



AGRICULTURE & ALLIED SECTORS, FOOD AND ENVIRONMENT



WHERE ARE WE?

Strengths

- Haryana has achieved high agricultural growth and leads in milk production
- Strong GSVA contribution; leading export contributor
- Advanced agri-tech adoption; extensive cold storage
- Guaranteed price support for over 24 crops
- 97% net area sown; high irrigation intensity
- Government initiatives like the Pradhan Mantri Fasal Bima Yojana (PMFBY) and "Mera Pani Meri Virasat" are promoting crop diversification and mitigating agricultural risks
- The productivity of major crops like rice, wheat, pulses, oilseeds, bajra and other crops are above the national average and are comparable to advanced countries in many arenas.
- Presence of robust and dynamic research infrastructure of agricultural universities with critical advancements in new frontiers of biofortified varieties, climate resilient technologies, resource conservation, biotechnological advancements along with scientific human resource base.

Areas of improvement

- Regulation of groundwater use and chemical inputs
- Improvement in policy frameworks and encourage land consolidation
- Support land holders better by lowering input costs and boosting tech accessibility
- Enhance post-harvest care; curb stubble burning and promote sustainable practices
- Address challenges of disguised unemployment, seasonal work, and low wages in agricultural labour.

Opportunities

- Upscale aquaculture operations; diversify horticulture crops
- Expand natural/organic farming; promote climate-smart farming; develop green certifications
- Boost micro-irrigation coverage; improve soil health
- Increase tech penetration; strengthen value chains
- Enhance agri-exports
- Utilise AI and automate farming processes
- Explore agri-tourism as a supplementary income source for farmers and rural communities

Threats

- Groundwater overextraction risk; pesticide overuse impact and soil salinity increase
- Climate change effects; air pollution escalation
- Rising production costs and market price volatility
- Inequality in tech access

WHERE DO WE WANT TO GO?



VISION

Haryana will **Future-Secure Agriculture and Food** by transforming itself into a global hub of sustainable, high-value agriculture, driven by innovation, empowered farmers, and climate-resilient systems, while ensuring economic prosperity, reduced agrarian dependency, and leadership in organic and horticultural markets and fostering diversified rural economic growth through new avenues like agri-tourism.



MISSION

With the aim to revolutionise its agrarian economy, Haryana will adopt the EEE Approach — Equitable, Eco-Friendly, and Experimental Farming by diversifying crops, adopting cutting-edge technology, and building efficient supply chains to quadruple farmer income in real-value terms, promote agro-industries, and transition 20% of farmland to organic/natural practices by 2047. We will empower smallholders, consolidate landholdings, and leverage national missions to create a future where farming is profitable, sustainable, and aspirational.

GOALS

- Percentage of GSVA in Agriculture & Allied Sectors to the total GSVA - > 7.2% (approximately)
- Agricultural productivity aims to shift away from water-intensive crops like paddy to promote sustainable and natural farming methods, encouraging a move toward high-value alternatives such as horticultural crops.
- Percentage of net area under natural/organic farming - > 20%
- Cold Storage Capacity (in '000 tonnes) - > 600
- Percentage of degraded land developed for farming activities - > 20%
- Compensate for the area shift from farm sector to non-farm sector through increase in productivity, sustainable crop diversification and technology intensive production process.

ASPIRATIONAL FUTURE

To ensure a prosperous, eco-conscious agricultural sector with enhanced income and livelihoods through optimised resource utilisation, which maximises yields and ensures enduring food security using advanced agricultural technologies to mitigate post-harvest losses and enhance sustainability. Rural economic growth is stimulated by guaranteed price support and farmer-friendly policies.

- The food crops like rice, wheat, millets, pulses and oilseeds; cash crops like cotton and sugarcane shall remain the core of agri-production process but with resource efficient technology paradigms and high productivity comparable to global standards.
- Establish world class agricultural education, research and extension infrastructure for the citizens, support public-funded technology generation and delivery as it is affordable to the farmers. Promote crops like maize, sugarcane and other crops to be the efficient source of green energies.

HOW WILL WE REACH THERE?

Climate Resilience & Environment: Enforce region-specific precision farming, net-zero GHG emission laws, and sustainable water use; use AI-satellite tools for climate monitoring, disaster forecasting, and pollution control.

Sustainable Agriculture Practices: Mandate organic certification and promote agroforestry, crop diversification, and soil testing; support training through digital platforms and build agro-ecological buffer zones.

Advanced Agri-Tech Integration: Promote AI-driven precision farming and IoT systems for equitable access; set up pilot farms, innovation hubs, and certification institutes in agri-robotics.

Supply Chain & Post-Harvest Management: Incentivise cold chain infrastructure, biodegradable packaging, and AI-based logistics; deploy smart warehouses, predictive analytics, and mobile post-harvest units.

Economic Viability & Market Adaptation: Provide subsidies for high-value crops, AI-backed price forecasting, and export support; create direct farm-to-market contracts and training in agri-business management.

Agrarian Reforms & New Markets: Simplify land leasing, secure tenancy rights, and strengthen Farmer Producer Organisations (FPOs); promote agritech incubation, blockchain-led traceability, and climate-smart trade ventures.

Focus on Allied and Non-farm Sectors: Diversifying Haryana's agricultural economy; focusing on Horticulture, Animal Husbandry, and Pisciculture is essential to buffer the direct impact of environmental and market forces on the income of farmers.

Advancing Agricultural Research and Technology for Food and Nutritional Security: Investment in R&D for the generation of technologies, technological adaptation and its delivery to every farmer and using the land to its capacities. The breakthrough in pulse crops, oilseed crops and cash crops like cotton through biotechnological tools for food as well as nutritional security and agrarian prosperity.

Strengthening Post-Harvest Infrastructure and Value-Added Agriculture: World-class infrastructure of storage, post-harvest handling and value addition; integration of farm enterprises for a viable and sustainable farming systems.

3 BIG ACTIONS

01 Zero Burn, Green
Return Initiative

03 Sky Harvest 2047

02 Agri-Tech City & Smart
Storage Network

INTRODUCTION

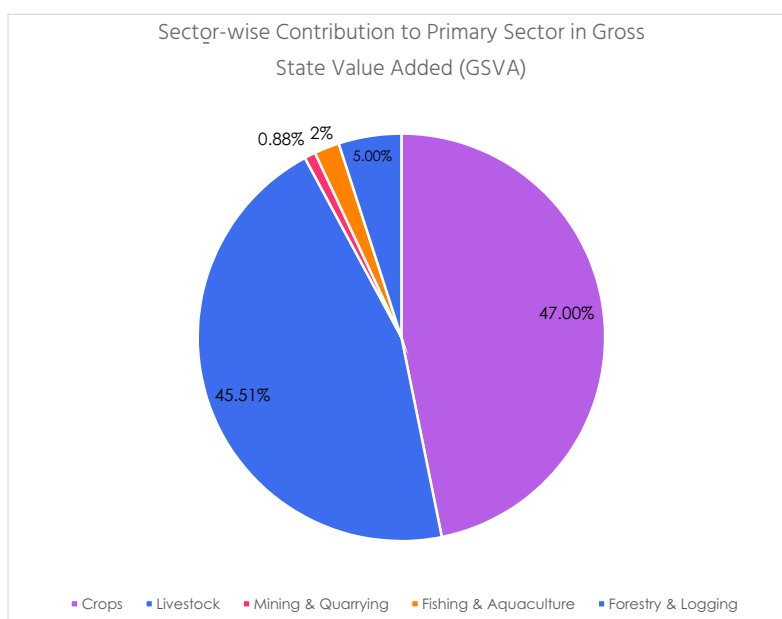
Haryana's agricultural landscape stands at a transformative crossroads. As the "Bread Basket of India," the state punches above its weight—contributing significantly to national food security despite occupying just 1.34%¹ of India's geographical area, with 35.84 lakh hectares² of cultivated land supporting nearly 30% of its workforce and generating 18% of the state economy.³ While the sector boasts impressive achievements—wheat yields reaching 6,177 kg/hectare,⁴ horticulture producing 68.43 lakh MT annually,⁵ and a thriving livestock sector with 122.20 lakh tonnes of milk production⁶—these gains are increasingly threatened by sustainability challenges that cannot be ignored. Critical issues, including severe groundwater depletion (135.74% extraction rate)⁷, soil health degradation by excessive chemical inputs and continued rigorous tillage from excessive chemical inputs (28,99,680 MT of fertilisers and 4,440.3 MT pesticides annually), climate change impacts, and fragmented landholdings (68.57% being small and marginal farmers)⁸, require immediate attention.

WHERE ARE WE?

Current Status

Agricultural Production and GSVA

- Agriculture & Allied Sectors: 17.9% contribution to GSVA (2024-25)⁹
- Agricultural growth rate: 8.1% in 2023- 24¹⁰
- Wheat yield: 6,180 kg/hectares (2024-25)¹¹
- Rice yield: 7,415 kg/hectares (2024-25)¹²



Graph 20: Sector-wise Contribution to Primary Sector in Gross State Value Added (GSVA)

(Source: Statistical Abstract of Haryana 2023-24)

Government Initiatives

- Multiple farmer benefit schemes – Har Khet Swasth Khet, Mera Pani Meri Virasat, Bhavantar Bharpayee Yojana, Direct Seeding of Rice, Crop Residue Management (CRM) Incentive
- Use of technology and linking of crop sown data with insurance, mandis, and girdawari records
- Advanced data collection and citizen service portals – Meri Fasal Mera Byora, e-Kshatipurti, e-Girdawari Mobile app
- Push towards sustainable agriculture through CRM, groundwater conservation, and promoting natural farming
- Policy paradigms supported by technology, innovations and entrepreneurship for their tangible impact and very high dividends across crops, cropping systems and farming systems.

Land Use and Irrigation

- Micro-irrigation coverage: 11.96% (2022)¹³
- Natural/Organic farmlands: 5,303 hectares of 66,05,000 hectares gross cultivated area¹⁴
- Net Area Sown: 3,585 thousand hectares (90.73%)¹⁵
- Irrigation intensity: 176.7%¹⁶

Horticulture

- Production: 68.43 lakh MT (2023-24)¹⁷
- Area: 4.12 lakh hectares (6.28% of gross cropped area)¹⁸
- Fruits: 0.70 lakh hectares producing 8.56 lakh MT¹⁹
- Vegetables: 3.35 lakh hectares producing 59.14 lakh Mt²⁰

Livestock and Dairy²¹

- Milk production: 122.20 lakh tonnes (2023-24)
- Per capita milk availability: 1,105 g/daily (2023-24)
- Cattle population: More than 20 lakh
- Total livestock population ≈90 lakh (cattle, buffalo, goat, sheep, pig, poultry)

Fisheries²²

- Area under fish farming: 23,317 hectares (from 58 hectares in 1966)
- Total fish production: 2.32 lakh metric tonnes (2024-25)
- Saline aquaculture area: 2,360 hectares producing 15,468 tonnes of fish/shrimp

Conservation of Flora and Fauna in Haryana

Protected Areas and In-Situ Conservation

- The state maintains two National Parks (Sultanpur and Kalesar), eight Wildlife Sanctuaries, and two Conservation Reserves covering approximately 303.92 square kilometres, which constitutes 0.69% of the state's geographical area.²³
- The largest protected area is Kalesar National Park, spanning 4682 hectares in the Shivalik foothills and supporting diverse wildlife including elephants, wild boar, sambhar, chital, and red jungle fowl.
- Sultanpur National Park, covering 142 hectares near Gurugram, serves as a crucial habitat for over 300 bird species including migratory waterfowl.²⁴
- Recent conservation efforts have expanded to include community-based conservation through the establishment of community reserves. In 2025, Haryana declared two new community reserves - the 144-

acre Chaudhariwali Community Reserve in Hisar and the 68-acre Shri Guru Jambheshwar Chinkara Community Reserve in Bhiwani²⁵

Ex-Situ Conservation and Specialised Breeding Programmes

- Haryana has developed several specialised breeding centres to support species conservation through ex-situ programmes.
- The Jatayu (Vulture) Conservation and Breeding Centre at Pinjore represents one of the most successful conservation initiatives, established in collaboration with the Bombay Natural History Society to save three critically endangered Gyps vulture species from extinction.²⁶
- The centre has successfully bred over 300 vultures since 2008, with release programmes initiated in 2015-16 to reintroduce captive-bred birds to the wild.²⁷
- The state operates multiple specialised breeding facilities including the Red Jungle Fowl breeding programme at Morni, which focuses on maintaining genetic purity of this ancestral species of domestic chickens.²⁸
- Additional facilities include the Peacock and Chinkara Conservation Breeding Centre at Jhabua in Rewari district, the Chinkara Breeding Centre at Kairu in Bhiwani, and the Elephant Rehabilitation Centre at Ban Santour in Yamunanagar.²⁹

FUTURES TRIANGLE (*Refer to page number 28 for an in-depth overview of the Futures Triangle.)

