AMCHAM INDIA

YES BANK

CULTIVATING TOMORROW

How Technology is Redefining India's Food Production

MESSAGE

The global agri-food industry is on the brink of a transformative revolution, driven by advances in technology, sustainable practices, and an increased need for food security. As the world faces pertinent challenges like climate change, population growth, resource scarcity, the role of technology in agriculture and food processing has become even more critical. Technological advancements have the potential to enhance productivity, reduce environmental impact, and ensure food security. Technological innovations will have a significant impact by way of increased productivity, reduced labor, and making farming more efficient and sustainable. Innovations like precision agriculture, GPS, sensors, and drones will allow farmers to optimize resource use, reduce waste, and improve crop yields. Automation and advanced machinery also help decrease the reliance on manual labor, while new seed technologies and AI-powered solutions improve resilience and overall farm management.

Across India, technology is becoming the central engine of agricultural and food-processing transformation. With initiatives like Digital Agri Mission, AgriStack, the MahaKrishi AI Policy, the India AI Mission, ONDC, UP AGRIVERSE, etc., India is leapfrogging to the advance use of technology into the core sector of the Indian economy i.e. agriculture. It the right time to convert digital divide into digital dividend. A tech skilled farmer has the potential to make a multi fold impact on the entire food value chain. This is a defining juncture, one that calls for strategic vision and collaborative action. It is an opportune time for all stakeholders — the government (both central and state), industry, academia, FPOs, technology providers, global institutions, and consumers, to work together and make the much-needed impact.

U.S. Industry in India has played a catalytic role in this digital and tech transformation. Their impact is across the agrifood value chain, whether investing in advanced technologies or partnering with local enterprises, start-ups and research institutions, and they are committed to bring global best practices, cutting-edge technologies and high standards of safety, sustainability, and transparency. Members of AMCHAM India remain deeply committed to facilitate these partnerships — ensuring that the best of U.S. innovation and global expertise contributes meaningfully to India's food-production transformation. These innovations are not only strengthening India's food ecosystem but making India, the global food hub. For India to become the World's Food basket technology will play the key role.

Around the world, technology is reshaping how food is grown, processed and delivered. As India prepares for Viksit Bharat 2047, ensuring food and nutritional security for a projected population of 1.6 billion will require producing over 400 million tonnes of food grains annually — a significant leap from the current 330+ million tonnes. The role of technology will be the key in achieving this feat.

This report comes at a moment when India's food and agriculture landscape is undergoing one of the most significant transformations in its history. We hope 'Cultivating Tomorrow: How Technology is Redefining India's Food Production,' informs strategy, inspires collaboration and supports the advancement of a world-class food-production ecosystem in India.

Ms. Ranjana Khanna
Director General CEO
AMCHAM India

FOREWORD

As India advances towards the mid-21st century, agriculture stands at the cusp of profound transformation. By 2050, India must produce more than 400 million tonnes of food grains and over 650 million tonnes of fruits and vegetables to feed an estimated population of about 1.67 billion. This imperative arises amid intense constraints. These include highly fragmented arable land, increasing farm-labor shortage, declining groundwater levels, worsening climate volatility and rising GHG emissions. The need to produce more from less, through smarter, sustainable and technology driven approaches has never been more critical.

Technology today stands at the intersection of Indian Agriculture's productivity, resilience, and sustainability—redefining how we grow, move, and consume food. Digital tools are bridging long-standing efficiency gaps across the agri-value chain. These range from soil intelligence and predictive analytics that guide precision farming decisions to smart irrigation, drone-based crop monitoring and AI-driven post-harvest solutions. At a deeper level, technological advances reshaping this sector go far beyond digitalization. These encompass precision genetics, bio-inputs, farm mechanization and renewable energy use. Advanced post-harvest management and value addition solutions complete this transformation, together defining the next frontier of sustainable food systems. These innovations are not only improving yields and reducing resource wastage but are also empowering farmers with real-time insights, market linkages and access to financial and advisory ecosystems that were once beyond their reach.

The Government of India has been at the forefront of promoting multi-dimensional technological innovations in agriculture. Visionary initiatives such as the Digital Agriculture Mission, AgriStack, e-NAM, ONDC and the NAMO Drone Didi Scheme are fostering interoperable digital frameworks that encourage innovation, transparency and farmer empowerment. Complementing these are long-standing government initiatives such as the National Mission on Sustainable Agriculture, National Food Security Mission, RKVY, PM-KUSUM and the PM Kisan SAMPADA Yojana. All of these initiatives underline technology's central role in driving productivity, efficiency and climate resilience. The private sector has strengthened these efforts by building relevant technological solutions, data platforms, and resilient supply chains. Together, these public-private endeavors are laying the foundation for a technology-enabled food production system that is sustainable, inclusive, efficient, and globally competitive.

YES BANK is sincerely committed to playing a catalytic role in the development of the India's food and agriculture sector. We serve not just as a banking partner but also work alongside the private sector, government, and industry associations. Together, we assimilate and propagate knowledge that contributes to the sustainable growth of this sector. To this end, YES BANK, in partnership with AMCHAM, is privileged to present this Knowledge Report titled "Cultivating Tomorrow: How Technology is Redefining India's Food Production". This report explores the full arc of technology's role in the food ecosystem, across production, processing, value addition, and sustainability - capturing emerging trends that promise to redefine India's role in the global food economy.

I sincerely hope that this report will contribute to ongoing efforts by policymakers, industry leaders, and innovators to accelerate a technology driven transformation of Indian agriculture, paving the way for a future that is both prosperous and sustainable for all.

Sincerely,

Prashant Kumar
Managing Director & CEO
YES BANK Ltd.

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1 Technology: Key Enabler for Transforming Indian Agriculture

1.1 The Changing Paradigm of Indian Agriculture

Agriculture has long been the backbone of India's economy- ensuring food security, sustaining livelihoods of about 45.8%[1] of the population and serving as a vital pillar of rural employment and regional development. While the sector's contribution to GDP is about 16%[2], the sector's importance extends far beyond this number. Over 89% of India's agricultural household sow less than two hectares of land[3]. These small-scale farms sustain millions of rural families and make the sector indispensable for poverty alleviation and inclusive economic growth. Exhibit 1 highlights the economic significance of the agriculture sector in India.

Exhibit 1: Agriculture - A critical pillar of the Indian economy

Employment	GDP contribution	Foodgrain production	Exports	GVA
Supports 45.8% of India's Population	Contributes ~16% to India's GDP	Total foodgrain production of India reached 353.9 Mn MT in 2024-25 (3rd advance estimate)	Agri-Exports touched USD 51.9 Billion in FY25	Contributed 17.8% to total GVA in 2023-24

Growth in agriculture remains 2-3 times more effective at reducing poverty than an equivalent amount of growth generated in other sectors.

