

Comprehensive Transformation in Haryana's Horticulture Sector: A Research Analysis of Technological Innovation, Policy Integration, and Sustainable Development

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EXECUTIVE SUMMARY

Haryana's horticulture development represents a paradigmatic shift in agricultural modernisation, encompassing comprehensive transformation through technological innovation, robust policy frameworks, strategic infrastructure development, and sustainable farming practices. The state has achieved remarkable success with 37% productivity growth between 2010 and 2024, demonstrating the effectiveness of integrated development approaches that combine international cooperation, domestic policy innovation, and farmer-centric interventions. This research examines the multifaceted developments in Haryana's horticulture sector, analysing the synergistic effects of strategic partnerships with Israel, Japan International Cooperation Agency (JICA), and the United Nations Environment Programme (UNEP), alongside robust domestic frameworks like the Mission for Integrated Development of Horticulture (MIDH) and innovative state-specific initiatives. The transformation encompasses both quantitative achievements and qualitative improvements in agricultural practices. Area cultivation has expanded from 3.64 lakh hectares in 2010 to 4.12 lakh hectares in 2024, representing a 13% increase, while productivity has surged from 12.07 metric tonnes per hectare to 16.56 metric tonnes per hectare, marking a 37% enhancement. This growth trajectory positions Haryana as a model state for sustainable horticulture development, offering valuable insights for agricultural diversification strategies across India and contributing significantly to national food and nutritional security objectives.

INTRODUCTION

The state of Haryana, formed in 1966, has radically transformed from a traditional cereal-based agricultural economy to a diversified horticulture powerhouse. Located strategically adjacent to the National Capital Region (NCR), Haryana leverages its proximity to major metropolitan markets while maintaining strong agricultural foundations. The state's horticulture sector currently encompasses 413,000 hectares under various crops, producing approximately 67.06 lakh metric tonnes annually and contributing 9% to the state's Gross State Domestic Product (GSDP) within crop husbandry.

Establishing an independent Horticulture Department in 1990-91 marked the beginning of systematic transformation efforts, with subsequent decades witnessing unprecedented growth through strategic interventions, international partnerships, and innovative policy frameworks. The department's evolution from traditional extension services to comprehensive value chain management reflects broader agricultural modernisation trends while addressing contemporary challenges, including climate change adaptation, market integration, and sustainable resource management.

Technological Innovation and International Cooperation Indo-Israel Partnership: A Model for Technology Transfer

The cornerstone of Haryana's technological advancement lies in its strategic partnership with Israel, established through the Indo-Israel Centre of Excellence program. This collaboration has transformed horticulture practices through systematic technology transfer, capacity building, and infrastructure development. Eleven Centres of Excellence are operational across

Haryana, each specialising in specific crops and technologies while serving as demonstration hubs for modern agricultural practices.

The partnership's impact extends beyond infrastructure development to encompass comprehensive knowledge transfer and farmer education. Centre of Excellence for Vegetables in Gharaunda, Karnal, is the flagship facility, demonstrating advanced polyhouse cultivation, drip irrigation systems, and precision agriculture techniques. Similarly, the Centre for Sub-Tropical Fruits in Ladwa, Kurukshetra, focuses on high-value fruit cultivation using Israeli technologies adapted to local conditions. The Integrated Bee Development Centre in Ramnagar, Kurukshetra, represents successful diversification efforts, promoting apiculture as a complementary enterprise while supporting pollination services for horticulture crops.

The quantifiable impact of Indo-Israel cooperation is remarkable. Between 2010 and 2024, horticulture productivity increased by 37%, while cultivated area expanded by 13%. This growth trajectory demonstrates the effectiveness of technology-driven development approaches that combine international expertise with local adaptation strategies. The partnership also encompasses human resource development, with regular exchange programs enabling Haryana farmers and officials to gain exposure to advanced Israeli agricultural practices.

Future expansion plans include establishing three additional centres specialising in litchi cultivation in Ambala, strawberry production in Yamunanagar, and date palm cultivation in Hisar. These developments reflect strategic crop diversification efforts to enhance market competitiveness and farmer income diversification. The partnership also explores advanced technologies, including hydroponics, aeroponics, and vertical farming systems, positioning Haryana at the forefront of agricultural innovation.