The Futures Triangle provides a dynamic framework for understanding the complex forces shaping Haryana's agricultural landscape. It examines three critical dimensions: "Pushes of the Present" capturing current drivers of change, both positive (such as natural/organic farming initiatives and technological advances) and negative (including groundwater depletion and policy gaps); "Pulls of the Future" highlighting aspirational forces (like innovative technologies and guaranteed price supports) alongside potential risks (including rising costs and widening technological disparities); and "Weights of the Past" acknowledging historical factors that either enable progress (such as early conservation efforts) or create inertia (including entrenched unsustainable practices). This multidimensional analysis reveals the tension between competing forces and illuminates potential pathways as Haryana navigates toward a sustainable agricultural future. Understanding these interconnected forces is essential for developing effective interventions that can overcome barriers while leveraging existing momentum for positive transformation.

Pushes of the Present

Positive

Increased production of high-yield crops like wheat, rice and cotton owing to the adoption of modern agriculture practices

Significant budgetary allocation INR 8658.66 crore (in FY 2025-26) for agriculture & allied activities³⁰

Negative

Soil Degradation and declining nutrient-use efficiency due to high pesticide use (4,066 metric tonnes in FY 2020- 21)³¹, raising environmental concerns

Persistent **groundwater overexploitation** causing water scarcity and agricultural instability

Positive

5,303 hectares of certified **organic/natural farmland³²** promoting sustainable agriculture

Noticeable **diversification towards allied activities** like horticulture, floriculture, and animal husbandry, providing additional income sources and reducing dependency on traditional crops

Increasing integration of **advanced agricultural technologies in weather monitoring** improving efficiency and sustainability

Improvements in rural infrastructure, including better road connectivity and irrigation facilities, facilitating easier access to markets and resources and boosting agricultural productivity

Market-focused initiatives **bolstering farmer income** and agricultural sustainability

Structured State Environment Action Plan has been formalised for improved waste management, clean energy adoption, and sustainable agricultural practices

Pulls of the Future

Positive

Adoption of **progressive policies for renewable energy** and leveraging of the strong agricultural base to develop bioenergy can provide sustainable energy solutions and reduce dependency on conventional energy sources

Growing **emphasis on sustainable agricultural practices**, including efficient water use and reduced reliance on chemical fertilisers, can lead to long-term environmental benefits and increased productivity

Negative

Scattered small and marginal landholdings **limiting efficiency and modernisation**

Agricultural technologies contributing to **environmental risks through e-waste**

Crop Diversity Decline: Reduction in the cultivation of coarse cereals and pulses, leading to less crop diversity

Declining Total Factor Productivity threatening **economic viability and market adaptability**

Negative

Rising production costs are impeding technology adoption

Fluctuations in market prices and limited access to broader markets could continue to challenge farmers, affecting their income stability and growth potential

Positive

Initiatives such as the **OECM Aravalli** pioneer community-led, nature-based conservation to strengthen Haryana’s ecological resilience and inspire similar efforts across ecological zones

Continued **investment in R&D** for developing high-yield and climate-resilient crop varieties is expected to boost agricultural output and resilience to climate change

Innovative agricultural technologies (Precision Agriculture, Vertical Farming, Aquaponics) are enhancing sustainability

Weights of the Past

Positive

Haryana’s Green Revolution Legacy in the 1960s and 1970s, which introduced high-yield crop varieties and modern farming techniques, set a foundation for agricultural prosperity

The state's longstanding agricultural tradition has fostered a **robust knowledge base and skilled workforce**, contributing to continued agricultural productivity and innovation.

Early adoption of technologies like greenhouse farming and drip irrigation lay the groundwork for advancement

Environmental regulations positively impacted ecosystem health

Cold storage facilities (382 in 2023)³³ reduce post-harvest losses

Negative

Persistent soil degradation due to chemical use may lead to reduced soil fertility, impacting crop yields and long-term agricultural sustainability

Despite efforts to improve **financial accessibility**, small and marginal farmers may still face challenges in obtaining affordable credit, limiting their ability to invest in technology and infrastructure

Negative

High costs and technological barriers limiting technology adoption and worsening post-harvest losses

Monoculture practices in the past, focusing on a narrow range of crops, have **limited biodiversity** and made the agricultural sector vulnerable to pests, diseases, and market fluctuations

Over-reliance on groundwater for irrigation degrading water resources

Excessive fertiliser and pesticide use compromising long-term agricultural productivity

Stubble burning contributing to air pollution and climate change

WHERE DO WE WANT TO GO?

VISION 2047

By 2047, Haryana will Future-Secure Agriculture and Food by transforming itself into a global hub of sustainable, high-value agriculture, driven by innovation, empowered farmers, and climate-resilient systems, while ensuring economic prosperity, reduced agrarian dependency, and leadership in cereals, pulses, oilseeds, cash crops, animal husbandry, horticulture, fisheries under resource efficient production phenomenon including the organic/natural production systems.

- **Climate Resiliency:** Pioneering water conservation, carbon-neutral farming, and environmental stewardship
- **Sustainable Agriculture:** Expanding natural/organic farming, agroforestry, and biodiversity enhancement to regenerate ecosystems
- **Technological Innovation:** Deploying precision agriculture, hydroponics, vertical farming, and AI-driven systems to optimise resource use
- **Supply Chain Excellence:** Developing seamless farm-to-market networks with minimal waste and maximum value retention
- **Economic Prosperity:** Ensuring farming remains profitable, markets are stable, and value addition is maximised
- **Focus on Allied Sectors:** Expanding non-farm sectors, like horticulture, fisheries, animal husbandry, mushroom cultivation, and apiary development is vital for diversifying Haryana's agricultural economy and boosting rural livelihoods.

STRATEGIC MISSION*

Future-Secure Agriculture and Food – The EEE Approach

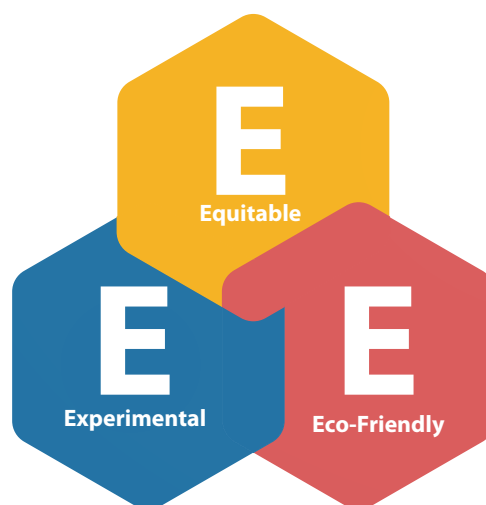
Haryana is committed to transform its agricultural landscape through the **EEE Approach – Equitable, Eco-Friendly, and Experimental Farming**. This forward-looking strategy aims to revolutionise Haryana's agrarian economy by diversifying crops, adopting cutting-edge technology, and building efficient supply chains to quadruple farmer income in real-value terms, promote agro-industries, and transition 20% of farmland to organic/natural practices by 2047. We will empower smallholders, consolidate landholdings, and leverage national missions to create a future where farming is profitable, sustainable, and aspirational.

*Aligned Departments: Agriculture, Horticulture, Animal Husbandry, Fisheries, Forests, Environment, Cooperation, Food & Supplies

1. Equitable: This dimension focuses on creating fair opportunities and inclusive benefits for all involved in agriculture – from small and marginal farmers and labourers. It seeks to ensure equitable access to resources, fair pricing, and a balanced share in the prosperity generated by the sector, thereby reducing disparities and fostering social justice within rural communities.

2. Eco-Friendly: Emphasising sustainable and environmentally responsible practices, this component encourages the adoption of techniques that conserve water, improve soil health, and reduce pollution. It aims to safeguard natural resources for future generations while addressing the growing risks of climate change and environmental degradation.

3. Experimental: This aspect promotes culture of innovation by encouraging the adoption of new crop varieties, precision farming technologies, advanced agronomic practices and sustainable practices. By fostering experimentation, the approach prepares farmers to adapt to changing conditions and enhances the resilience of Haryana’s agriculture.



However, a significant challenge lies in the existing resistance among farmers to adopt new technologies, driven by the need for income security and limited scope for risk-taking ability. Overcoming this requires gentle policy nudges, financial safeguards, and supportive schemes (extension support from State agriculture universities and ICAR institutes) that ease the transition towards sustainable and future-ready agriculture.

GOALS

Indicator	Baseline	Baseline Source	Target 2030	Target 2036	Target 2047	Benchmarks
Growth Rate of Agriculture & Allied Sectors (%)	4.4%	Annexure 2	5.17%	5.33%	2.01%	Based on the research paper "Viksit Haryana@2047: A Triad Framework for Inclusive and Sustainable Growth"

Indicator	Baseline	Baseline Source	Target 2030	Target 2036	Target 2047	Benchmarks
Forest cover to total geographical area	4.04% (2020 - 21)	MoEFCC, GOI	> 4.7%	> 5%	> 6%	National target of 33% land under forest cover. Targets aligned with India's commitment under Paris Agreement; progressive increase through agroforestry expansion, ecological restoration, and carbon sequestration initiatives.
Proportion of net sown area to cultivable land	90.73% (2021-22)	Statistical Abstract of Haryana 2022-23	100%	100%	100%	Full utilisation of cultivable land ensures food security and maximises agricultural output while promoting sustainable land management practices. Achievable through land reclamation and modern farming techniques.
Percentage of degraded land developed for farming activities	11.09% (2020)	Department of Agriculture and Farmers Welfare	100%	100%	100%	UN Land Degradation Neutrality targets; Land Degradation Neutrality Fund aims for 12 million hectares globally by 2030. Targets align with SDG 15.3 for land degradation neutrality by 2030; progressive improvement through soil remediation techniques and sustainable land management.

Indicator	Baseline	Baseline Source	Target 2030	Target 2036	Target 2047	Benchmarks
Percentage of net area under natural/organic farming	0.144% (March 2023)	Statistical Abstract of Haryana 2022-23	~5%	> 10	> 20%	Leading states (Sikkim - 100%, Uttarakhand - 12%). Targets align with National Programme for Organic Production goals; progressive adoption curve reflecting certification timelines and market development for organic produce.
Availability of milk per capita per day (liters)	1,105 (2023-24)	Economic Survey of Haryana 2024-25	1607	> 1745	> 2,000	Global leaders: USA (960 L/capita/year), New Zealand (630 L/capita/year). Targets reflect Haryana's position as leading dairy producer; achievable through genetic improvement, feed management, and value-chain strengthening.
Poultry egg production (in lakhs)	85,595.79 (2023-24)	Department of Animal Husbandry & Dairying	1,20,000	> 130590	> 1,50,000	National targets aim for 145 eggs per capita by 2030. Progressive growth reflecting improved breed development, disease management, and modernised poultry operations aligned with protein security objectives.