Source: https://www.pib.gov.in/PressReleasePage.aspx?PRID=2172351, Economic Survey 2024-25, https://www.pib.gov.in/PressReleasePage.aspx?PRID=2149703, MoSPI, GVA contribution at current prices, The Periodic Labor Force Survey- 2023, https://www.worldbank.org/en/topic/agriculture/overview

[1] The Periodic Labor Force Survey- 2023
[2] Economic Survey, 2024-25
[3] https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=1910357

Over the past decades, Indian agriculture has continually evolved in response to the country's changing socio-economic needs. From the Green Revolution of the 1960s to present day, the sector has transitioned from a period marked by chronic food shortages to one characterized by self-sufficiency and an increasing role in global food and agri-exports. Going forward, several macrotrends will further define the asks from Agriculture. Exhibit 2 highlights the key macrotrends influencing the transformation of agriculture sector.

Exhibit 2: Macrotrends that are redefining the asks from agriculture

Feeding a Growing and Urbanizing Population By 2050, India must feed 1.67 billion people with 52% urban population.	**Shifting Consumption from Staples to High-Value Crops** Demand for protein-rich, high-value foods is rising with income growth.	**Persistent Malnutrition Despite Food Self-Sufficiency** 67% children and 57% women face anemia.
Growing Impact of Climate Extremes 33.9 and 35 million hectares lost to floods and droughts, respectively, between 2015–2021.	**Declining Groundwater Levels due to Intensive Farming** Agriculture consumes nearly 90% of India's freshwater withdrawals, and 62% of irrigation depends on groundwater.	**Rising GHG Emissions** India's agriculture contributes ~13.72% to total GHG emissions, creating pressure for climate-smart practices and carbon credit frameworks.
Widening Income Gap Between Farm and Non-Farm Sectors Agricultural households earn only one-third of their average total monthly income from farming.	**Land Fragmentation** Average land holding estimated to drop to 0.32 Ha by 2030.	**Decreasing Labour Availability** Labour force employed in agriculture in India is expected to decrease from 45.8% in 2022-23 to 25.7% by 2050.

Source: United Nations Population Division, World Urbanization Prospects, NFHS-5 & World Food Program Reports, CGWB 2023, https://www.weforum.org/stories/2024/08/income-insurance-india-climate-resilience/, All-India Rural Financial Inclusion Survey (NABARD 2021–22), https://icar-nrri.in/wp-content/uploads/2019/07/6.-Energy-Footprints-of-Rice-Production_14.pdf, https://www.pib.gov.in/Pressreleaseshare.aspx?PRID=1518097, https://www.pib.gov.in/PressReleasePage.aspx?PRID=2113720#:~:text=The%20number%20of%20worker%20added,and%20income%20support%20to%20farmers, https://www.pib.gov.in/PressReleasePage.aspx?PRID=2089589

These new challenges and expectations have redefined the nation's priorities that go beyond merely producing enough food. **Ensuring food and nutritional security, driving sustainability and climate resilience and raising farmer income and livelihoods** is now a top priority.

1.1.1 Ensuring Food and Nutritional Security

India's population is projected to rise to over 1.67 billion by 2050[4], accompanied by rising urbanization (52% by 2050)[5] and increasing per capita incomes. In addition, growing awareness on health and wellness, rising environmental and ethical consciousness, and changing family structures towards nuclear and dual-income households are reshaping consumption behaviour. Consumers are increasingly seeking nutritious, diverse, and higher-quality food. These demographic and socio-economic dynamics are driving food demand and marking significant shifts in dietary patterns — from staple grains to protein-rich foods, animal products, fruits and vegetables.

[4] United Nations World Population Prospects

[5] United Nations Population Division, World Urbanization Prospects

Feeding the future population will require a substantial increase in food production. Estimates suggest, India must produce more than 400 million tonnes of food grains and more than 650 million tonnes of fruits and vegetables by 2050 to meet demand the growing demand[6]. This implies that farmers need to grow more food on the same or even shrinking land base. Meeting future food needs will require significant boost in productivity.

Moreover, despite advances made towards access to nutritious food, malnutrition persists significantly. Reports suggest that about 67% of children and 57% of women in India are affected by anaemia. The nutrition indicators for children under 5 show stunting (impaired development due to malnutrition) at 35.5%, wasting (low weight for height) at over 19% and prevalence of underweight at over 32%[7]. Agriculture now needs to combat these problems. This requires diversifying crops, improving food quality, and strengthening value chains so that people have secure access to affordable and nutritious food.

1.1.2 Driving Sustainability and Climate Resilience

Decades of intensive farming has increasingly strained India's natural resource base, leading to declining soil health, depleting water tables, and rising ecological imbalances. With climate change exacerbating these vulnerabilities, there is now a pressing need to embed sustainability and resilience at the core of agricultural practices. Extreme weather events are already taking a toll. Between 2015 and 2021, India lost nearly 33.9 million hectares of crops to excessive rainfall and another 35 million hectares to drought[8]. Moreover, by 2030, India is projected to see a substantial 5.8% decline in working hours – equivalent to 34 million full-time jobs – due to heat stress[9].

Agriculture today consumes almost 90%[10] of India's freshwater withdrawals, and 62% of irrigation depends on groundwater, intensifying water stress across several regions[11]. Moreover, the sector contributes ~13.72%[12] to total GHG emissions, underscoring the urgent need for climate-smart transformation. Going forward, agriculture needs to use water efficiently, preserve soil health, and cut greenhouse emissions, all while adapting to erratic climate patterns. The sector needs to become far more climate-resilient and environmentally sustainable to ensure long-term stability.

1.1.3 Raising Farmer Income and Livelihoods

Despite its central role in India's economy and food system, agriculture has long been associated with low and volatile farm incomes. With millions of households dependent on farming, uplifting rural livelihoods through diversified income opportunities, improved productivity, and stronger market linkages is essential for inclusive growth.

However, structural shifts are rapidly reshaping the agricultural landscape. The cost of cultivation is on an increase (20-40% increase in cost of production since 2021) while price realization remains low (farmers realize only 30-40% of end consumer price). Furthermore, the average landholding size is projected to decline to just 0.32 hectares by 2030, intensifying the challenge of ensuring viable farm incomes[13]. At the same time, the labour

[6] Estimates derived from NITI Ayog report-Working Group on Crop Husbandry, Agriculture Inputs, Demand and Supply

[7] National Family Health Survey (NFHS-5) 2019-21, Ministry of Health and Family Welfare, Govt. of India

[8] World Economic Forum- https://www.weforum.org/stories/2024/08/income-insurance-india-climate-resilience/

[9] World Economic Forum- https://www.weforum.org/stories/2024/08/income-insurance-india-climate-resilience/

[10] https://data.worldbank.org/indicator/ER.H2O.FWAG.ZS (annual freshwater withdrawals- % of total freshwater withdrawals)

[11] Central Ground Water Board

[12] https://www.pib.gov.in/PressReleasePage.aspx?PRID=2089589

[13] https://icar-nrri.in/wp-content/uploads/2019/07/6.-Energy-Footprints-of-Rice-Production_14.pdf; Working paper series by RBI

force engaged in agriculture is expected to fall sharply — from 45.8%[14] in 2022-23 to 25.7% by 2050[15], reflecting a major demographic and economic transition. These changes underscore the urgency of transforming the sector to enhance efficiency, sustainability, and resilience while ensuring dignified livelihoods for farmers.