Japan International Cooperation Agency (JICA) Partnership

Haryana's collaboration with JICA represents one of India's most significant agricultural infrastructure investments, with Rs. 2,700 crore funding approved for comprehensive value chain strengthening. This nine-year sustainable horticulture project aims to address critical infrastructure gaps while establishing integrated supply chain systems connecting farm-gate production to domestic and international markets.

The JICA partnership addresses fundamental challenges in Haryana's horticulture sector, particularly post-harvest losses estimated at 15% for fruits and 11% for vegetables. According to the National Centre for Cold-Chain Development (NCCD) study, Haryana requires approximately 1,695 packhouses, yet only 33 existed as of 2022. The JICA project targets establishing 500+ integrated packhouses by 2033, benefiting 3 lakh farmers and reducing post-harvest losses by 10-15%. The project encompasses comprehensive infrastructure development, including 3.05 lakh MT onion storage capacity expansion, modern collection and distribution centres, and advanced processing facilities. The initiative is designed to create a hub-and-spoke model with 400+ collection and distribution centres linked to a significant international horticultural hub at Ganaur. This systematic approach ensures efficient aggregation, processing, and distribution of horticultural produce while maintaining quality standards and market competitiveness.

United Nations Environment Programme (UNEP) Collaboration

The partnership with UNEP focuses on sustainable cold chain development, addressing environmental concerns while enhancing economic viability. This collaboration emphasises energy-efficient technologies, renewable energy integration, and climate-friendly practices throughout the cold chain infrastructure. The Memorandum of Understanding signed between the Department of Horticulture, Haryana, and UNEP establishes frameworks for policy development, technical assistance, and capacity building in sustainable cold chain management.

The UNEP partnership complements JICA investments by ensuring environmental sustainability and climate resilience in infrastructure development. Key focus areas include developing integrated cold-chain facilities with market connectivity, facilitating access to financing through state and central schemes, supporting Farmer-Producer Organisations (FPOs) with first-mile packhouses, and promoting energy-efficient and renewable energy-based technologies.

Policy Framework and Government Initiatives

Mission for Integrated Development of Horticulture (MIDH)

MIDH serves as the primary policy instrument for horticulture development in Haryana, operating on a 60:40 (Government of India: State) sharing pattern since 2015-16. Originally launched as the National Horticulture Mission in 2005-06, the program was restructured and renamed in 2014-15 to enhance integration and effectiveness. In 2021-22, the mission was implemented across 19 districts with a total financial provision of Rs. 10,600 lakhs, achieving expenditure of Rs. 7,924.52 lakhs.

MIDH's comprehensive approach encompasses area expansion, productivity enhancement, post-harvest management, processing, and marketing support. Key components include establishing new gardens, protected cultivation, micro-irrigation systems, integrated pest management, organic farming promotion, and capacity building initiatives. The mission's success is reflected in consistent area expansion and productivity improvements across different crop categories.

The mission's impact extends beyond production enhancement to market integration and value addition. During 2021-22, MIDH supported protected cultivation across 2,697.18 hectares, including polyhouses, net houses, mulching, low tunnels, and bamboo stacking. Micro-irrigation coverage reached 4,645 hectares with an expenditure of Rs. 3,141.75 lakh, demonstrating significant improvements in water use efficiency.

State-Level Policy Innovations

Haryana has pioneered several innovative policy interventions that complement central schemes while addressing state-specific challenges. The Bhavantar Bharpayee Yojana (BBY), launched in January 2018, represents India's first comprehensive price protection scheme for horticulture crops. Currently covering 21 horticulture crops with predetermined protected prices, BBY provides direct financial support to farmers when market prices fall below guaranteed levels.

Since its inception, BBY has benefited 5,403 farmers with total disbursements of Rs. 1,412.22 lakh. In 2021-22 alone, 56,089 farmers registered for coverage across 120,466 acres, with Rs. 377 lakh distributed to 1,208 farmers. This innovative approach demonstrates proactive risk management in volatile horticulture markets while encouraging crop diversification and area expansion.