Indicator	Baseline	Baseline Source	Target 2030	Target 2036	Target 2047	Benchmarks
Fish productivity (kg per hectare per year)	7,232.46 (2021)	Department of Fisheries, Gol	16000	> 20940	> 30,000	Global leaders: China (>25,000 kg/ha/yr). Targets reflect transition to intensive aquaculture systems, species diversification, and improved water management technologies.
Productivity of fruits and vegetables (Metric Tonne/Hectare)	Fruits: 12.22; Vegetables: 17.65	Statistical Abstract of Haryana 2023-24	Fruits: 20; Vegetables: 21.95	Fruits: 30 Vegetables: 28	Fruits: > 50; Vegetables: > 40	Global leaders: Netherlands (Vegetables: >50 MT/ha). Targets align with National Horticulture Mission objectives; achievable through protected cultivation, precision farming, and climate-resilient varieties.
Percentage of farmers issued Soil Health Card	93.5 (2019-20)	Department of Agriculture and Farmers Welfare	100		100	National target of 100% coverage under Soil Health Card scheme. Complete coverage essential for precision agriculture and sustainable soil management; achievable through digital integration and mobile testing units.

Indicator	Baseline	Baseline Source	Target 2030	Target 2036	Target 2047	Benchmarks
Cold storage capacity (in '000 tonnes)	382 (2023)	Directorate of Marketing and Inspection (DMI) upto 2009, National Horticulture Board (NHB), National Horticulture Mission (NHM), Horticulture Mission for North East & Himalayan States (HMNEH) and Ministry of Food Processing Industries (MoFPI)	450	> 503	> 600	National Cold Chain Development target: 35 million MT by 2030. Progressive capacity increase aligned with production growth projections; essential for reducing post-harvest losses and supporting export targets.

POSSIBLE FUTURE SCENARIOS

BUSINESS AS USUAL FUTURE

- Persistent market uncertainties and price fluctuations threaten long-term sustainability and livelihoods
- Inadequate policy frameworks impede efforts to address critical challenges
- Continued soil degradation leads to poor yields and heightened food insecurity
- Inefficiencies due to scattered landholdings and absentee landlordism hinder modernisation

NEGATIVE DISRUPTIVE FUTURE (RISKS)

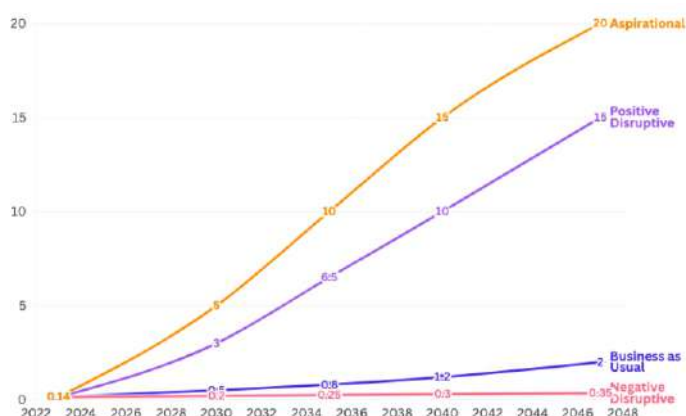
- Widened disparities among farmers impede overall progress and competitiveness
- Declining Total Factor Productivity and rising production costs threaten economic viability
- Environmental degradation intensifies due to water overuse, chemical inputs, and stubble burning
- Long-term sustainability of agriculture and the environment is increasingly threatened

POSITIVE DISRUPTIVE FUTURE (OPPORTUNITIES)

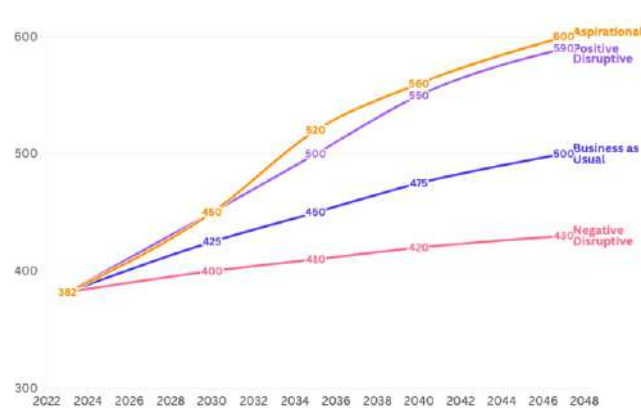
- Haryana emerges as a trailblazer in eco-friendly agricultural practices
- Continued investment drives innovation and improves productivity and sustainability
- Market-focused initiatives bolster farmer income and enhance value chains
- Increased agricultural exports position Haryana as a leader in sustainable agriculture and economic growth

ASPIRATIONAL FUTURE

- Optimised resource utilisation maximises yields and ensures enduring food security
- Advanced agricultural technologies mitigate post-harvest losses and enhance sustainability
- Prosperous, eco-conscious agricultural sector with enhanced income and livelihoods
- Rural economic growth stimulated by guaranteed price support and farmer-friendly policies



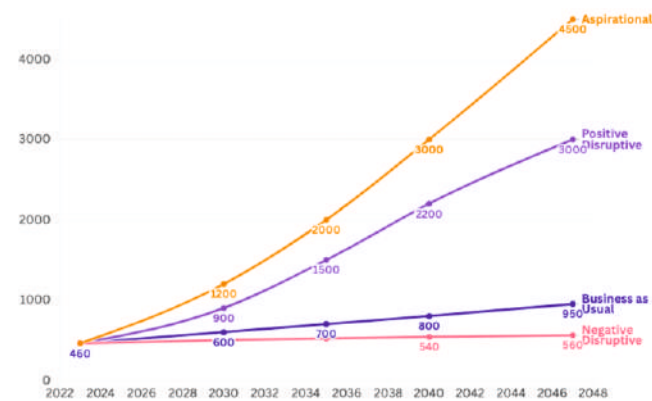
Graph 21 (a): Percentage of Net Area under natural/organic farming



Graph 21 (b): Cold Storage Capacity (in '000 tonnes)



Graph 21 (c): Groundwater Extraction Rate (%)



Graph 21 (d): Number of Farmer Producer Organisations (FPOs)

HOW WILL WE REACH THERE?

Realising Haryana’s agricultural vision calls for a comprehensive, interconnected strategy across six core domains. Productivity-led growth must be driven through research, innovation, and agro-climatic zone-based planning, ensuring that government schemes align with local ecological strengths, particularly in horticulture. With declining natural resources, focus shifts to climate-smart practices, efficient water management, and regenerative agriculture to restore soil health and raise soil carbon from 0.3% to 1% by 2047. Key actions include no-till or reduced tillage, cover cropping, use of compost and manure, and integration of trees and shrubs through agroforestry and horticulture for long-term carbon storage. Minimising post-harvest losses requires an integrated cold chain system connecting farm gate to consumer—covering collection, grading, sorting, pre-cooling, processing, and refrigerated transport. Such seamless infrastructure strengthens value chains, improves quality, and boosts farmer incomes.

Modernisation of agriculture depends on digitalisation, precision farming, and AI-enabled decision systems for efficient resource use and risk management. Expanding post-harvest infrastructure, market linkages, and innovative financing mechanisms will further enhance productivity and stability. Above all, transformation must remain inclusive, empowering farmers of all landholding sizes through reformed land policies, strong FPOs, and diversified, future-ready markets. The strategic pathways outlined provide actionable short- and long-term pathways toward an equitable, sustainable, and globally competitive agriculture ecosystem by 2047.

Issues

- 🔍 Climate Resilience and Environmental Protection
- 🔍 Sustainable Agriculture Practices
- 🔍 Advanced Agricultural Technologies
- 🔍 Supply Chain and Post-Harvest Management
- 🔍 Economic Viability and Market Adaptation
- 🔍 Agrarian Reform and Innovative Markets

ISSUE 1: CLIMATE RESILIENCE AND ENVIRONMENTAL PROTECTION

The agricultural landscape in Haryana faces mounting challenges from climate change and environmental degradation. While the Green Revolution propelled food production, it left environmental concerns, including intensive agrochemical use and biodiversity loss. Rapidly depleting groundwater reserves, exacerbated by water-intensive crops like paddy (covering 17.78 lakh hectares in 2023-24)³⁴ and subsidised electricity, have reached critical levels with a 135.74% extraction rate.³⁵ Additional challenges include air pollution from stubble burning (declining but still significant with 1,118 incidents in 2024)³⁶ and agricultural greenhouse gas emissions that have nearly doubled from 39.57 to 75.72 Mt Co₂ between 2005-2023.³⁷ Building resilience against climate variability and extreme weather events is now imperative for ensuring food security and sustainable livelihoods.

Current Status

- ✔ Annual groundwater extraction: 11.80 billion cubic metres (extraction rate: 135.74%)³⁸
- ✔ Agricultural electricity subsidy: INR 5,941.17 crore (2024-25)³⁹
- ✔ Paddy stubble burning cases: 6,987 (2021), 3,661 (2022), 2,303 (2023), 1,118 (2024) Ministry of Environment, Forests and Climate Change (MoEFCC)
- ✔ GHG emissions increase: 39.57 Mt CO₂ (2005) to 75.72 Mt carbon dioxide equivalent (Co2e) (2023)⁴⁰
- ✔ Carbon dioxide emissions from crop residue burning: 2,344.59 to 2,602.82 gigagrams/year (2011-2020)⁴¹

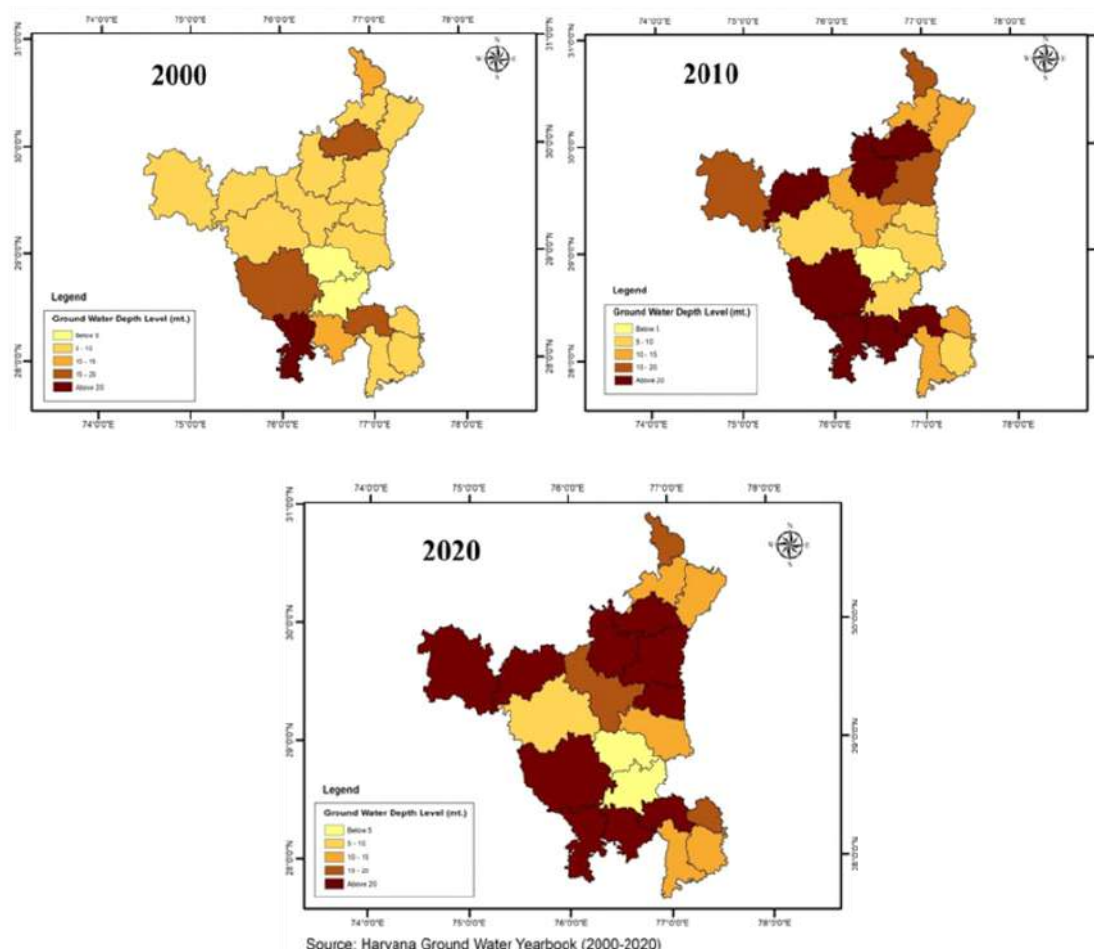
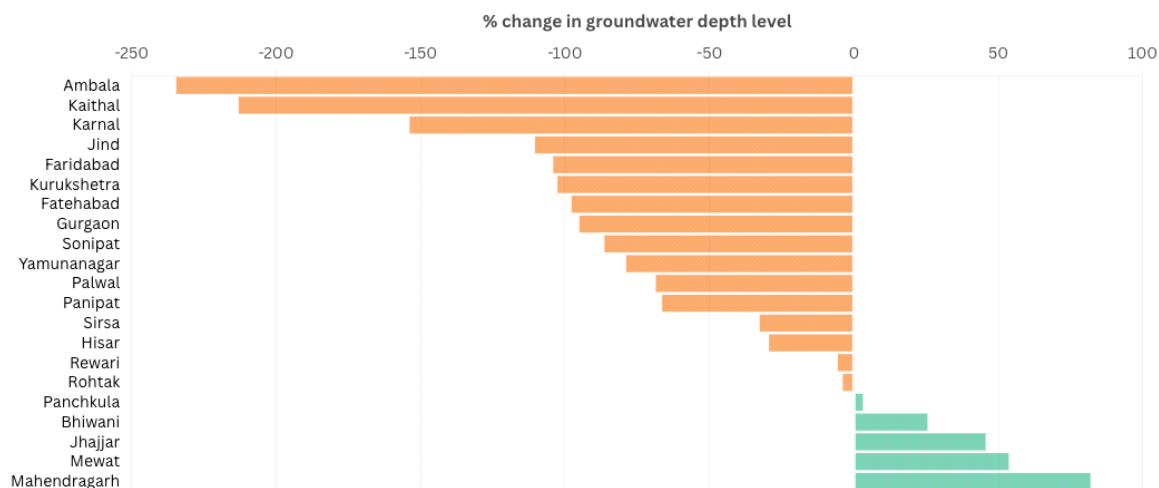


