural farming promotes the diversity of soil organisms and provides habitats for beneficial insects and animals. The integration of livestock further strengthens the system, as natural inputs like cow dung and urine enrich the soil and support a holistic, ecological farming cycle. These practices improve soil organic carbon levels, increase microbial biomass, and encourage natural predators that aid in pest management (Khadse *et al.*, 2018). Additionally, reduced tillage and residue retention contribute to soil carbon sequestration, making natural farming a sustainable and environmentally restorative approach.

Case Studies on Organic and Natural Farming of Horticultural Crops in India

- **Mountain Horticulture and the Role of the Uttarakhand Organic Commodity Board:** Mountain districts of Uttarakhand have traditionally practiced low-input farming, which laid the foundation for the Uttarakhand Organic Commodity Board's initiatives to promote organic and near-organic horticultural value chains such as apples, pears, walnuts, amla, and high-value medicinal and aromatic crops. Orchards in alpine and sub-alpine zones, along with temperate vegetables, are managed through practices like organic soil management, terracing, integrated pest management, and the use of indigenous varieties adapted to local conditions. These efforts have enhanced product differentiation through organic and geo-specific branding, offering opportunities for GI recognition and niche markets while also delivering ecosystem benefits such as reduced soil erosion and improved biodiversity. However, full commercialization requires stronger infrastructure and market linkages to sustain farmer livelihoods and expand the reach of organic mountain produce.
- **Himachal Pradesh's Transition to Organic and Natural Farming in Fruits and Vegetables:** Himachal Pradesh, a horticulture-driven hill state known for apples, stone fruits, nuts, vegetables, and floriculture, has advanced organic/natural farming through the Prakritik Kheti Khushhal Kisan Yojana (PK3Y), inspired by Subhash Palekar's principles. Targeting 50,000 hectares by 2022, pilot projects in districts like Kangra,

Mandi, and Kullu promote natural inputs such as Jeevamrit, Beejamrit, mulching, and cow-based preparations across fruit orchards (apple, pear, peach, plum, apricot, walnut), off-season vegetables (tomato, capsicum, cauliflower, cabbage, leafy greens), and floriculture (marigold, carnation, lilium). Outcomes include reduced input costs, better prices for "chemical-free" vegetables in local markets, and improved soil health indicators, with the scheme gaining FAO recognition in 2018 as a model for climate-resilient agriculture.

- **Organic Makhana (Foxnut) in Bihar (value-chain modernization for a niche horticultural product):** Makhana (Euryale ferox), a traditional aquatic crop of the Mithila region in Bihar (Purnia/Kosi belt), is being modernized as an organic superfood through initiatives by universities and state agricultural bodies. Efforts include improved pond management with organic inputs, introduction of high-yielding varieties like Sabour Makhana-1, mechanization in harvesting and processing, and post-harvest upgrades to meet organic standards. These interventions aim to expand the area under organic makhana, enhance processing efficiency, and boost farmer incomes by linking production to premium markets, while organic branding and potential GI recognition offer further value addition to this niche horticultural product.
- **Emerging Horticulture in the Northeast (Organic Opportunities through the Kiwi Mission in Arunachal Pradesh):** Northeastern states are promoting horticultural expansion through organic and natural practices, exemplified by the Kiwi Mission in Arunachal Pradesh, which focuses on developing organic kiwi orchards and Centres of Excellence with model orchards. These initiatives emphasize quality planting material, integrated organic nutrient management, training, and value addition to build sustainable fruit systems including kiwi, apples, and avocados. Leveraging the region's low-input hill agro-ecology, such programs aim to tap premium domestic and export markets, though success will depend on strengthening cold-chain infrastructure, ensuring planting material quality, and enhancing farmer capacity.
- **Organic Mango in Maharashtra:** Certified organic Alphonso mangoes fetch premium prices in export Europe and the Middle East markets.
- **Organic Vegetables in Sikkim:** Sikkim became the first fully organic state in 2016, demonstrating large-scale adoption.
- **Andhra Pradesh Community-managed Natural Farming (APCNF):** Adopted by over 700,000 farmers across 3.5 million acres, showing reduced input costs and improved resilience.
- **Banana Cultivation in Maharashtra:** Natural farming practices reduced water usage by 30% and improved bunch quality.