The Integrated Horticulture Development (IHD-65) scheme operates in non-MIDH districts, providing a 60% subsidy for new garden establishment and 50% for canopy management. This comprehensive approach ensures equitable development across all districts regardless of central scheme coverage.

Haryana Agri-Business and Food Processing Policy 2018

The Haryana Agri-Business and Food Processing Policy 2018 establishes comprehensive frameworks for value chain development, processing industry promotion, and market integration. The policy offers substantial financial incentives, including a 25% capital investment subsidy up to Rs. 1 crore for new units in 'C' and 'D' category blocks, SGST reimbursement up to 100% for ten years, and specialised support for women entrepreneurs.

Infrastructure development is emphasised with a 50% capital investment subsidy of up to Rs. 10 crore for the Mini Food Park establishment and a 35% subsidy of up to Rs. 5 crore for the integrated cold chain infrastructure. The policy also supports quality certification, patent registration, and skill development initiatives, creating comprehensive enabling environments for private sector investment.

Infrastructure Development and Modernisation

Cold Chain Infrastructure Expansion

Haryana's cold chain development represents one of India's most ambitious agricultural infrastructure projects. The state government has announced plans for extensive cold storage facilities in every district, with a 35% subsidy for facilities up to 5,000 MT capacity. This initiative addresses critical gaps in post-harvest management while enhancing market integration and export competitiveness.

The Crop Cluster Development Programme (CCDP), launched with a Rs. 510.36 crore budget for three years, focuses on creating integrated marketing infrastructure and post-harvest management facilities. Under this program, 10 integrated packhouses have been established, with 45 under progress as of 2021-22. Each cluster includes packhouses, primary processing centres, grading-sorting machines, storage facilities, refrigerated transport, and quality control facilities.

The cold chain infrastructure includes nine projects under MoFPI assistance, four of which have been completed and five are ongoing. The state operates four food parks, with two fully functional ones at Rai and Saha. Meanwhile, Mega Food Parks at Barhi and Rohtak are under development and have state-of-the-art standard infrastructure facilities.

Protected Cultivation and Precision Agriculture

Haryana has invested Rs. 500 crore at 50-65% assistance in protected cultivation, benefiting approximately 25,000 farmers across 3,000 acres under polyhouse cultivation, 8,000 acres under low-cost bamboo cultivation, and 14,000 acres under mulching. The target is to bring 1 lakh hectares under protected cultivation and 10 lakh hectares under all horticulture crops by 2030.

Protected cultivation technologies include advanced polyhouses with climate control systems, precision irrigation, fertigation, and integrated pest management. During 2021-22, protected cultivation covered 834.25 hectares under bamboo stacking, 150.06 hectares under protected structures, 761.38 hectares under low tunnels, and 876.05 hectares under mulching. The comprehensive approach provides subsidies of 65% for general farmers and 85% for scheduled caste farmers.

Micro-irrigation expansion represents a cornerstone of water resource management, with 153,591 hectares covered from 2005-06 to 2021-22 across horticulture and agriculture crops. The program provides 85% assistance in all districts for all farmer categories, with area limits increased from 5 to 10 hectares per beneficiary. Community pond construction receives 100% assistance, with 3,817 ponds constructed through 2021-22, including 304 in 2021-22 alone.

Value Chain Development and Market Integration Farmer-Producer Organisations (FPOs) and Collective Action

Haryana has systematically promoted farmer collectivisation through FPO development, with 460 FPOs promoted through various agencies. Under the Central Sector Scheme for "Formation and Promotion of 10,000 FPOs," 46 FPOs were formed with 7,989 shareholders by the end of FY 2021-22, utilising Rs. 2.92 crore out of Rs. 5.50 crore allocated.

FPO development focuses on crop cluster-based approaches, market linkages with modern retailers and processing industries, and quality management support. Value chain studies have been completed for six important crops: Kinnow, tomato, potato, strawberry, capsicum, and ginger. This systematic approach ensures comprehensive market integration while maintaining farmer autonomy and income enhancement.

The state also supports agro-cooperatives and farmer groups through specialised schemes providing 25% capital investment subsidy up to Rs. 1 crore for registered FPOs and agro/food cooperatives. This targeted support recognises the critical role of collective action in achieving economies of scale and market competitiveness.