These evolving demands on Indian agriculture — producing more food, ensuring better nutrition, achieving sustainability, and raising farmer incomes — can no longer be met through business-as-usual farming. The gap between current agricultural performance and future requirements is widening. Yield growth of staple crops has slowed in recent years, while land and water resources are increasingly under pressure and traditional methods are reaching their limits.

India now needs a quantum leap in agricultural capability — one that goes beyond incremental improvements to a transformational change driven by technology and innovation. Just as improved seeds, fertilizers, and irrigation powered the Green Revolution in the 20th century, new technologies must now lead the next agricultural revolution in the 21st century.

1.2 Agriculture at the Cusp of a New Technological Revolution

Indian agriculture is entering a defining phase where technology is becoming the central force, shaping its future growth and resilience. The sector is moving towards a digitally connected, data-informed, and innovation-led ecosystem. This evolution is being powered by rapid advances in connectivity, analytics, automation, and platform-based solutions that are reimagining how farming, markets, and services interact.

A convergence of factors – from rising digital connectivity to novel, innovative and economical models and enabling government policies – is creating a fertile ground for sweeping changes in how farming and agribusiness operate.

The rapid expansion of mobile internet and smartphone penetration in rural India has become a key enabler of agricultural technology adoption. As of March 2024, there were 398.35 million rural internet subscribers and 95% villages in India had access to internet with 3G/4G mobile connectivity[16]. Farmers now access real-time weather alerts, agronomic advice, and market prices through mobile applications. The growing availability of local-language content and voice-enabled platforms is further breaking literacy barriers, making digital technology inclusive and accessible even to small and marginal farmers.

> The Government of India's BharatNet project is aiming to connect all Gram Panchayats (GPs) in the country with Optical Fibre Cable (OFC) connectivity, so as to provide broadband services to the rural households. Out of total 2.22 lakh Gram Panchayats envisaged under the two phases BharatNet, 2.14 lakh Gram Panchayats have been made service ready[17].

Equally transformative is the surge in agritech startups and private sector participation in technology adoption across the food production ecosystem. Private enterprises have been proactively driving the adoption of technology not only within company operations but also across the broader agricultural value chain — from farms to markets. Agribusinesses, food processors, and input companies are embedding digital tools into their production,

[14] https://www.pib.gov.in/PressReleasePage.aspx?PRID=2113720#:~:text=The%20number%20of%20worker%20added,and%20income%20support%20to%20farmers.

[15] https://www.pib.gov.in/Pressreleaseshare.aspx?PRID=1518097

[16] https://www.pib.gov.in/PressReleasePage.aspx?PRID=2040566

[17] https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=2077908

procurement, and distribution systems to enhance efficiency, traceability, and sustainability. Companies are digitizing their supply chains through blockchain-based traceability, AI-driven logistics, and predictive analytics for demand planning. At the farm level, agri-tech startups and agribusiness corporates are deploying precision farming solutions, digital advisory platforms, and IoT-enabled monitoring systems to improve crop yields and resource use. This dual approach — strengthening internal systems while empowering farmers and partners with technology and digital innovations is creating an ecosystem that makes innovation inclusive, scalable, and impactful across India's agri-food landscape.

Another strong signal of impending transformation is the policy support and public investment in agri-technology. Recognizing technology as a catalyst, the Indian government and policy-makers are actively pushing digital agriculture initiatives — including formation of over 10,000 new Farmer Producer Organizations (FPOs) to give them scale and bargaining power, building the AgriStack, a unified national database of farmers and farmlands, to enable targeted delivery of services like credit, insurance, and tailored advisories, launch of Digital Agriculture Mission, soil health card program, and e-NAM (National Agricultural Market) amongst others.

All these developments are leading to an imminent transformation in agriculture, led by introduction of new and advanced technology. Looking into the future, one can envision an Indian agriculture that is highly modernized: farmers routinely using climate-smart practices and data-driven decisions, omnipresent farm automation in irrigation and harvesting, and robust agri-value chains that seamlessly connect producers to consumers. While imminent challenges pertaining to digital literacy, infrastructure in remote areas, and affordability of technologies do exist, the stage is set for a tech-driven revolution in Indian agriculture. With the right strategic focus, technology will be the key lever that elevates Indian agriculture into a new era of growth. The coming years are likely to witness more technology driven change in this sector than the past few decades combined.

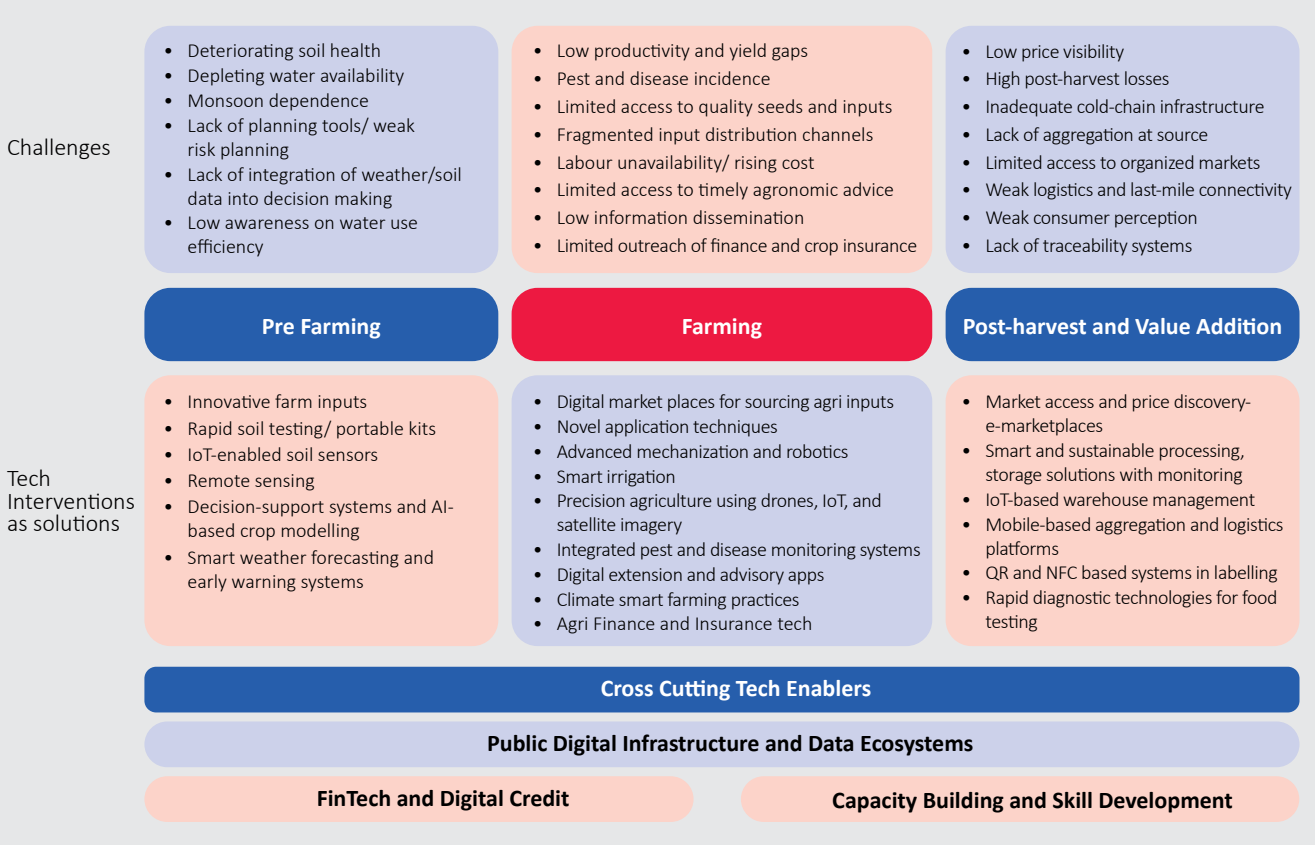
2 Technological Interventions Redefining India's Food Production