Figure 3: District-wise Groundwater Depth in Haryana over 2000-2020
(Source: Haryana Groundwater Yearbook (2000-2020))



Graph 22: Percentage Change in Groundwater Depth Level

(Source: National Compilation on Dynamic Ground Water Resources of India 2024)

- NOTE: Historical data for Charkhi Dadri are not readily available since the district was formed in 2016.

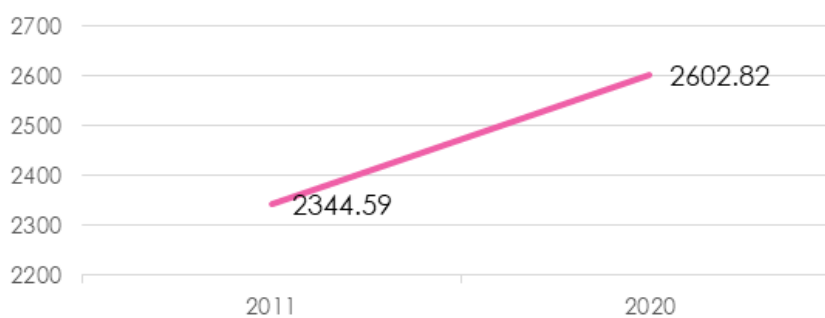
Paddy Farm Fire Counts in Haryana



Graph 23: Paddy Farm Fire Counts in Haryana

(Source: PIB <https://pib.gov.in/PressReleaseframePage.aspx?PRID=1981276>)

Co2e Emissions from Crop Residue Burning



Graph 24: CO2e Emissions from Crop Residue Burning

(Source: Deshpande M V, et al Greenhouse gas emissions from agricultural residue burning have increased by 75 % since 2011 across India, Science of The Total Environment)

Economy-wide Emissions Estimates

Figure 1: GHG Emissions Estimates of Haryana (2005 to 2018)



Graph 25: GHG Emissions Estimates of Haryana 2005 to 2018
(Source: Trend Analysis of GHG Emissions of Haryana)

Factors Influencing the Issue

- **Political Will and Policy Framework:** Government commitment through regulatory measures and incentives directly impacts adoption rates of climate-resilient practices and technologies.
- **Market and Public Perception:** Growing public awareness and consumer demand for environmentally responsible products are creating strong market incentives, driving the financial viability of climate-smart agricultural practices and attracting investment.
- **Farmer Education and Attitude:** Knowledge gaps and traditional practices often hinder implementation of climate-resilient technologies and sustainable farming methods.
- **Technological Innovation:** Precision agriculture, renewable energy integration, and water conservation technologies offer solutions but require accessible financing mechanisms.
- **Environmental Pressures:** Water scarcity, rising temperatures, and extreme weather events create urgency for adaptation strategies.
- **Research and Development:** Ongoing scientific innovation in climate-adaptive crop varieties and farming techniques supports transition to resilient agriculture.
- **Livestock Productivity and Methane Mitigation**
 - Heat Stress and Drought Impacts: Rising temperatures and prolonged dry spells are directly affecting livestock health and milk yields, leading to reduced income and nutritional security for rural households.

- **Methane Reduction through Improved Feeding:** Adoption of improved feed formulations, probiotics, and balanced diets can significantly cut methane emissions per unit of milk produced, enhancing both productivity and environmental outcomes.
- **Biogas and Manure Management:** Promoting biogas plants and scientific manure management systems can help reduce greenhouse gas emissions, recycle nutrients, and generate clean energy for rural households.

Impacts of the Issue

Direct Impact

- Reduced water usage and pressure on groundwater from water conservation practices
- Reduced air pollution and health hazards from eliminating stubble burning
- Enhanced adaptation to changing climate conditions
- Initial investment costs in climate-resilient infrastructure

Indirect Impact

- Improved water availability and quality, enhanced soil health and biodiversity, economic benefits from diversification, increased resilience to climate impacts, and preserved aquifer levels
- Improved soil fertility, mitigated GHG emissions, enhanced biodiversity and ecosystem health
- Improved agricultural productivity despite climate variability, sustainable land and water management, and ecosystem health preservation
- Enhanced community resilience to climate risks, reduced vulnerability, ensured food security, reduced emissions, and climate change mitigation

Global Learnings

Global Best Practice

Israel's Drip Irrigation Revolution

Israel pioneered modern drip irrigation technology, a transformative solution to the challenge of overexploitation of groundwater in agriculture. With water efficiency levels reaching up to 95–100%, this innovation has enabled farmers to maintain high crop yields in arid and water-scarce environments. This technology has since been adopted globally and is credited with significantly improving water-use efficiency and sustainability in agriculture across multiple continents.⁴²

Disruptive Technologies - Mitigating Climate Change Through Biogas Production

Biogas, sourced from organic materials like food residues, manure, and slurry, offers a renewable energy solution for agriculture while closing the nutrient loop. By converting waste into biogas and utilising the resulting digestate as fertiliser, farmers can reduce GHG emissions, decrease reliance on chemical fertilisers, and secure additional income streams. This sustainable cycle enhances agricultural resilience and environmental stewardship.⁴³

Possible Pathways

Short-Term Pathway (2030)

Adoption of Climate-Smart Agriculture Practices

- Implement region-specific policies mandating precision farming and drip irrigation adoption, with compliance monitoring and financial incentives
- Implement mandatory, inclusive farmer training on climate-smart techniques through mobile apps, e-learning portals, and community-led outreach, ensuring last-mile access for smallholders, women, and tenant farmers

Technology-Driven Climate Risk Monitoring and Infrastructure

- Deploy satellite-integrated AI systems for climate risk monitoring with real-time data hubs for early intervention
- Modernise irrigation infrastructure with IoT-driven smart water systems and provide incentives for farmers to end crop burning

Water Harvesting and Pollution Mitigation Partnerships

- Establish collaborative partnerships with NGOs for large-scale water harvesting and pollution control campaigns

Strengthening Climate Resilience and Environmental Monitoring

- Establish Central Command Centre for Agriculture

Strengthening Water Security and Management

- Integrated and data-driven water management via Block/Sub-Division Level Water Security Councils and a Real-time Groundwater Monitoring Dashboard

Water Resource Management

- Develop a Real-Time Water Governance System using satellite and sensor-based monitoring
- Promote micro-irrigation, precision irrigation, and water-efficient crop planning

Long-Term Pathway (2047)

Advanced Technology for Climate Monitoring and Risk Management

- Develop comprehensive real-time climate monitoring platforms using AI and satellite imagery for policy-making and adaptation solutions
- Deploy AI-driven forecasting models integrating satellite and sensor data for automated disaster early warning and risk mitigation

Circular Economy and Waste Management in Agriculture

- Enforce Extended Producer Responsibility policies requiring industries to manage agricultural waste recovery and expand waste-to-energy systems

Water Resource Management

- Introduce a Water Credit System rewarding farmers for reducing water use against district benchmarks
- Establish basin-level integrated water management frameworks with AI-driven forecasting

Climate Resilience and Natural Farming

- Promote carbon-credit incentives for low-emission farming
- Embed resilience and disaster preparedness across all agriculture programmes through early warning and insurance linkages

Under Residue Management and Environmental Protection

- Enforce environmental safeguards through biodiversity enhancement, waste recycling, and low-emission technology adoption
- Integrate air quality and soil health monitoring into farm-level sustainability reporting

Short-Term Pathway (2030)

Climate Resilience and Natural Farming

- Pilot and validate natural farming practices across agro-ecological zones
- Integrate climate-smart technologies—stress-tolerant varieties, micro-irrigation, and renewable energy systems

Residue Management and Environmental Protection

- Incentivise Custom Hiring Centres (CHCs) for residue management machinery
- Promote composting, pelletisation, and biogas units as alternatives to stubble burning

Long-Term Pathway (2047)

ISSUE 2: SUSTAINABLE AGRICULTURE PRACTICES

Haryana, a key state in India’s agricultural landscape, has been at the forefront of agricultural development since the Green Revolution, playing a vital role in enhancing food grain production and contributing to national food security. However, the long-term sustainability of agriculture in the state is questionable due to intensive farming practices. Reliance on traditional rice-wheat cropping systems has resulted in groundwater depletion, soil degradation, and responsive varieties have increased dependency on chemical fertilisers and fertilisers & pesticides. In response, the Haryana Government is actively promoting sustainable agricultural practices through crop diversification programmes, the adoption of less water-intensive crops, and the encouragement of organic and natural farming. Notably, initiatives like **“Mera Pani Meri Virasat”** aim to motivate farmers towards water-saving techniques and alternative cropping patterns. In a significant development, the Chief Minister announced in February 2025 that **24,000 farmers have registered on the ‘Natural Farming Portal,’ with over 10,000 farmers currently practising natural farming on 15,170 acres of land**⁴⁴. Integrated Crop-Livestock Farming Systems (ICLFS) for small/marginal farmers improves soil fertility, recycles nutrients, diversifies income, and builds resilience.