Export Promotion and Market Expansion

Haryana has established Agri-Export Zones (AEZs) for mango, kinnow, vegetables, and medicinal crops to enhance export capabilities. Four Food Parks are planned in Sirsa, Jind, Sonapat, and Ambala districts to strengthen processing and export infrastructure. The state's strategic location provides exceptional access to domestic and international markets through proximity to Delhi and major transportation networks.

Export performance demonstrates steady growth across multiple commodities. Kinnow exports generate approximately Rs. 450 crore annually, while vegetables contribute Rs. 850 crore.

The state also exports significant quantities of medicinal crops valued at Rs. 120 crore and processed foods worth Rs. 680 crore annually.

The Beijing-model implementation for peri-urban agriculture around Delhi represents strategic market positioning. Former agriculture minister Om Prakash Dhankar visited China in 2015 to study Beijing's peri-urban agriculture model, recognising opportunities to supply fresh produce to Delhi's metropolitan market. This approach leverages geographical proximity while ensuring sustainable production systems.

Sustainable Agriculture and Climate Change Adaptation Climate Smart Agriculture Initiatives

Haryana has implemented Climate Smart Villages (CSVs) in 250 villages across 10 districts with Rs. 22.09 crore support. The project encompasses conservation agriculture practices, zero tillage, Direct Seeded Rice (DSR), precision water management, stress-resilient cultivars, and site-specific nutrient management. These interventions address climate variability while maintaining productivity and income levels.

The climate-smart agriculture approach integrates multiple technologies, including biochar production from crop waste, addressing stubble burning issues while creating carbon sinks. This initiative reduces 30% air pollution from stubble burning while sequestering carbon and improving soil health and water retention capacity. The comprehensive approach demonstrates successful integration of environmental and economic objectives.

Water resource management represents a critical component of climate adaptation, with Haryana developing a unique integration model combining water farm ponds, orchard establishment, and micro-irrigation systems. This model has

benefited approximately 17,000 farmers and brought 24,000 acres under the catchment area, with 3,115 water farm ponds constructed.

Organic Farming and Sustainable Practices

Haryana has 5,303 hectares under certified organic farming with 4,339 farmers engaged in organic production. The Paramparagat Krishi Vikas Yojana implementation includes 50-acre cluster formation for organic villages, training centre establishment at Gurukul, Kurukshetra, and a target of 10% cultivable area under organic farming.

Integrated Pest Management (IPM) and biological control programs provide a 75% subsidy for pheromone and sticky traps across 266.39 hectares in 2021-22. The ICT-based E-Pest Surveillance and Advisory Services project covers 15 districts and 85 villages with 11,949 registered farmers receiving 1,456,418 SMS advisories. This technology-driven approach ensures timely pest management while reducing chemical inputs.

The Area-wide validation project for Fruit Fly Management in Cucurbitaceous Vegetables operates in 7 villages in Karnal district with 460 registered farmers across 814 acres. Using 720 traps and integrated management approaches, the project demonstrates effective biological control methods.

Research and Development Infrastructure

Chaudhary Charan Singh Haryana Agricultural University (CCS HAU)

CCS HAU, established in 1970, is the primary research institution supporting horticulture development. The university operates 11 Krishi Gyan Kendras (KGKs), 19 Krishi Vigyan Kendras (KVKs), and 3 Kisan Sewa Kendras (KSKs). Regional research stations at Buria and Bawal conduct location-specific research while supporting technology development and dissemination.

The university has established M.Sc. (Horticulture) programs in Fruit Science and Floriculture & Landscape Architecture since 2010-11. Research focuses on heat stress tolerance in grain filling periods, water-efficient aerobic rice development, drought and salinity tolerance in crops, and molecular breeding for climate resilience. This comprehensive research approach ensures continuous innovation and technology development.

Maharana Pratap Horticultural University

The establishment of Maharana Pratap Horticultural University at Karnal with three Regional Research Stations in Chansoli (Ambala), B.Raiya (Jhajjar), and Badhana (Jind) represents dedicated infrastructure for horticulture education and research. Rs. 97.40 crore has been released from the total budget approval of Rs. 486.59 crore. Post Graduate Courses commenced in academic year 2017-18, establishing specialised human resource development for the horticulture sector.