India's food production ecosystem is undergoing a profound transformation, driven by the need to overcome persistent challenges that span the entire value chain—from soil to shelf. On the production side, issues such as declining soil health, fragmented landholdings, input inefficiencies, and climate variability continue to limit productivity and sustainability. Post-harvest, the sector grapples with high losses, inadequate storage and logistics, food safety gaps, and market inefficiencies that erode farmer income and consumer trust.

Against this backdrop, technology is emerging as a powerful enabler—introducing data-driven decision-making, automation, biotechnology, precision agriculture, digital traceability, and integrated supply chain solutions to reimagine how food is produced, processed, and distributed. These interventions are not only addressing long-standing pain points but also redefining the very architecture of India's food production landscape.

While many of these innovations are still in their early stages, they hold the power to strengthen both forward and backward linkages, enhance productivity, improve farmer incomes, reduce emissions, and ensure food safety and traceability. Exhibit 3 highlights how technological innovations can address key challenges across the food production system.

Exhibit 3: Technology driven solutions to current challenges in the food production system



Source: YES BANK Analysis, Industry discussions

Together, these technologies are not just transforming agricultural operations but reshaping the very architecture of India's food system — making it more efficient, inclusive, and resilient. This chapter explores how some of these technological advancements are transforming agriculture - across pre-farming, farming, post-harvest and value addition stages of the supply chain.

2.1 Pre-farming

Technological interventions at the pre-farming stage focus on planning, input optimization, and risk reduction. These innovations lay the foundation for productive and climate-resilient farming systems. Strategic deployment of technology at this stage enables better land preparation, resource optimization, and risk anticipation — ensuring that downstream processes operate on stronger, data-backed fundamentals. Select technology interventions include:

2.1.1 Innovative Farm Inputs

Innovation and technology interventions start at the genetic stage of seed. Indian researchers and seed-tech startups are leveraging gene editing to develop crop varieties resilient to biotic and abiotic stress. Indian scientists are now using technologies such as CRISPR-based gene editing to enhance traits like drought and heat tolerance. Unlike transgenic GMOs, these gene-edited seeds contain no foreign DNA. India's regulators have moved to enable this innovation exempting such genome-edited plants from GMO rules. These biotech advances promise seeds that better withstand pests and climate extremities.

Moreover, innovative agri-input products such as bio-inputs, nano-fertilizers, controlled-release nutrients, new technicals in crop protection and green formulations are helping farmers achieve higher nutrient efficiency, better productivity and reduced losses, while reducing environmental impact. These products enhance soil health, make nutrient delivery and crop protection more precise—signalling a shift from input-intensive to knowledge-intensive farming.

The government's focus on climate-resilient agriculture under programs such as the National Mission on Sustainable Agriculture (NMSA) is encouraging R&D in stress-tolerant seed varieties and bio-inputs for sustainable farming.

Innovative crop protection driving water efficiency

Agriculture accounts for more than 80-85% of the total fresh water drawl in India. Within that rice crop alone consumes approximately 40-45% of the irrigation water in India, owing to its water intensive cultivation practices. It takes nearly 4000-5000 liters of water to produce one kilogram of rice, making it highly unsustainable. Practices like Direct Seed Rice (DSR) can reduce water usage in rice significantly. But intense competition to rice from weeds has not made DSR very popular among farmers in the country.

In view of this challenge, FMC has innovated a unique mode of action herbicide which provides effective control of grassy and broad leaf weeds in rice crop. The product (which is currently under approval) will support farmers in adopting DSR without losing any crop yields. The product once adopted is likely to lead to 20-40% saving of water in transplanted rice.

2.1.2 Soil Health Management

The emergence of rapid, portable, and sensor-based soil testing technologies is changing the soil testing domain. Handheld and IoT-enabled soil sensors allow farmers to get real-time insights into soil pH, moisture, nutrient levels, and organic matter content, right at the field level. Portable kits generate results in minutes rather than weeks, enabling immediate and precise fertilizer recommendations. These systems, when integrated with AI platforms and input marketplaces, make nutrient application more targeted and efficient. For example, Bhu-Vision (Krishi-RASTAA) device, developed jointly by the Indian Institute of Rice Research, ICAR and Krishitantra, is a rapid soil testing device that can seamlessly conduct 12 key soil parameter tests in just 30 minutes, providing quick, accurate results directly to farmers and stakeholders through a soil health card on their mobile devices.

2.1.3 Remote Sensing

Advances in satellite imagery, drone technologies, and AI-based image processing enable a level of precision and scale that was unthinkable even a decade ago. High-resolution satellite data detects changes in vegetation cover, crop health, soil moisture, and pest or disease outbreaks in near real-time. This allows for early warning systems even before visible damage can be seen on the ground.

In India, private sector led platforms, and ISRO-driven programs are integrating satellite imagery with weather data, farm records, and advisory systems. These insights power everything from crop planning and water management to insurance and credit decisions, making the entire ecosystem more data-driven and risk-aware.

Remote sensing also plays a critical role in climate resilience. By mapping water stress zones, identifying vulnerable cropping patterns, and monitoring land degradation, it supports more informed planning and adaptive strategies. For agribusinesses and governments, it creates transparency, scalability, and a credible data layer for investment and policy design.

2.1.4 Weather and Risk Management

AI and machine learning models generate hyper-local weather forecasts and early warning systems and help farmers and agribusinesses plan sowing and irrigation schedules more effectively, minimizing climate-induced yield losses.

Predictive analytics and AI transform agricultural risk forecasting by using multi-source data — including climate models, soil data, pest surveillance, and market signals — to anticipate risks before they escalate. Machine learning models forecast potential crop losses, pest infestations, or climate-induced yield variations, allowing for early interventions and adaptive credit policies. This shift from reactive to predictive risk management supports farmers, agribusinesses, lenders and policy makers improving portfolio quality and reducing systemic shocks in the sector.

AI-based crop suitability models are also being developed, that are using predictive algorithms integrating agro-climate and market data to suggest the most profitable crop for each season and region. This shift from generic to intelligence-driven crop planning have the potential to further enhance productivity and ensure consistent supply.