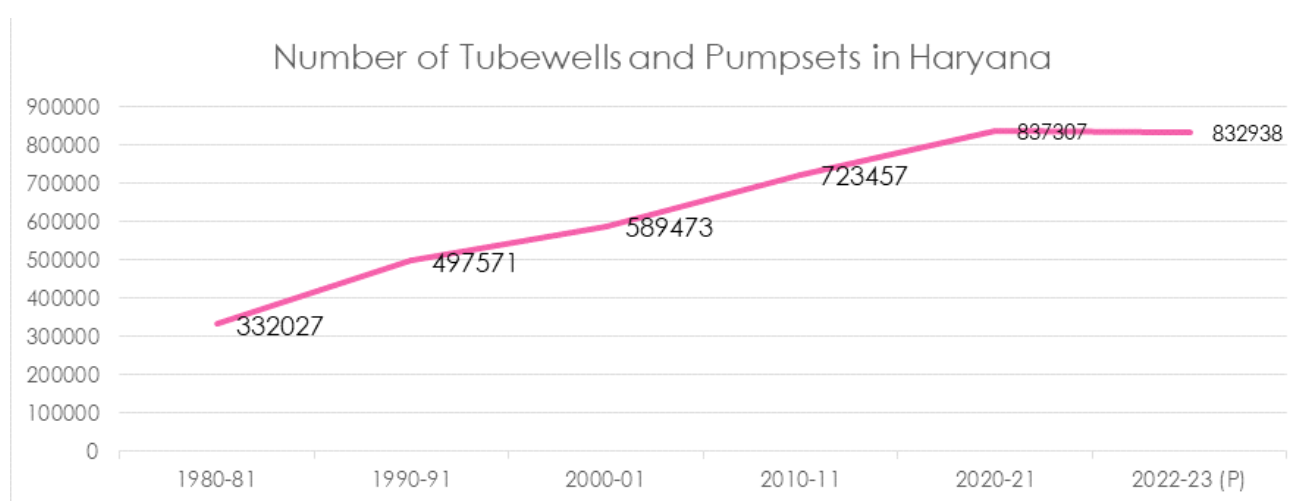
The state has dedicated 5,177.75 hectares to natural/organic farming⁴⁵ with ambitious expansion plans, while agroforestry systems based primarily on poplar and eucalyptus cover approximately 3% of farmlands.⁴⁶ However, soil health degradation remains a pressing concern due to excessive fertiliser and pesticide use (4,066 metric tonnes in FY 2020-21)⁴⁷, compromising long-term productivity and ecosystem health. Despite recognition of water conservation importance, adoption rates of micro-irrigation technologies remain suboptimal, with coverage of approximately 6,83,524 hectares (43,868 hectares under drip and 6,39,656 hectares under sprinkler irrigation)⁴⁸. Addressing these challenges through integrated approaches is critical for maintaining agricultural productivity and environmental sustainability.

Current Status

- ✔ Natural/organic farming area: 5,177.75 hectares⁴⁹
- ✔ Agroforestry coverage: 3% of farmlands⁵⁰
- ✔ Micro-irrigation area: 6,83,524 hectares (43,868 hectares drip, 6,39,656 hectares sprinkler)⁵¹
- ✔ 65 lakh Soil Health Cards issued⁵²
- ✔ Soil Testing Labs: 142 (52 static, 54 mini, 36 village-level)⁵³

Factors Influencing the Issue

- **Market Forces:** Growing consumer preference for organic and sustainably grown products creates economic incentives for adoption.
- **Policy Support:** Subsidies for organic inputs, certification, and water-saving technologies significantly impact adoption rates.
- **Economic Viability:** Transition costs and yield concerns during conversion periods are primary considerations for smallholder farmers.
- **Knowledge Access:** Agricultural extension services and farmer-to-farmer knowledge networks accelerate the implementation of conservation techniques.
- **Climate Change Impacts:** Erratic rainfall patterns and temperature fluctuations create urgency for resilient farming systems.
- **Social Factors:** Community cohesion and traditional knowledge systems influence collective action toward sustainable resource management.
- **Technological Innovation:** Advancements in precision farming, biological pest control, and soil health monitoring provide practical solutions.
- **Infrastructure Limitations:** Inadequate storage, processing, and market access facilities constrain value realisation from sustainable products.



Graph 27: Number of Tubewells and Pumpsets in Haryana
(Source: Department of Irrigation and Water Resources, Haryana)

Impacts of the Issue

Direct Impact

- Increased soil fertility and biodiversity from natural/organic farming
- Reduced soil erosion and water runoff from agroforestry
- Reduced water usage and enhanced efficiency through conservation techniques

Indirect Impact

- Enhanced water retention, reduced erosion, improved soil structure, increased crop yields, carbon sequestration, and long-term environmental sustainability
- Decreased flood risk, economic benefits from agroforestry products, diversified income streams, enhanced rural livelihoods
- Reduced waterlogging and salinisation, enhanced crop yields, stabilised groundwater levels, and prevention of further resource depletion

Global Learnings

Global Best Practice

Ethiopia's Community-Led Soil and Water Conservation Initiatives

Ethiopia has implemented extensive community-driven soil and water conservation programmes to combat severe land degradation and enhance agricultural productivity. Notably, projects like the Sustainable Water Fund's "Ziway-Shalla: Basin in Balance" have engaged local communities in constructing physical structures such as stone bunds and terraces to reduce soil erosion and improve water retention. These interventions have led to significant improvements in soil fertility, increased crop yields, and restored degraded landscapes.⁵⁴

Disruptive Technologies - Integrating Drone Technology for Sustainable Agriculture and Water Conservation

Through the utilisation of drones equipped with advanced sensors, farmers can precisely monitor crop health and detect signs of strain, enabling targeted irrigation and resource management. This strategic approach allows farmers to optimise water usage by watering only those plants in need, thereby enhancing agricultural efficiency and promoting environmental sustainability.⁵⁵

Possible Pathways

Short-Term Pathway (2030)

Sustainable Farming and Climate Resilience Incentives

- Enforce organic certification standards and provide financial incentives for agroforestry adoption and water conservation techniques
- Deploy drip and precision irrigation systems with IoT-based monitoring and provide financial incentives for farmers adopting crop diversification

Research and Data-Driven Interventions

- Partner with research institutions to conduct region-specific soil health studies and climate adaptation research
- Distribute affordable soil testing kits with AI-integrated digital platforms for real-time nutrient analysis and crop suitability guidance

Capacity Building and Knowledge Dissemination

- Allocate government grants and mobilise private sector investments for farmer training via digital platforms and on-site demonstrations

Promoting Sustainable Farming Practices

- Setting up Traditional Knowledge Information Centres for Agriculture

Promoting Millet Cultivation and Consumption

- Ensuring millet mainstreaming through Minimum Support Price (MSP) assurance, Public Distribution System (PDS) procurement, and nutrition programme inclusion

Policy and Institutional Strengthening

- Strengthen interdepartmental coordination for integrated agricultural development and ensure convergence of central and state-level schemes under a unified monitoring framework
- Align with PM-KUSUM, National Food Security Mission (NFSM), Rashtriya Krishi Vikas Yojana (RKVY) and State Agri Missions, integrating sustainability and entrepreneurship objectives

Long-Term Pathway (2047)

Policy Integration and Governance

- Embed sustainable agriculture principles into national policies with legally binding mandates monitored through AI-driven compliance systems

Institutional Development and Capacity Building

- Develop government-backed agricultural institutes offering specialised sustainability certifications and advanced training in climate-adaptive farming
- Establish farmer cooperatives and rural learning centres focusing on marginalised communities with hands-on training in regenerative agriculture

Ecological Restoration and Climate Mitigation

- Expand agroforestry zones and ecological buffer networks, restoring degraded lands with native vegetation through conservation corridors
- Implement large-scale reforestation and carbon sequestration projects using AI-driven land assessment for targeted restoration of degraded areas

Policy and Institutional Strengthening

- Establish the Haryana Agricultural Innovation Fund (HAIF) as a public-private seed fund to finance agri-startups in robotics, biotech seeds, precision tools, and sustainable inputs
- Create a unified institutional framework integrating agriculture, livestock, and allied sectors for One Health-aligned governance

Crop Diversification and Sustainability

- Promote Regenerative Agriculture Zones through “Regenerative Farming Clusters” integrating multi-cropping, biochar application, and carbon farming
- Foster secondary agriculture and rural enterprises for value addition and carbon credit generation

Soil Health and Nutrient Management

- Implement large-scale soil salinity management through subsurface drainage and green manuring

Short-Term Pathway (2030)

- Provide credit-linked subsidies and policy incentives for natural farming, residue management, and Integrated Pest Management (IPM) adoption
- Institutionalise periodic impact assessments and feedback loops for evidence-based policy refinement

Crop Diversification and Sustainability

- Develop region-specific diversification models focusing on high-value, low-water crops (pulses, millets, oilseeds, vegetables, fodder).
- Promote short-duration varieties and legumes/pulses in crop rotations to enhance soil fertility.
- Encourage agroforestry, horticulture-based models, and cluster-based diversification incentives.
- Scale up Direct Seeded Rice (DSR) and Zero-Tillage Wheat (ZTW) for water and energy optimization.

Soil Health and Nutrient Management

- Promote Soil Health Cards and customised nutrient management with biofertiliser and microbial consortia adoption.
- Establish soil, fertiliser, and pesticide testing laboratories, including mobile testing units.

Capacity Building and Human Resource Development

- Invest in training programmes for extension workers, FPO members, and youth across crop and allied sectors.
- Develop training modules on DSR, IPM, and regenerative practices tailored to Haryana's agro-climatic zones.
- Promote digital capacity building and farmer-to-farmer learning models.

Long-Term Pathway (2047)

- Advance carbon farming and soil organic matter restoration under regenerative agriculture frameworks.

Capacity Building and Human Resource Development

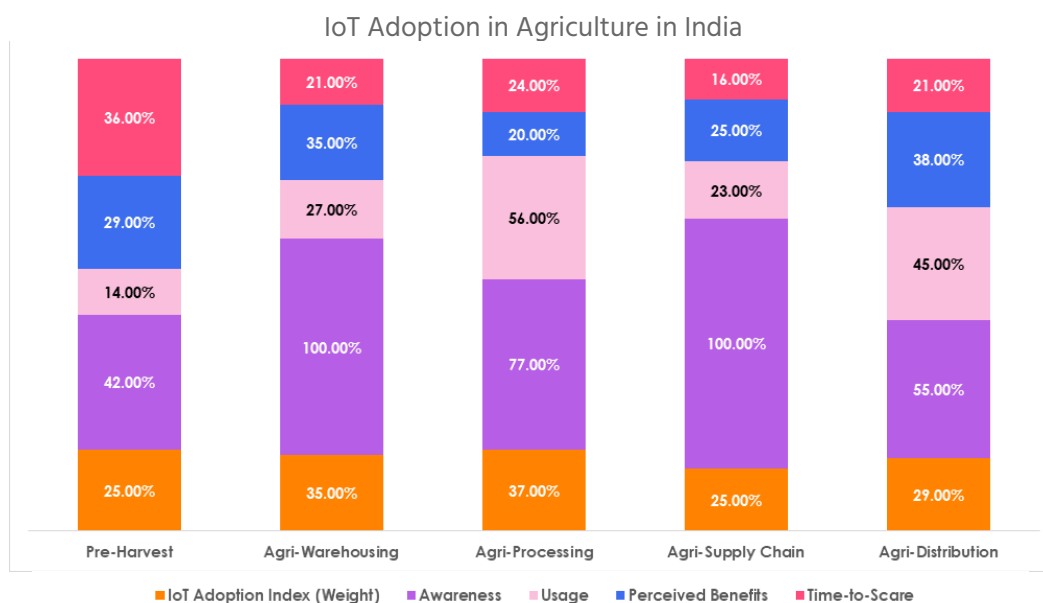
- Promote gender-responsive mechanization with lightweight, battery-operated tools and women-led cooperatives.
- Institutionalize agri-skill academies for continuous, adaptive learning.