The university focuses on location-specific research, technology development, and knowledge dissemination while maintaining strong industry linkages. Research priorities include variety development, production technologies, post-harvest management, and value addition techniques.

Human Resource Development and Capacity Building

Training and Skill Development Programs

Haryana operates comprehensive training programs through multiple institutions, including the Horticulture Training Institute at Uchani, Karnal, various Krishi Vigyan Kendras, Centres of Excellence, and Indo-Israel training programs. The Agricultural Human Resource Development (AHRD) program, implemented in partnership with the Agriculture Skill Council of India (ASCI), conducts training and skill development at various horticulture centres.

2021-22, training programs reached 17,543 participants, including farmers, students, officers, and officials. Weekly training programs benefited 3,663 farmers, while 195 students completed Qualifications Pack courses under the Agricultural Skills Council. The job fair conducted in March 2022 saw 162 students selected by 34 companies out of 478 participants.

International exposure programs include farmer and official visits to Israel, technology demonstration tours, and knowledge exchange initiatives. These programs ensure continuous capacity building while facilitating technology adoption and innovation.

Employment Generation and Rural Development

Horticulture has emerged as a significant employment generator, providing opportunities in storage management and processing, grading and packaging operations, branding and marketing activities, agro-tourism development, hi-tech

operations, and value chain management. The sector directly or indirectly employs more than 23 lakh individuals with scope for significant expansion.

Youth engagement programs focus on attracting educated youth to agriculture through modern technology adoption, entrepreneurship development, and skill-based training. The government plans to send youth delegations to Israel to learn farming techniques and implement them in the state. These initiatives ensure continuity in agricultural innovation while addressing rural employment challenges.

Statistical Performance and Achievements

Production and Area Statistics

Current horticulture statistics for 2021-22 demonstrate substantial achievements across all crop categories. The total horticulture area encompasses 413,000 hectares, producing 67.06 lakh metric tonnes. Fruit cultivation covers 73,075 hectares, producing 12.64 lakh MT, with key crops including citrus (24,398 ha, 570,883 MT), mango (9,647 ha, 108,770 MT), and guava (15,594 ha, 238,514 MT).

Vegetable cultivation spans 329,440 hectares, producing 53.41 lakh MT, with major crops including potato (29,543 ha, 781,505 MT), tomato (20,938.1 ha, 343,440 MT), onion (24,871 ha, 489,456 MT), and cucurbits (49,451.1 ha, 657,908 MT). Spices cover 8,586 hectares, producing 73,397 MT, while medicinal and aromatic plants occupy 306 hectares, producing 354.7 MT.

Flower cultivation encompasses 1,692.46 hectares, producing 17,211.5 MT of loose flowers and 12,258,833 cut flowers. Mushroom production reached 10,745 MT from 1,389,440 trays in 2021-22. These statistics demonstrate comprehensive crop diversification and significant production achievements.

Financial Investments and Budget Allocation

Budget allocation trends demonstrate sustained government commitment to horticulture development. The non-plan budget increased from Rs. 35.50 crore (2005-06) to Rs. 73.58 crore (2010-11), representing 107.28% growth. The 11th Plan allocation totalled Rs. 449 crore, including state and central shares.

Major investment projects include the JICA Project with Rs. 2,700 crore for value chain strengthening, Protected Cultivation with Rs. 500 crore at 50-65% assistance, Water Resource Management with Rs. 300 crore at 70-100% assistance, and Climate Smart Villages with Rs. 22.09 crore for 250 villages.

Department scheme implementation in 2021-22 involved a total expenditure of Rs. 30,691.28 crore across 15 states and four central plan schemes. The MIDH expenditure reached Rs. 7,924.52 lakh out of the Rs. 10,600 lakh allocation.