2.1.5 Agri Finance and Insurance Tech

Another critical pre-farming enabler is access to credit and insurance, where technology is playing an increasingly pivotal role. Traditionally, lack of formal credit history made it difficult for small farmers to get loans. Now, remote sensing and data analytics are giving financiers new ways to assess farm productivity and risk. For example, Indian startup SatSure uses satellite imagery and AI to generate farm-level reports that estimate a plot's crop yields, acreage, irrigation status, and climate risks. Financial institutions can use such data-driven credit scoring to decide loan amounts for farmers. This innovation improves farmers' access to credit and speeds up loan processing. Similarly, satellite data and drones are being used by insurers under the Pradhan Mantri Fasal Bima Yojana (PMFBY) to estimate crop damage and settle claims. The Pradhan Mantri Fasal Bima Yojana (PMFBY) has been integrated with digital tools such as mobile-based crop loss assessment, satellite monitoring, and geo-tagged field photographs for faster claim settlements. Start-ups and insurers are experimenting with parametric insurance models, where payouts are triggered automatically by data indicators such as rainfall deviation or temperature thresholds. Digital payment integration via DBT (Direct Benefit Transfer) ensures immediate and transparent disbursal to beneficiaries, while the use of drones and IoT sensors is improving the accuracy of damage assessment.

2.2 Farming

2.2.1 Digital Marketplaces for Sourcing of Farm Inputs

Digital marketplaces are enablers for bridging access gaps in the agri-input ecosystem. Digital platforms transform how farmers source seeds, fertilizers, and crop protection products, combining doorstep delivery with digital advisory and input financing. Blockchain and traceability solutions ensure authenticity, preventing counterfeit products from entering the supply chain and improving farmer confidence.

2.2.2 Novel Application Techniques

Complementing the advances in agri inputs are novel application techniques powered by automation and precision tools. Drone-based spraying systems ensure uniform application while reducing input use. Variable Rate Technology (VRT) adjusts the input dosage based on soil conditions, building efficiency in input usage. The combination of AI-backed machine vision and automatic nozzle shutoffs on GPS-guided spray equipment also significantly improve efficiency of crop protection solution application and prevent overlap.

2.2.3 Mechanization and Smart Irrigation

Advanced mechanization and robotics alleviate the challenge of growing labor shortage and increase operational efficiency. Autonomous tractors and robotic weeders reduce drudgery, while drone-based crop monitoring and mapping systems help detect issues early. Drones, equipped with GPS-guidance and automated sprayers, can rapidly apply fertilizers and pesticides with precision.

Smart irrigation systems integrate sensors, IoT, and AI to optimize water usage. Real-time soil moisture data, combined with automated irrigation scheduling and weather forecasts, allows for precise irrigation decisions—cutting water use effectively. Sensor-driven solutions help automate drip irrigation, schedule fertigation, and even targeted nutrient delivery based on soil data. Moreover, solar-powered micro-irrigation brings these systems to smallholders, making sustainability economically viable.

2.2.4 Precision Agriculture and Crop Health Monitoring

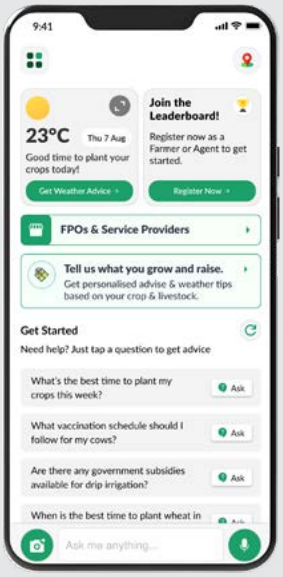
Precision agriculture uses IoT (Internet of Things) sensors, data analytics and AI. These tools allow farmers to tailor water, fertilizer, and crop management precisely to plant needs, rather than relying on guesswork. AI-powered dashboards synthesize data from satellites, IoT sensors, and weather systems to guide planting, irrigation, and pest management decisions. Platforms offer decision support tools and predictive analytics that improve yield forecasting and optimize resource allocation.

With a combination of spectral sensors and chips, cameras mounted on unmanned aerial vehicles (UAVs) or drones gather large volumes of data (e.g., soil moisture, plant health, etc.) that AI models analyse to share insights that assist farmers with targeted farm management operations.

2.2.5 Climate Smart Advisory and Farming Practices

Technological innovation in farming is increasingly aligning with sustainable practices to address climate risks. For example, precision agronomy advisory services are helping farmers adapt to erratic weather by altering planting times or crop choices. In climate-vulnerable regions, NGOs and startups use analytics to recommend more resilient crop varieties (like shorter-duration rice ahead of a predicted late monsoon). The Government's extension arm has launched platforms (like the Kisan Suvidha app and WhatsApp groups) to disseminate crop management advisories widely. The government's recent Digital Agriculture Mission explicitly calls for a framework to integrate AI/IoT in agriculture and to create a federated farmer database that can power personalized advisory services.

How AI-powered FarmerChat is Strengthening Smallholder Farming in India



FarmerChat is an AI-powered, multilingual and multimodal App that provides hyperlocal, climate-smart advisory to farmers, works in low-connectivity environments, and helps them make better decisions both on and off the farm, along with strengthening their market opportunities.

In India, the App has reached over 350,000 farmers, including women, tribal farmers, and frontline extension workers. Around 60% of active users report taking action based on the advisories, with satisfaction rising steadily. In traditional extension systems, farmers often wait for in-person visits, which are often delayed, limited in coverage, and hard to scale. By delivering localized guidance directly to farmers' phones, FarmerChat reduces dependence on repeated field visits and makes support easier to access when decisions need to be made. This helps advisory services reach the last mile more efficiently, improves consistency of information, and lowers the overall cost of delivery while continuing to complement and strengthen the work of frontline extension networks at scale.

Using Retrieval-Augmented Generation (RAG) with human-in-the-loop moderation, the platform delivers accurate, locally relevant guidance. Continuous feedback and the Golden Q&A system reduce errors and improve responses over time. FarmerChat is evolving into an integrated platform where farmers can access schemes, procure inputs, connect with service providers, and join marketplaces. Upcoming features include AI-driven crop calendars, video-based guidance, and gamified rewards—making support more accessible, engaging, and actionable.

Digital Green is advancing this work in collaboration with sectoral partners and government stakeholders, aligning with India's Viksit Bharat vision by supporting resilient and sustainable agriculture, inclusive access to digital advisory, and stronger local livelihoods.

2.3 Post Harvest and Value Addition

Technology's influence extends well beyond farm, into the critical post-harvest and value addition legs of the value chain. The post-harvest stage, crucial for quality management, food safety and prevention of food loss has become a key arena for innovation and investment. Supported by digital platforms, automation, advanced processing and food safety technologies and modern logistics solutions, technology serves as a key enabler of value creation and competitiveness in the value chain.