ISSUE 3: ADVANCED AGRICULTURAL TECHNOLOGIES

The ever-increasing demand for food production, driven by population growth, presents significant challenges for Haryana's agricultural sector. Traditional farming methods struggle to meet this escalating demand, especially amid rising pollution levels and unpredictable climate patterns. The adoption of advanced technologies offers promising solutions—with the Indian Hydroponics Market reaching 506.7 Million USD in 2024 (projected CAGR: 16.91%),⁵⁶ the Vertical Farming Market valued at 82.7 million USD (projected to reach 579.7 million USD by 2033),⁵⁷ and the Precision Agriculture Market at 102.31 million USD (projected 6.12% growth through 2030).⁵⁸ The Haryana Government is actively promoting the use of technology in agriculture through several forward-looking initiatives. The state has introduced AI and drone technology for assessing crop yields and losses, improving efficiency and decision-making in farming. To facilitate the adoption of drone technology, training programmes are being offered to farmers, enabling them to become certified drone pilots. In a historic move, the government has also decided to provide drone-based spraying services for agrochemicals, including nano urea, ensuring this facility reaches every farmer's field. These initiatives form part of a broader strategy to integrate digital technologies into agriculture, aiming to enhance productivity, sustainability, and farmer welfare. However, adoption remains uneven, with greater integration in processing sectors than pre-harvest operations, highlighting the need for targeted initiatives to design and implement innovative farming techniques tailored to the region's specific needs and constraints.

Current Status

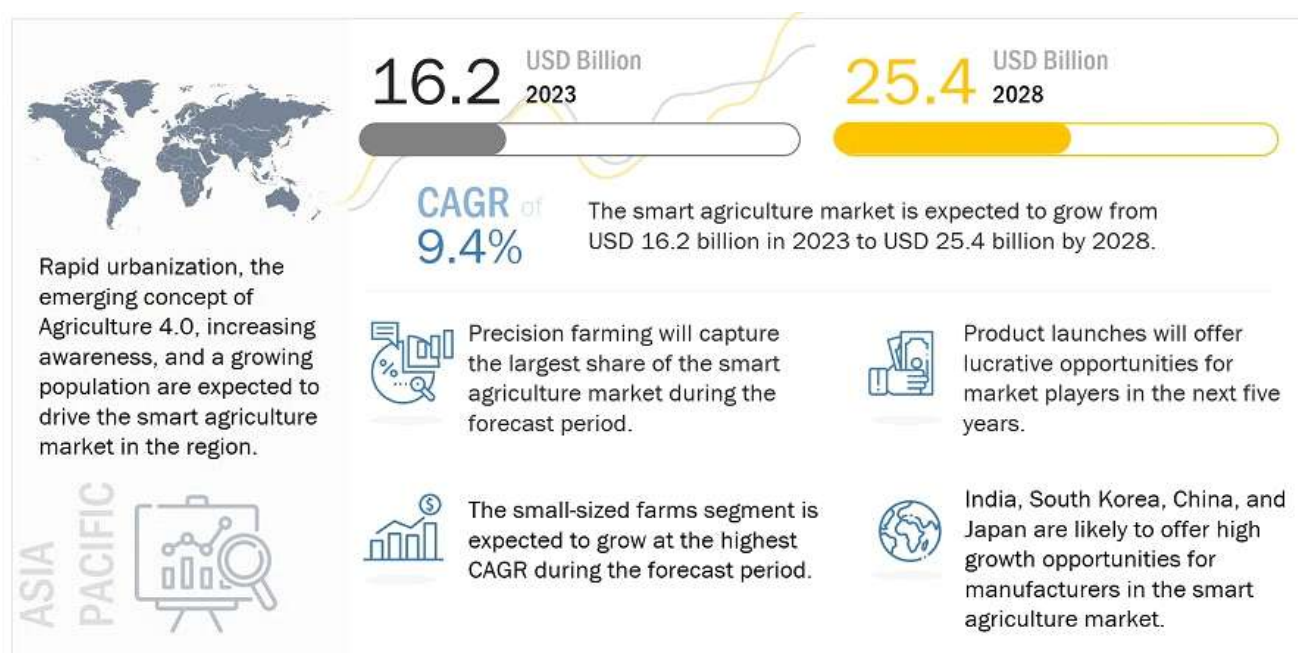
- ✔ Indian Hydroponics Market: 506.7 Million USD (2024), CAGR of 16.91% (projected 2025-2033)⁵⁹
- ✔ India Vertical Farming Market: 82.7 million USD (2024), projected to reach 579.7 million USD by 2033⁶⁰
- ✔ Higher IoT adoption in agricultural processing than in pre-harvest operations
- ✔ India Precision Agriculture Market: 102.31 million USD (2024), CAGR of 6.12% (projected 2026-2030)⁶¹
- ✔ Smart Agriculture Market growth: 16.2 billion USD (2023) to 25.4 billion USD (2028)⁶²
- ✔ Government allocation for new agricultural technologies: 200.22 million USD (2020-21), 276.3 million USD (2021-22)⁶³



Graph 28: IoT Adoption in Agriculture in India
(Source: Statista 2024)

Factors Influencing the Issue

- **Government Support:** Policy frameworks, subsidies, and regulatory environment create enabling conditions for technological innovation.
- **Technological Advancement:** Ongoing innovation in IoT, AI, blockchain, and biotechnology provides increasingly sophisticated agricultural solutions.
- **Real-Time Disease Forecasting and Bio-Surveillance:** The use of IoT-enabled sensors, Geographic Information System (GIS) mapping, and AI analytics is transforming livestock health management. Real-time animal disease forecasting and bio-surveillance systems enable early detection of outbreaks, quick response mechanisms, and data-based policy decisions—reducing losses and improving overall resilience in the livestock sector.
- **Environmental Pressures:** Water scarcity and climate variability generate demand for resource-efficient technologies like hydroponics and vertical farming.
- **Market Dynamics:** Premium pricing for high-quality produce and export opportunities provide economic incentives for technology adoption.
- **Knowledge Access:** Training, technical support, and demonstration projects significantly influence implementation success.
- **Economic Viability:** Initial investment costs versus long-term returns remain decisive factors, especially for small and marginal farmers.
- **Infrastructure Requirements:** Power supply stability, internet connectivity, and transportation networks determine technological feasibility.
- **Social Acceptance:** Cultural attitudes toward technology and willingness to deviate from traditional practices affect adoption rates.



Smart Agriculture Market Forecast to 2028

Figure 4: Smart Agriculture Market Forecast to 2028

(Source: Markets and Markets <https://www.marketsandmarkets.com/Market-Reports/smart-agriculture-market-239736790.html>)

Impacts of the Issue

Direct Impact

- Enhanced resource efficiency through optimal nutrient delivery, efficient water and land usage, and precise monitoring
- Development of skilled workforce through training and education
- Strengthened animal health systems addressing emerging and re-emerging zoonotic diseases, antimicrobial resistance (AMR), and food safety implications.

Indirect Impact

- Consistent crop quality, higher yields, increased profitability, economic growth, reduced environmental footprint
- Growth of agricultural technology startups and research, new market opportunities both locally and internationally

Global Learnings

Global Best Practice

United States' IoT-Driven Precision Agriculture:

In the United States, farmers are increasingly adopting IoT technologies to enhance precision agriculture practices. By deploying sensors that monitor soil moisture, nutrient levels, and crop health in real-time, farmers can make data-driven decisions to optimise resource usage, improve yields, and reduce environmental impact. This technological integration supports sustainable farming by enabling targeted interventions and efficient management of agricultural inputs.⁶⁴

Disruptive Technologies - Enhancing Agriculture with IoT Technology

The agriculture industry harnesses various technologies like the IoT to streamline operations and boost productivity. One prime application of IoT in agriculture is crop monitoring, where IoT sensors for temperature, humidity, light, pH, and soil moisture offer valuable insights leading to improved yields for farmers. Additionally, IoT sensors and connected devices play a crucial role in livestock management, enabling farmers to monitor the activities and health of their animals more effectively. This digital transformation in livestock management simplifies farmers' tasks and enhances overall farm efficiency.⁶⁵

Possible Pathways

Short-Term Pathway (2030)

Regulatory Framework and Compliance

- Establish legally binding guidelines for AI-driven precision farming and sensor-based irrigation systems with compliance monitoring

Long-Term Pathway (2047)

Policy Integration and Equitable Access

- Embed AI-driven precision farming, automated irrigation, and climate-smart technologies into agricultural policy frameworks, ensuring affordability and equitable access across all landholding categories

Short-Term Pathway (2030)

Public-Private Innovation and Technology Deployment

- Collaborate with agri-tech firms and research institutions to deploy region-specific smart farming solutions with data exchange platforms
- Set up publicly accessible pilot farms showcasing hydroponic and vertical farming systems with real-time data tracking
- Invest in AI-driven agricultural databases and IoT sensor networks for resource optimisation and climate impact prediction
- Build One Health-based disease surveillance capacity through multi-sectoral collaboration, training of stakeholders, and strengthening of veterinary and public health laboratories

Capacity Building and Digital Advisory

- Launch structured training programmes integrating AI-powered advisory tools and mobile applications for the practical application of advanced farming techniques

Accelerating Agricultural Innovation and Technology Integration

- Establish District and Village Agricultural Innovation Hubs and Clubs to promote adoption of modern farming techniques, experimentation, and knowledge sharing among farmers

Technology, Research, and Innovation

- Strengthen research–extension–farmer linkages through Agri-Innovation Hubs and KVK feedback systems
- Facilitate AI-based precision agriculture integrating digital monitoring and automation tools
- Foster start-up incubation and innovation hubs in value addition, biotech, and sustainable inputs

Integrated Crop–Livestock–Allied Systems

- Promote Integrated Farming System (IFS) models combining crops, livestock, and fisheries for resource recycling.

Long-Term Pathway (2047)

Global Research Partnerships and Innovation Transfer

- Form long-term collaborations with global research institutions for joint technology transfer programmes, enabling cross-border innovation

Technology-Driven Infrastructure and Systems

- Develop predictive AI models for crop optimisation, blockchain-secured supply chains, and IoT-powered farm monitoring systems for resource efficiency
- Build dedicated innovation centres equipped with automated hydroponics, AI-enabled soil analysis labs, and robotics-integrated farming systems

Advanced Training and Skilling

- Establish specialised vocational institutes offering advanced certifications in precision agriculture, AI-driven farm management, and agri-robotics
- Develop export-oriented livestock value chains and food safety certification systems to align with international standards and enhance global market access

Technology, Research, and Innovation

- Create a Farmer Data Cooperative – a statewide, farmer-owned data platform ensuring sovereignty and fair monetisation.
- Expand parametric agri-insurance using AI and satellite analytics for real-time payout mechanisms

Integrated Crop–Livestock–Allied Systems

- Replace blanket crossbreeding programmes with targeted genetic improvement and selective breeding
- Expand AI-based breed improvement, veterinary extension, and reproductive management

Monitoring, Evaluation, and Data Systems

- Institutionalise data-driven governance frameworks for predictive analytics, impact evaluation, and adaptive policy design

Short-Term Pathway (2030)

- Encourage manure-to-compost and biogas generation for circular resource flows

Monitoring, Evaluation, and Data Systems

- Build robust agricultural databases for productivity, climate, and socio-economic indicators
- Enable real-time digital dashboards for scheme performance tracking

Long-Term Pathway (2047)

- Integrate multi-sectoral data systems for agriculture, livestock, and natural resources management

ISSUE 4: SUPPLY CHAIN AND POST-HARVEST MANAGEMENT

In Haryana, effective supply chain and post-harvest management are crucial for minimising losses and optimising agricultural productivity. Current data reveals significant post-harvest losses in wheat, estimated at 406.74 thousand tonnes valued at INR 748.39 crore in 2019-20.⁶⁶ The state possesses 382 cold chain units with a capacity of 8,67,884 metric tonnes,⁶⁷ but this infrastructure remains insufficient given projected demands—food grain requirements are expected to reach 340-355 million tonnes nationally by 2033-34,⁶⁸ with substantial increases in dairy and horticulture products. Strategic initiatives, including allocating 25% of annual State Horticulture Mission funds for post-harvest management and allowing 100% FDI in food processing, represent important steps. However, comprehensive approaches incorporating biodegradable packaging, advanced cold chain development, sensor technologies, and AI-driven demand forecasting are essential to address persistent challenges of market gluts, price volatility, and quality deterioration throughout the value chain.