Comparative Analysis: Organic vs. Natural Farming

Aspect	Organic Farming	Natural Farming
Input Use	Organic manures, composts, biofertilizers	Cow-based and farm-made inputs only
Certification	Requires formal certification (NPOP, USDA)	Generally uncertified, based on trust
Cost of Production	Moderate (certification and input costs)	Very low (minimal external inputs)
Market Scope	Premium domestic & export markets	Local and community markets
Adoption	Widespread but input-dependent	Growing rapidly, especially in smallholders

Status of Organic and Natural Farming in India

❖ **Organic Farming**

- India ranks 4th globally in organic farming area (FiBL & IFOAM, 2022).

- Over 2.8 million ha of cultivable land under organic certification.
- Key organic horticultural crops: tea, coffee, spices, fruits (banana, mango, citrus), and vegetables.
- Sikkim declared the first fully organic state in 2016.

❖ **Natural Farming**

- Natural farming promoted under Bhartiya Prakritik Krishi Paddhati (BPKP), part of Paramparagat Krishi Vikas Yojana (PKVY).
- Andhra Pradesh leads with the largest community-based natural farming program (APCNF).
- Pilot projects in Himachal Pradesh, Maharashtra, and Gujarat demonstrate success in horticultural crops like apple, pomegranate, and banana.

Opportunities in Organic and Natural Horticulture

1. **Market Opportunities**

- Rising domestic demand for residue-free produce among health-conscious consumers.
- Export potential to high-value markets such as the EU, USA, and Gulf countries.

2. **Policy Support**

- Government schemes (PKVY, MOVCDNER, BPKP) provide financial incentives and training.
- State-level models (Sikkim organic, Andhra Pradesh natural farming) show replicability.

3. **Environmental Benefits**

- Reduced dependence on chemical inputs mitigates soil and water pollution.
- Contributes to climate change adaptation and mitigation.

4. **Socio-economic Opportunities**

- Employment generation through value addition, processing, and eco-tourism.
- Farmer Producer Organizations (FPOs) can facilitate collective marketing.

5. **Research and Innovation**

- Scope for developing bio-inputs, microbial inoculants, and ICT-based traceability tools.

Challenges in Adoption

- **Yield Gap**: Lower yields in initial years compared to chemical farming (Seufert *et al.*, 2012).
- **Market Access**: Limited organized supply chains for organic/natural produce.
- **Certification Issues**: High costs and lengthy procedures in organic farming.
- **Knowledge Gaps**: Lack of farmer training and awareness.
- **Pest & Disease Pressure**: Need for skillful management without chemicals.

Government Policies and Support in India

- **Paramparagat Krishi Vikas Yojana (PKVY)**: Promotes cluster-based organic farming. PKVY clusters often include vegetables, fruits and spices. Key practices: group certification via FPOs/SHGs, training in composting, green manuring, bio-pesticides, and cluster-level post-harvest/marketing interventions.
- **National Mission on Sustainable Agriculture (NMSA)**: Supports soil health and water-use efficiency.
- **Mission Organic Value Chain Development in North Eastern Region (MOVCDNER)**: Focuses on linking farmers to markets.
- **State-level Initiatives**: Sikkim (organic state), Andhra Pradesh (natural farming), Uttarakhand (organic clusters).

Future Prospects and Recommendations

- Strengthening research-extension-farmer linkages for organic/natural horticulture.
- Developing low-cost technologies for pest, nutrient, and weed management.
- Encouraging participatory guarantee systems (PGS) for certification.
- Expanding domestic and export markets with better value chains.

- Promoting digital platforms and FPOs for marketing residue-free horticultural produce.

Conclusion

Organic and natural farming represent two promising pathways for achieving sustainable horticultural production in India. Organic farming, with structured certification and export potential, offers opportunities for commercial-scale horticulture, while natural farming ensures low-cost, eco-friendly practices suitable for smallholders. Both systems address soil health, biodiversity, and food safety, contributing to long-term sustainability. With proper policy support, awareness, and research innovations, these approaches can transform horticulture into a resilient, profitable, and environmentally sustainable sector.

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