2.3.1 Market Access and Price Discovery

The effort to connect farmers directly with marketplaces through digital platforms that integrate aggregation, logistics, and price discovery has been at the core of business systems and policy making. Market linkages that once relied only on middlemen are now being substituted by data-driven systems/platforms, which offer end-to-end visibility and fair pricing. Through these platforms, farmers gain access to buyers, transport, and payment systems — all on a single interface. A major innovation is the rise of electronic marketplaces. The Government's flagship e-NAM (National Agriculture Market) platform has integrated 1,522 wholesale mandis across India into a unified online market as of mid-2025. Through e-NAM, over 17.9 million farmers and 4,518 FPOs can access real-time prices and sell to distant buyers online[18]. Complementing e-NAM, private B2B agri-marketplaces such as Ninjacart and Udaan have emerged. These startups connect farmers directly with institutional buyers (retail chains, hotels, processors) by building end-to-end supply chains.

2.3.2 Innovative Storage and Logistics Solutions

Smart warehousing and cold chains transform how food moves and stays fresh. IoT-based sensors monitor temperature and humidity in real time, ensuring cold chain integrity from field to consumer. Modular, portable cold storage units and renewable energy-based solutions deployed at farm-gate and FPO levels, create decentralized networks that minimize transportation losses and empower farmers to store produce locally and sell when prices are favourable.

The logistics and supply chain layer is also being optimized through digital integration. Predictive demand algorithms and route optimization tools reduce wastage and costs. Companies also use aggregation models and shared logistics platforms to link farmers directly with processors and retailers, shortening the supply chain while increasing efficiency.

2.3.3 Traceability

Traceability technology is an emerging trend too, especially for high-value exports. Export oriented food processing companies with sustainability pledges are increasingly focusing on sourcing from farms with verifiable practices. Thus, companies are offering blockchain-based traceability for commodities like coffee, basmati rice, organic produce, etc., which can help farmers access premium markets. APEDA's new initiative BHARATI (Bharat's Hub for Agritech for Export Incubation) explicitly aims to nurture 100 agritech startups focusing on export-oriented innovation – including blockchain traceability, AI-based quality control, and innovative packaging to meet global standards. Regionally, there are success stories such as MahaGrapes in Maharashtra – a consortium of grape FPOs that implemented traceability to meet EU quality specifications, enabling small farmers to become exporters. These examples underscore the shift towards transparent, shorter supply chains: better information flow (via digital platforms) and better physical flow (via improved logistics).

[18] https://www.pib.gov.in/PressReleasePage.aspx?PRID=2148525

2.3.4 Smart and Sustainable Processing

At the processing end, technology is enabling a major pivot towards smart, sustainable and resource-efficient processing systems.

Smart manufacturing lines, equipped with automation and predictive analytics, ensure real-time monitoring of parameters like moisture, color, and nutrient retention. Combined with AI-based grading and robotics-enabled packaging, these innovations ensure that food is processed safely, consistently, and with minimal wastage.

Energy-efficient equipment, automated sorting and grading systems, and precision-controlled dryers reduce energy intensity and ensuring consistent product quality. The emergence of processing clusters—powered by solar energy, biomass, and agri-waste—signals a broader commitment to build sustainable value chains.

2.3.5 Food Safety

Recent advancements are redefining food safety assurance through the integration of rapid diagnostic technologies, biosensors, AI-enabled analytics, and blockchain-based traceability systems. Portable and real-time testing devices enable on-site detection of select contaminants, adulterants, and pathogens, reducing the lag between sample collection and result generation. Artificial intelligence and machine learning further enhance food testing by enabling predictive quality control and anomaly detection.

Modern food labelling systems are being transformed by digital technologies such as blockchain, IoT, and smart packaging. QR codes, RFID tags, and near-field communication (NFC) chips embedded in labels now connect consumers directly to a product's digital footprint. By scanning a label, one can access verified data on the product's origin, processing history, certifications, and even sustainability parameters such as water footprint or carbon emissions. This shift from static to interactive labelling is redefining how consumers perceive and engage with food.

2.4 Cross-Cutting Enablers

Technology transformation across India's food and agriculture ecosystem is sustained by a set of cross-cutting enablers that integrate, accelerate, and scale innovations. These enablers — spanning data ecosystems, financing, and capacity building — form the backbone that connects diverse technologies across the agri-value chain. They ensure that innovation translates into measurable efficiency, inclusivity, and resilience by building the environment in which digital tools and data-driven solutions can thrive.

2.4.1 Public Digital Infrastructure and Data Ecosystem

A fundamental enabler transforming India's food and agriculture system is the development of Public Digital Infrastructure (PDI) and integrated data ecosystems. In September 2024, the Government of India approved the Digital Agriculture Mission, with an allocation of INR 2,817 crores to accelerate digital transformation through a national Agristack—a federated farmers' database designed to unify information on land, crops, weather, soil, and water resources. This initiative, supported by the Krishi Decision Support System, aims to empower policymakers, researchers, and farmers with data-driven insights for improved crop planning, risk management, and resource optimization. The Union Budget 2023–24 and 2024–25 explicitly emphasized on creating a Digital Public Infrastructure for Agriculture, noting it will support crop planning, market intelligence, and agri-tech innovation for years to come. Additionally, open access to datasets on weather (through MOSDAC and IMD), land, and crop

statistics is further empowering innovators to develop predictive and precision tools for farmers, policymakers, and value chain actors. Together, these initiatives are laying the foundation for a transparent, data-driven, and innovation-led agricultural ecosystem in India.

2.4.2 FinTech and Digital Credit

In addition to advances in assessing creditworthiness, innovation in agri-financing is reshaping capital flow across the value chain—from smallholders to MSMEs and exporters. Fintech solutions leveraging alternative data, AI-driven credit scoring, and digital public infrastructure are expanding access to formal credit and reducing turnaround time. Tools such as UPI, account aggregator frameworks, and open APIs are enabling seamless data exchange between lenders and agri-platforms, improving risk profiling and transparency. Meanwhile, supply-chain finance, warehouse receipt lending, and digital export platforms are enhancing liquidity and efficiency in trade. Together, these innovations are driving a more inclusive, technology-enabled financial ecosystem that supports growth and resilience across India's agri-food system.

2.4.3 Capacity Building and Skill Development

For technology to truly create impact, digital literacy and human capacity must evolve alongside it. AI-powered advisory tools and multilingual chatbot services are expanding access to localized and real-time agricultural guidance. Digital training portals and simulation-based learning modules are building farmers' technical skills in precision agriculture and equipment handling. In parallel, community-based digital hubs and farmer data wallets are improving access to information, services, and markets, helping bridge the rural digital divide.

Technology is the central lever for agricultural transformation in India. The next phase of growth will depend on scaling these innovations, ensuring last-mile accessibility, and fostering collaborations among government, private sector, and farmer institutions. As India advances toward a data-driven and sustainable agricultural future, integrating technology across the value chain will be key to achieving productivity, profitability, and resilience.