Dairy processing upgradation for export quality, traceability, and periodic external evaluation will also be key to strengthening Haryana's agro-industrial competitiveness and enhancing its contribution to global food value chains.

Current Status

- ✔ Estimated post-harvest losses in wheat (2019-20): 406.74 thousand tonnes (INR 748.39 crore)⁶⁹
- ✔ Cold storage facilities: 382 units with 8,67,884 metric tonnes capacity (2023)⁷⁰
- ✔ Government initiatives: 25% of annual State Horticulture Mission funds allocated for post-harvest management⁷¹
- ✔ Projected food grain demand (2033-34, All India): Rice 126 Mt, Wheat 119-120 Mt, Total 340-355 Mt⁷²
- ✔ Projected demand for dairy & horticulture (2032-33, All India): Liquid Milk 219 million KL, Vegetables 245.45 million tonnes, Fruits 175.91 million tonnes⁷³

Factors Influencing the Issue

- **Regulatory Framework:** Policies incentivising investment in cold chain infrastructure and quality standards enforcement determine development pace.
- **Technological Advancements:** Innovations in preservation techniques, smart packaging, and real-time monitoring offer transformative potential.
- **Infrastructure Limitations:** Inadequate storage facilities, processing units, and transportation networks create supply chain bottlenecks.

- **Market Dynamics:** Price volatility and evolving consumer preferences for quality and traceability drive demand for improved handling.
- **Environmental Considerations:** Sustainability requirements increasingly shape packaging and preservation methods.
- **Knowledge Gaps:** Insufficient awareness of proper harvest timing, handling techniques, and storage protocols contributes to avoidable losses.
- **Financing Constraints:** Limited access to capital restricts investment in critical infrastructure, particularly for small-scale producers.
- **Quality Standards:** International market requirements and food safety regulations influence post-harvest management practices.

Impacts of the Issue

Direct Impact

- Reduced post-harvest losses, increasing farmer income
- Enhanced quality and shelf life of agricultural produce
- Increased private sector participation in agricultural value chains

Indirect Impact

- Improved market access, better price realisation, enhanced food security, and economic resilience for farming communities
- Strengthened rural economy through increased employment opportunities, sustainable agricultural growth, and reduced dependency on external markets
- Enhanced resilience to market fluctuations and climate change, long-term agricultural sustainability

Global Learnings

Global Best Practice

Singapore's Smart Packaging Innovations for Shelf-Life Extension

Singapore has pioneered the use of smart packaging technologies to extend the shelf life of perishable goods. Innovations include biodegradable materials embedded with sensors that monitor freshness indicators such as gas emission levels. These intelligent packaging solutions not only reduce food waste by providing real-time quality assessments but also align with environmental sustainability goals by minimising plastic usage.⁷⁴

Disruptive Technologies - Portable Cold Storage Solutions

Portable cold storage solutions are transforming agriculture by prolonging the shelf life of crops and minimising post-harvest losses. These cutting-edge units, tailored for agricultural use, are easily movable and incorporate advanced cooling technology. They can empower farmers to enhance profits by facilitating delayed sales and entering into international markets, enabling them to amplify their revenue streams and maximise their harvest's potential.⁷⁵

Possible Pathways

Short-Term Pathway (2030)

Infrastructure Investment and Support

- Provide tax benefits and subsidies for private sector investment in refrigerated transport and cold storage infrastructure
- Modernise warehouses with energy-efficient, climate-controlled environments, smart monitoring technologies, and solar-powered automation systems
- Deploy mobile post-harvest units and digital advisory platforms, ensuring accessibility for small and marginal farmers

Standards and Sustainability

- Establish mandatory post-harvest quality standards and subsidise biodegradable packaging materials with eco-label certification

Technology and Market Intelligence

- Develop AI-powered predictive analytics systems, integrating real-time market trends and climate impact assessments

Enhancing Post-Harvest Management and Value Addition

- Establish post harvest & processing infrastructure with mini agro parks at block level with small-scale processing units

Post-Harvest Management and Market Linkages

- Develop rural cold chain, storage, and processing infrastructure for value chain integration.
- Establish solar-powered micro cold chains co-owned by FPOs for perishables.
- Promote aggregation models (FPOs, cooperatives) for stronger market access

Long-Term Pathway (2047)

Smart Monitoring and Automation

- Implement legal mandates for IoT-based real-time monitoring in warehouses and transport units with automated compliance tracking
- Deploy predictive AI models integrating market trends, weather patterns, and consumer behaviour for accurate demand forecasting

Skills and Institutional Development

- Establish specialised vocational institutes offering certifications in cold chain logistics, automated packaging, and AI-driven inventory management

Green and Resilient Logistics

- Scale adoption of solar-powered refrigeration and renewable energy-driven cold chains, with incentives for eco-certified logistics and low-emission transport solutions

Global Collaboration

- Form cross-border partnerships for knowledge exchange on post-harvest innovations, creating global research alliances

Post-Harvest Management and Market Linkages

- Standardise processing and milling protocols for key crops (rice, onion, tomato, potato)
- Strengthen horticultural and dairy supply chains with improved planting material, traceability, and export-quality standards

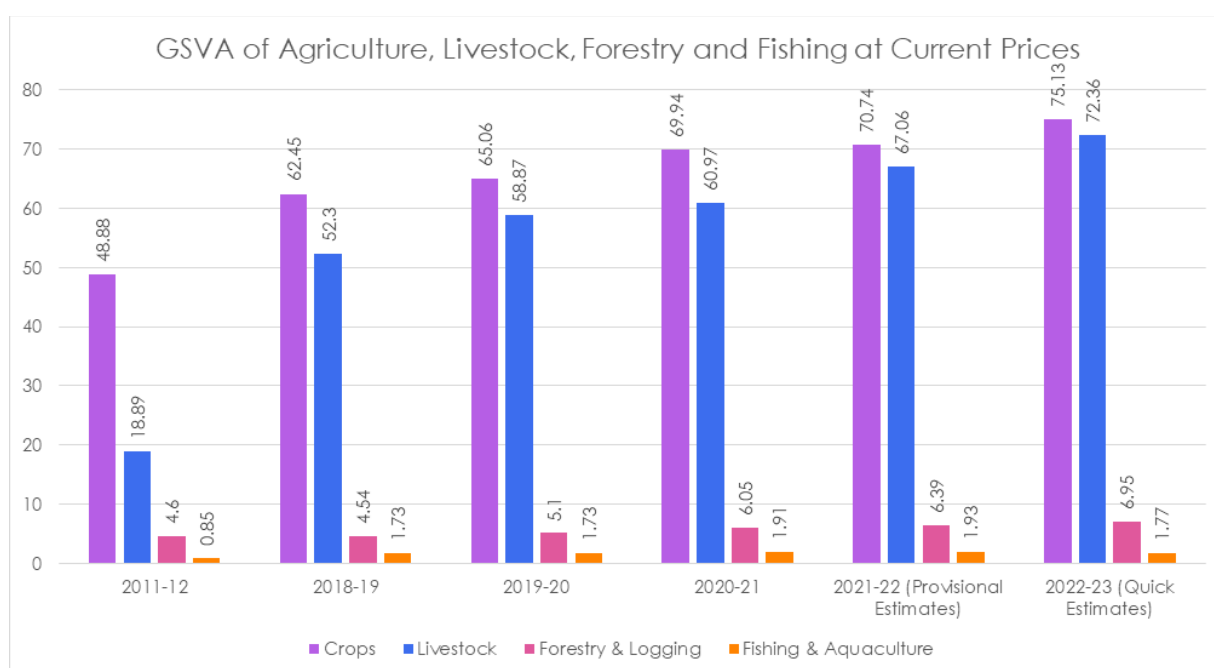
ISSUE 5: ECONOMIC VIABILITY AND MARKET ADAPTATION

Economic viability and market adaptation represent cornerstone challenges for Haryana's agricultural transformation. While innovative initiatives like "Mera Pani Meri Virasat" (providing INR 7,000 per acre in 2023, increasing to INR 8,000 in 2025-26)⁷⁶ demonstrate policy commitment, significant obstacles remain in transforming traditional farming into profitable business enterprises. Despite substantial insurance payouts under

PMFBY (INR 8,540.18 crore from Kharif 2016 to 2023),⁷⁷ farmers continue to face coverage gaps and payout uncertainties. The sector's robust economic foundation—contributing INR 88,450.02 crore to GSVA⁷⁸ and generating exports worth INR 14,396.57 crore from 1.39 million metric tonnes⁷⁹—provides a solid base for growth, but requires strategic interventions in diversification, value addition, market linkages, and price stabilisation to ensure sustainable profitability and resilience in an increasingly volatile market environment.

Current Status

- ✔ "Mera Pani Meri Virasat" scheme: INR 7,000 per acre (2023),⁸⁰ increasing to INR 8,000 per acre (2025-26)⁸¹
- ✔ State budget allocation for the scheme: INR 70 crore (2023)⁸²
- ✔ PMFBY claims paid in Haryana: INR 8,540.18 crore (Kharif 2016 to Kharif 2023)⁸³
- ✔ GSVA for Agriculture (Crops and Livestock) at constant prices: INR 88,450.02 crore (2024-25)⁸⁴
- ✔ Agricultural exports (2022-23): 1,394,010.10 metric tonnes valued at INR 14,396.57 crore⁸⁵



Graph 29: GSVA of Agriculture, Livestock, Forestry and Fishing at Current Prices (INR crore)
(Source: Department of Economic and Statistical Affairs, Haryana. Statistical Abstract of Haryana 2022-23)

Factors Influencing the Issue

- **Government Initiatives:** MSPs, procurement systems, and subsidy structures create essential safety nets for farmers.
- **Market Evolution:** Changing domestic and international market demands present both opportunities and vulnerabilities.
- **Digital Platforms:** Technology advancement in market information systems bridges information asymmetries between producers and consumers.
- **Financial Infrastructure:** Access to credit, comprehensive insurance products, and investment capital enables farm modernisation.
- **Physical Infrastructure:** Quality of storage, processing facilities, and transportation networks directly impact market access.

- **Climate Volatility:** Unpredictable weather patterns introduce fundamental uncertainty into production planning and market supply.
- **Knowledge and Capacity Gaps:** Limitations in business management, marketing, and value addition techniques hinder profitability.
- **Value Chain Integration:** Degree of vertical integration in agricultural value chains affects income distribution among stakeholders.
- **Labour Market Dynamics:** Prevalence of disguised unemployment, seasonal work, and low wages impact farmer income and rural livelihoods.
- **Diversification Opportunities:** Growing demand for experiential tourism and rural getaways creates avenues for agri-tourism.