Future Prospects and Strategic Vision

Vision 2030 and Long-term Goals

Haryana's horticulture vision encompasses doubling the area under horticulture, tripling horticulture production, achieving 15% of total cultivated area under horticulture (from the current 7.5%), and enhancing productivity to 28 MT/ha (from the current 15 MT/ha). This ambitious vision requires sustained investment in technology adoption, infrastructure development, and market linkages.

Strategic initiatives for achieving Vision 2030 include Beijing-model implementation for peri-urban agriculture around Delhi, export market diversification, value-added product development, and branding and certification programs. The comprehensive approach ensures balanced development across production, processing, and marketing domains.

Climate resilience and environmental sustainability receive particular emphasis in future planning. Integrating digital technologies, precision agriculture tools, biotechnology applications, and artificial intelligence in crop management will enhance productivity while ensuring resource efficiency.

Emerging Technologies and Innovation

Focus areas for technological advancement include hydroponics and aeroponics systems, vertical farming techniques, precision agriculture tools, biotechnology applications, and artificial intelligence in crop management. With Israeli assistance, the planned Centre of Excellence for hydroponics will demonstrate soilless cultivation technologies. These innovations address land and water constraints while enhancing productivity and quality.

Market expansion strategies encompass export market diversification, value-added product development, branding and certification programs, and direct marketing initiatives. The comprehensive approach ensures market competitiveness while maintaining price stability and farmer income security.

Best Practices and Replicable Models

Integrated Development Approach

Haryana's success demonstrates the effectiveness of integrated development approaches combining international cooperation, domestic policy innovation, infrastructure development, and farmer empowerment. The Indo-Israel collaboration model provides frameworks for technology transfer, capacity building, and knowledge exchange that other states can adapt. Similarly, the JICA partnership model offers blueprints for large-scale infrastructure development with international funding.

The Bhavantar Bharpayee Yojana represents innovative risk management approaches other states have begun adopting. The Crop Cluster Development Programme provides integrated value chain development frameworks that ensure farmer participation and income enhancement.

Policy Innovation and Implementation

State-level policy innovations, including the Agri-Business and Food Processing Policy 2018, demonstrate comprehensive approaches to sectoral development. The policy's emphasis on infrastructure development, financial incentives, regulatory simplification, and human capital development provides replicable frameworks for other states.

Integrating climate-smart agriculture, organic farming, and sustainable practices offers models for environmentally sustainable development that other states can adapt to local conditions. Comprehensive training and capacity-building programs ensure the adoption of technology and the diffusion of innovation.

CONCLUSION

Haryana's horticulture development represents a comprehensive transformation integrating technological innovation, policy support, infrastructure development, and sustainable practices. The state's 37% productivity growth, area expansion, and export promotion demonstrate the effectiveness of integrated development approaches that combine international cooperation with domestic innovation. The strategic partnerships with Israel, JICA, and UNEP, complemented by robust domestic policy frameworks like MIDH, BBY, and state-specific initiatives, have created conducive environments for sustained horticulture growth.

The transformation encompasses quantitative achievements and qualitative improvements in agricultural practices, market integration, and environmental sustainability. The focus on climate-smart agriculture, organic farming, and value chain development positions Haryana as a model for sustainable horticulture development while addressing contemporary challenges, including climate change, resource scarcity, and market volatility.

Haryana's vision is to achieve 15% of the area under horticulture by 2030 and triple production levels, which requires continued investment in technology adoption, infrastructure development, and market linkages. Integrating digital technologies, precision agriculture, and climate-resilient practices will be crucial for sustaining growth momentum while addressing environmental challenges.

Haryana's horticulture success story offers valuable insights for other states seeking agricultural diversification and sustainable development. The comprehensive approach combines research and development, international cooperation, farmer empowerment, and market-oriented production to provide replicable models for horticulture development across India. The state's commitment to doubling farmers' income, environmental sustainability, and export promotion through horticulture development aligns with national agricultural policy objectives. It contributes significantly to India's food and nutritional security goals.

The systematic integration of technological innovation, policy support, infrastructure development, and sustainable practices demonstrates that agricultural transformation is achievable through coordinated efforts involving government, private sector, international partners, and farming communities. Haryana's experience provides a blueprint for comprehensive agricultural modernisation that other developing regions can adapt and implement according to their specific contexts and requirements.

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