3 Government Initiatives Promoting Technology Adoption

The Government of India has undertaken a series of strategic initiatives to mainstream technology across the food production ecosystem, recognising its transformative potential in enhancing productivity, transparency, and farmer prosperity. From creating robust digital public infrastructure under the Digital Agriculture Mission and promoting research and innovation in frontier technologies like AI and IoT, to encouraging entrepreneurship and startups in agri-tech, the government's efforts span the entire agri-value chain. Dedicated programmes are being implemented to promote use of advanced technology to improve productivity, build sustainability, provide effective farmer extension services, develop robust post-harvest infrastructure, strengthen processing and value addition, and build innovation ecosystems across the food production value chain that support technology adoption at scale. Together, these initiatives are building the foundation for a technologically empowered agricultural sector—one that is data-driven, resilient, and inclusive, enabling farmers and agri-enterprises to participate more effectively in the modern food economy.

Exhibit 4 highlights key government initiatives aimed at accelerating technology adoption and innovation across the agricultural value chain.

Exhibit 4: Key government initiatives promoting technology adoption and innovation in agriculture

Initiatives towards creation of Digital Public Goods	✓ Digital Agriculture Mission (AgriStack, Krishi Decision Support System (Krishi-DSS) ✓ Open Network for Digital Commerce (ONDC)
Initiatives promoting research in the areas of IoT and AI in Agriculture	✓ National Mission on Interdisciplinary Cyber Physical Systems (NM-ICPS) ✓ Research, Development, and Innovation (RDI) Scheme ✓ The Centre of Excellence for Artificial Intelligence in Agriculture (ANNAM.AI)

Initiatives for promotion of agri-entrepreneurship and startups	✓ RKVY-RAFTAAR (Remunerative Approaches for Agriculture and Allied Sector Rejuvenation) ✓ AgriSURE Fund ✓ Atal Innovation Mission (AIM) ✓ Bharati Initiative by APEDA
Initiatives promoting tech adoption for improving crop productivity and farmer income	✓ National project on soil health and fertility ✓ Pradhan Mantri Fasal Bima Yojana (PMFBY) ✓ Digital soil-health cards ✓ Mission for Integrated Development of Horticulture (MIDH) ✓ National Mission on Sustainable Agriculture (NMSA) ✓ National Food Security Mission (NFSM) ✓ National Pest Surveillance System (NPSS)
Initiatives promoting the usage of drones in agriculture	✓ Namo Drone Didi Scheme ✓ Drone Subsidies under SMAM
Initiatives promoting tech adoption for infrastructure development and credit facilitation	✓ National Agriculture Market (e-NAM) ✓ Agriculture Infrastructure Fund (AIF) ✓ PM-Kusum
Initiatives promoting tech adoption for processing and value addition	✓ Pradhan Mantri Kisan Sampada Yojana (PMKSY) under MoFPI ✓ MoFPI's Formulation of Micro Food Enterprises scheme ✓ Production Linked Incentive (PLI) Scheme for Food Processing ✓ Animal Husbandry Infrastructure Development Fund ✓ Pradhan Mantri Matsya Sampada Yojana (PMMSY)
Initiatives promoting tech adoption for extension	✓ National Interactive Digital Platform ✓ Kisan Suvidha mobile application ✓ Krishi Yantra

Source: YES BANK Analysis, Industry discussions

3.1 Creation of Digital Public Goods

3.1.1 Digital Agriculture Mission

With an outlay of INR 2817 crores[19], the Digital Agriculture Mission has been launched as an umbrella program to drive digital technologies in agriculture. Under this mission, various initiatives are being undertaken including- creation of digital infrastructure for agriculture, establishment of digital extension services, development of farmer centric mobile applications, promotion of sensor-based technologies for crop and soil health monitoring and the integration of artificial intelligence and machine learning in agriculture. The mission aims to provide farmers with real-time market information, enable direct market linkage and facilitate e-commerce platforms for agricultural products. The two foundational pillars of this effort are AgriStack and a Krishi Decision Support System.

3.1.1.1 Agristack

- Agristack is the foundational component of the mission, aiming to create a unified and trusted data ecosystem for farmers and other stakeholders across the agri-value chain. Agristack creates a unified platform by integrating farmer, land, crop, and market data to streamline government schemes and empower farmers with better access to credit, inputs, advice, and markets. The stack is envisaged as a digital public good like "Aadhar" for efficient and effective scheme/service delivery to the farmers. It is being built in a 'federated architecture' as a collaborative project between the various agencies of the Central and State Governments and the Union Territories. It consists of three foundational registries or databases in the agriculture sector — Farmers' Registry, Geo-referenced village maps and Crop Sown Registry through Digital Crop Survey.

- By integrating disparate farm data, AgriStack is expected to enable targeted and paperless access to government schemes, credit, insurance, and advisories for millions of farmers. Already, 19 states have signed onto this initiative and pilot projects (e.g. digital crop surveys and farmer ID creation) have been conducted in six states to test the system. The end goal is to issue digital IDs to 11 crore farmers (till 2026-27) and to cover all districts under Digital Crop Survey (by 2025-26)[20], laying the groundwork for data-driven agriculture.

3.1.1.2 Krishi Decision Support System (Krishi-DSS)

- Krishi-DSS is a geospatial platform launched in 2024, to integrate data and analytics to assist farmers, policymakers, and other stakeholders in making informed decisions in agriculture. The system integrates multiple data types, including soil information, weather forecasts, satellite imageries, groundwater data and field information from various sources, which is processed and analyzed to generate actionable insights.

3.1.2 Open Network for Digital Commerce (ONDC)

- A pioneering initiative by the Government of India aimed at democratizing digital commerce by creating an open, interoperable platform that connects buyers, sellers, logistics providers, and payment systems across sectors—including agriculture.

- In the agri-food domain, ONDC is enabling farmers, Farmer Producer Organizations (FPOs), agri-startups, and rural enterprises to directly participate in digital marketplaces without being tied to any single platform.

[19] https://www.pib.gov.in/PressReleasePage.aspx?PRID=2050966

[20] https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=2051719

- By integrating with existing systems like e-NAM and FPO apps, ONDC facilitates seamless digital transactions for over 5,000 FPOs[21]. It empowers producers with tools for inventory management, digital payments, logistics coordination, and real-time market access, thereby reducing dependency on intermediaries and enhancing price transparency.

3.2 Research in the Areas of IoT and AI in Agriculture

3.2.1 National Mission on Interdisciplinary Cyber Physical Systems (NM-ICPS)

- Launched by Department of Science and Technology (DST), Government of India, NM-ICPS is a visionary initiative aimed at fostering innovation and research. Under the Mission, 25 Technology Innovation Hubs (TIHs) have been set up in premier institutes of national importance across the country in advanced technology verticals. Out of the 25 Technology Innovation Hubs, 3 hubs (IIT Ropar-Technology and Innovation Foundation, TIH Foundation of IOT and Internet of Everything (IoE), IIT Bombay and AI4ICPS Foundation at IIT Kharagpur)[22] are involved in the applications of IoT and AI in the agriculture sector with the objective of carrying out research, translation and technology development.