Impacts of the Issue

Direct Impact

- Increased profitability and income stability through effective market strategies and insurance
- Greater farmer confidence and willingness to invest in innovation
- Reduced disguised unemployment and improved wages for agricultural labour.
- Creation of new supplementary income streams for farmers and rural households through agri-tourism activities

Indirect Impact

- Enhanced agricultural investment and technology adoption, improved productivity and competitiveness, strengthened resilience to market fluctuations, long-term economic growth and sustainability
- Improved access to financial resources, enhanced market integration, expanded agricultural value chains, diversified rural economy and accelerated regional development
- Enhanced rural livelihoods, reduced migration, and a more stable agricultural workforce
- Stimulation of local economies, preservation of rural heritage, and enhanced community engagement

Global Learnings

Global Best Practice⁸⁶

Philippines' Cacao Value Chain Integration for Smallholder Prosperity

In the Philippines, a collaborative initiative involving the Mennonite Economic Development Associates (MEDA),⁸⁷ Kennermer Foods International, and Mars Inc. has successfully integrated over 1000 smallholder

Disruptive Technologies - Enhancing Agricultural Sustainability Through Crop Diversification

Crop diversification offers resilience against pests, diseases, and climatic variations, ensuring stable incomes for farmers and fostering biodiversity. By reducing reliance on monoculture farming it promotes healthier soils, decreases chemical inputs, and mitigates the impact of pests and diseases. Diversified farming practices optimise

farmers into the global cacao value chain. This programme provides comprehensive support, including technical training in Good Agricultural Practices (GAP), access to financing, and market linkages. By intercropping cacao with existing coconut plantations, farmers diversify their income sources and enhance land productivity.

resource utilisation, leading to increased productivity while minimising environmental harm. For instance, wheat-legume intercropping in France increased the land equivalent ratio (LER) by 11% to 32% and reduced weed biomass by 50% to 90%. Similarly, Asian countries' shift towards high-value crops has boosted land productivity and created employment opportunities in the agricultural sector.⁸⁹

Possible Pathways

Short-Term Pathway (2030)

Farmer Training and Capacity Building

- Allocate government and private sector funds for targeted farmer training in market analysis and business management
- Launch digital and on-field training initiatives on precision farming and post-harvest technologies
- Introduce skill development programmes focused on advanced farm machinery operation, post-harvest processing, and digital agriculture to enhance labour productivity and wages

Market Intelligence and Risk Mitigation

- Deploy AI-powered mobile applications offering real-time price trends and market intelligence for optimised production planning
- Implement dynamic pricing models backed by AI-driven market forecasting and minimum price guarantees to protect farmers from extreme market volatility
- Develop robust digital commodity trading platforms, integrated with existing market information systems, to facilitate transparent and efficient trading of commercial crops

Strengthening Commercial Agriculture

- Introduce financial subsidies and tax breaks for farmers adopting high-value crops with processing industry support

Long-Term Pathway (2047)

Global Market Integration and Trade

Infrastructure

- Forge trade agreements with key international markets, establishing direct procurement channels and standardised quality benchmarks
- Create government-backed financial schemes for cold chain logistics, export certification, and global supply chain integration
- Expand specialised training institutes offering advanced courses in agri-business management, export compliance, and technological innovation
- Incentivise large-scale aggregation and professional management of commercial crop value chains with low-emission processing systems, green certification, and sustainable export infrastructure to boost farmer share in global markets

Digital and Predictive Market Intelligence

- Deploy predictive AI models analysing climate trends, soil health, and market demand for real-time farm optimisation and risk management
- Establish a national framework for commodity market intelligence, utilising AI and blockchain to provide comprehensive real-time data on commercial crop supply, demand, and global price movements, ensuring fair and efficient trading

Short-Term Pathway (2030)

- Establish direct contracts between farmers and agribusiness firms, enabling guaranteed buybacks and price stability mechanisms

Agri-Tourism Promotion

- Launch pilot projects and provide seed funding for farmers interested in developing agri-tourism ventures (e.g., farm stays, guided tours, local produce sales)
- Develop marketing platforms and partnerships with tourism agencies to promote agri-tourism circuits in Haryana

Rural Enterprise, Tourism, and Income

Diversification

- Develop secondary agriculture enterprises—food processing, herbal products, bio-inputs, and agri-handicrafts
- Promote agri-tourism corridors such as “Millet Heritage Trail” or “Organic Farm Stays”

Long-Term Pathway (2047)

Sustainable Rural Employment and Labour Welfare

- Develop a comprehensive rural employment policy focusing on year-round agricultural and allied sector opportunities, including value-added processing and agri-logistics
- Implement fair wage guidelines and social security schemes for agricultural labourers, leveraging digital platforms for transparent payments

Agri-Tourism Ecosystem Development

- Establish a dedicated Agri-Tourism Development Board to provide policy support, infrastructure development, and capacity building for rural communities
- Integrate agri-tourism into regional development plans, creating comprehensive rural economic zones that link farming, processing, and tourism

Rural Enterprise, Tourism, and Income

Diversification

- Scale up agripreneurship ecosystems with youth and women-led start-ups
- Link agri-tourism and rural enterprises with digital marketplaces and export promotion networks

ISSUE 6: AGRARIAN REFORM AND INNOVATIVE MARKETS

Haryana's agricultural landscape faces structural challenges that demand fundamental reforms alongside market innovation. With 68.57% of farming households operating as small or marginal farmers (holding less than two hectares),⁹⁰ fragmentation severely limits economies of scale and investment capacity. Haryana must address its fragmented landholding structure and strengthen its 460 FPOs⁹¹ to seize diversification opportunities in the rapidly growing alternative protein markets (projected to reach USD 1.21 billion by 2029)⁹². This structural reform should align with the aggressive promotion of nutri-cereals, where resource efficiency and climate resilience are focal points for the coming years, particularly by elevating crops like bajra, maize, barley, and chickpea to staple food status alongside rice and wheat. This convergence will create pathways for inclusive growth across the state's small and marginal farming communities. These concurrent developments offer a powerful convergence point where structural reforms in landholding and organisation can align with high-value, future-oriented market opportunities, creating pathways for inclusive growth that reach across Haryana's diverse farming communities. To ensure such “future-ready markets” are resilient and globally aligned, reforms must also embed zoonotic disease risk management and food safety capacity-building—strengthening consumer confidence, export potential, and overall agrarian sustainability.

Current Status

- ✔ FPOs: 460, including Farmer Producer Companies⁹²
- ✔ Land Distribution: 87% of Indian farmers cultivate less than two hectares; 69% own less than one hectare⁹³
- ✔ Plant-Based Meat Market in India: 135 million USD (2023), projected to quadruple by 2030⁹⁴
- ✔ Indian Plant Protein Market: 0.91 billion USD (2024), projected to be 1.21 billion USD by 2029⁹⁵
- ✔ Farmer demographics: Marginal farmers (49.29%), small farmers (19.28%), others (31.43%)⁹⁶
- ✔ Small and marginal farmland areas (2015-16): 3,91,705 hectares and 4,59,439 hectares respectively⁹⁷

Factors Influencing the Issue

- **Land Fragmentation:** Small, scattered holdings and absentee landlordism fundamentally constrain operational efficiency and modernisation potential.
- **Policy Environment:** Land leasing regulations, cooperative formation rules, and collective marketing laws determine consolidation feasibility.
- **Emerging Consumer Preferences:** Growing demand for plant-based and alternative proteins creates new value chain opportunities.
- **Technological Innovation:** Advancements in food processing, alternative protein development, and market platforms enable market access for smaller producers.
- **Access to Finance:** Availability of specialised funding mechanisms determines innovation capacity, particularly for FPOs and agri-startups.
- **Knowledge Ecosystem:** Linkages between research institutions and farmer groups are essential for innovation transfer.
- **Community Cohesion:** Existing cooperative traditions and social structures influence collective approaches to market access.
- **Supply Chain Development:** Infrastructure for specialised handling, processing, and preservation of novel products affects market viability.

Impacts of the Issue

Direct Impact	Indirect Impact
<ul style="list-style-type: none"> • Consolidated landholdings improving economies of scale and input access • Strengthened FPOs improving market linkages and collective bargaining • Access to emerging alternative protein markets 	<ul style="list-style-type: none"> • Improved land tenure security, increased long-term investments, greater agricultural productivity, enhanced technology adoption, better credit access, and reduced socioeconomic disparities • Enhanced access to services and inputs, increased income stability, diversified income sources, facilitated technology adoption, and strengthened rural economies • Adoption of innovative technologies, developed supply chains, increased R&D investment, diversified income sources, new rural employment opportunities, and enhanced food security through nutritional diversification

Global Learnings

Global Best Practice

Netherlands' Leadership in Plant-Based Meat Innovation

The Netherlands has emerged as a global leader in the development and promotion of plant-based meat alternatives. Companies like The 'Vegetarian Butcher' and 'Meatable' are at the forefront, utilising advanced technologies to create products that mimic the taste and texture of traditional meat. This shift not only caters to changing consumer preferences but also addresses environmental concerns associated with conventional livestock farming.⁹⁸

Disruptive Technologies - Innovating Plant-Based Protein: Shear Cell Technology

A Dutch startup is set to deploy shear cell technology, a novel approach to texturising plant-based proteins, at a commercially viable scale this summer. This innovative method employs heat and pressure to mimic the texture of animal proteins, offering precise control over the final product's texture. Unlike high-moisture extrusion cooking processes, shear cell technology typically requires less energy and enables the creation of whole cuts with enhanced texture.⁹⁹

Possible Pathways

Short-Term Pathway (2030)

Land Access and Institutional Reforms

- Revise agrarian policies to streamline land leasing frameworks, enabling smallholders to access larger contiguous plots

Farmer Collectives and Inclusive Growth

- Introduce direct subsidy programmes and tax exemptions for small farmers joining FPOs to enhance collective market bargaining power
- Collaborate with financial institutions and NGOs to provide mentorship and digital advisory services for FPO-led sustainable farming
- FPOs for Animal Husbandry and Dairy-Support the creation and strengthening of FPOs in the animal husbandry and dairy sectors, with strong linkages to technology incubation centres, research institutions, and extension agencies

Data-Driven Agricultural Planning

- Deploy AI-enabled tools for analysing land use efficiency, crop yields, and market trends for data-driven decision-making

Long-Term Pathway (2047)

Tenancy Rights and Legal Reforms

- Protect tenancy rights and ensure equitable land distribution through new legal provisions, fostering trust and stability for cultivators

AgriTech Innovation and Sustainable Production

- Establish targeted funding and incubation for agritech to promote AI-driven, climate-smart farming systems, sustainable protein production, and low-emission yield optimisation aligned with fair market price discovery
- Fund state-of-the-art biotechnology labs and pilot units for cultivated proteins and dairy alternatives, leveraging AI-driven automation and blockchain traceability for ethical sourcing and transparent pricing.

Global Partnerships and Trade Integration

- Form bilateral trade agreements and global research partnerships for climate-smart food ventures, integrating blockchain for secure and transparent international trade and equitable value distribution

Short-Term Pathway (2030)

Sustainable Agro-Logistics Infrastructure

- Upgrade rural road networks and establish energy-efficient agro-logistics hubs with renewable-powered cold storage and direct farmer-market linkage platforms

Innovation and Incubation for Plant-Based Protein Enterprises

- Promote R&D and incubation for plant-based protein enterprises through a dedicated innovation hub.

Long-Term Pathway (2047)

Digital Supply Chain Transparency

- Implement a national, integrated framework of blockchain-led digital ledgers and IoT-powered sensors across the agricultural supply chain for real-time, immutable records, product authentication, end-to-end traceability, and dynamic, data-driven fair pricing

BIG ACTIONS

1. Zero Burn, Green Return Initiative

A bold push to eradicate stubble burning by converting crop residues into biofuels and organic fertilisers, while scaling drip irrigation and eco-friendly farm practices—turning a pollution challenge into a sustainable revenue opportunity.

2. Agri-Tech City & Smart Storage Network

The state will develop a pioneering Agri-Tech City with vertical farms, agribusiness incubators, and precision labs, alongside an AI-driven cold storage and logistics network to halve post-harvest losses.

3. Sky Harvest 2047

A state-led campaign that harnesses advanced drones, robotic harvesters, and AI-driven precision tools to perform seeding, spraying, and crop monitoring, drastically cutting resource usage and operational costs.

WORKING GROUP - 4

Departments

- | | | | |
|--|-------------------------------|---|---|
| 1. Department of Agriculture and Farmers Welfare | 2. Department of Horticulture | 3. Department of Animal Husbandry & Dairying | 4. Environment, Forest, and Wildlife Department |
| 5. Department of Fisheries | 6. Department of Cooperation | 7. Food, Civil Supplies & Consumer Affairs Department | |

Timeline

29/08/2023



First meeting was held at Registrar Cooperative Societies Haryana, Bays 27-30, Sector 2 Panchkula

23/01/2024



Second meeting was held at Registrar Cooperative Societies Haryana, Bays 27-30, Sector 2 Panchkula. (Participants - 15)

15/03/2024



The Strategic Foresight Workshop convened at Hotel Mountview, Sector 10, Chandigarh. (Participants - 63)



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