3.2.2 Research, Development, and Innovation (RDI) Scheme

- Launched on November 3, 2025, the Research Development and Innovation (RDI) Scheme Fund of INR 1 lakh crores marks a landmark step in strengthening India's research and development ecosystem. The scheme aims to build a private sector–driven innovation environment that can accelerate the nation's scientific and technological progress. Recognizing the critical role of the private sector in driving innovation and commercializing research, the RDI Scheme provides long-term financing or refinancing support with extended tenors at low or nil interest rates. The initiative aims to encourage greater private investment in RDI, particularly in sunrise and strategic sectors.

- The scheme also addresses existing challenges in funding private research by offering growth and risk capital. It focuses on facilitating innovation, promoting technology adoption, and improving competitiveness across emerging areas.

3.2.3 The Centre of Excellence for Artificial Intelligence in Agriculture (ANNAM.AI)

- Branded as Alliance for Next-Gen Nourishment through Agriculture Modernization – Artificial Intelligence, ANNAM.AI, is a pioneering initiative launched under India's national AI strategy to harness the power of artificial intelligence for sustainable and resilient agricultural development.

- Established at IIT Ropar, ANNAM.AI focuses on developing advanced AI tools and models for precision farming, yield optimization, livestock management, and climate-resilient agriculture. It serves as a collaborative platform for interdisciplinary research, startup incubation, and public-private partnerships, aiming to translate cutting-edge AI research into scalable solutions for farmers, agribusinesses, and policymakers. By integrating data from satellite imagery, IoT devices, and farm-level sensors, the centre supports real-time decision-making and predictive analytics across the agricultural value chain.

[21] https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=2010600

[22] https://www.pib.gov.in/PressReleasePage.aspx?PRID=1885193#:~:text=Department%20of%20Science%20&%20Technology%20(DST,including%20IoT%20and%20AI%2C%20namely:

3.3 Agri-Entrepreneurship and Startups

The Government of India has launched several initiatives to foster innovation, entrepreneurship, and commercialization in the agriculture and food sector. These programs aim to build a robust ecosystem for agri-tech startups, enabling them to address challenges across the value chain—from production and processing to logistics and exports.

3.3.1 RKVY-RAFTAAR (Remunerative Approaches for Agriculture and Allied Sector Rejuvenation)

- Under this scheme, startups in the agriculture sector receive financial support for product development, market linkage, and commercialization. The program operates through a network of Agribusiness Incubation Centres (R-ABIs), which provide mentoring, technical assistance, and access to pilot testing facilities. RKVY-RAFTAAR plays a pivotal role in nurturing early-stage innovations and scaling them for broader impact.

- Department of Agriculture and Farmers Welfare has appointed 5 Knowledge Partners and 24 Agribusiness Incubators for training and incubation of agri-startups and implementation of this programme.[23]

3.3.2 AgriSURE Fund

- AgriSURE is a strategic initiative by Government of India to finance start-ups for agriculture and rural enterprise, relevant for farm produce value chain. With a total corpus of INR 750 crore, INR 250 crore each is contributed by the Government of India and NABARD respectively, and INR 250 crore is to be mobilized from other institutions including private investors. The primary objective of the fund is to support innovative, technology driven high-risk, high-impact activities in agriculture and allied areas[24].

3.3.3 Atal Innovation Mission (AIM)

- A flagship initiative aimed at fostering a culture of innovation and entrepreneurship across the country. AIM's objective is to develop new programmes and policies for fostering innovation in different sectors of the economy (including the agriculture sector), provide platforms and collaboration opportunities for different stakeholders, and create an umbrella structure to oversee the innovation and entrepreneurship ecosystem of the country.

3.3.4 BHARATI Initiative by APEDA

- The BHARATI initiative (Bharat's Hub for Agritech, Resilience, Advancement and Incubation for Export Enablement) is a flagship program launched by APEDA to support 100 agri-food and agri-tech startups.

- It focuses on promoting innovation in areas such as GI-tagged products, organic and superfoods, processed foods, livestock, and AYUSH-related exports. The initiative encourages the use of advanced technologies like AI, blockchain, and IoT to enhance traceability, quality control, and export readiness, with the overarching goal of achieving USD 50 Bn in agri-food exports by 2030.

[23] https://www.pib.gov.in/PressReleasePage.aspx?PRID=2003181

[24] https://www.nabard.org/agrisure.aspx#:~:text=The%20fund's%20target%20beneficiaries%20include:%20*%20Agritech,Ltd.%2C%20a%20wholly%20owned%20subsidiary%20of%20NABARD.

3.4 Improving Crop Productivity and Farmer Income

3.4.1 National Project on Soil Health and Fertility

- This scheme provides farmers with soil health cards that provides macro and micro-nutrient levels, enabling informed decisions on fertilizer application. Issued every three years, these cards help optimize input use and reduce costs while maintaining long-term soil productivity.

- The initiative promotes balanced nutrient management, which is critical for preventing soil degradation and ensuring consistent yields. Rapid soil testing technologies are being introduced to complement the soil health card system. These tools use spectroscopy and mobile apps to deliver instant analysis, eliminating the need for lab-based testing. This real-time feedback empowers farmers to make timely and accurate decisions.

3.4.2 Pradhan Mantri Fasal Bima Yojana (PMFBY)

- The Pradhan Mantri Fasal Bima Yojana (PMFBY) is a flagship crop insurance scheme launched by the Government of India to provide comprehensive risk coverage to farmers against crop loss due to natural calamities, pests, and diseases. It aims to stabilize farmer incomes, encourage investment in agriculture, and ensure food security by reducing the financial burden of crop failure.

- The scheme has been integrated with digital tools such as mobile-based crop loss assessment, satellite monitoring, and geo-tagged field photographs for faster claim settlements. Based on pilot studies in states like Maharashtra and Karnataka, the National Crop Insurance Portal (NCIP) has incorporated remote sensing and predictive analytics into the scheme, allowing for more reliable yield estimation and risk profiling.

3.4.3 Digital Soil-Health Cards

- A digital soil-health-card program entails mapping soil composition and quality at the farmer level. It could help agtech companies in India to promote precision-farming initiatives and tailor offerings for specific farmer groups.

3.4.4 Mission for Integrated Development of Horticulture (MIDH)

- This central scheme promotes horticultural crops through area expansion, post-harvest management, and market linkages. MIDH emphasizes technology induction and has established several Centers of Excellence (CoEs) in collaboration with global partners (e.g., Indo-Israel CoEs) as regional hubs for high-tech horticulture. These CoEs conduct trials on improved cultivars, greenhouse designs, micro-irrigation, and precision farming techniques, and showcase validated technologies to farmers and nurseries. The scheme also supports nurseries, tissue culture labs, integrated pest management, and protected cultivation structures. By leveraging global expertise and domestic research, MIDH facilitates adoption of modern practices such as ultra-high-density planting in mango, hydroponics for vegetables, and drone-based orchard monitoring—enhancing productivity and quality in India's horticulture sector.

3.4.5 National Mission on Sustainable Agriculture (NMSA)

- NMSA, part of India's climate action plan, focuses on promoting sustainable farming practices and climate resilience. Key interventions include the Rainfed Area Development scheme and the Soil Health Card initiative, which enable site-specific nutrient management through extensive soil testing and fertility mapping. The mission also supports water conservation and agroforestry, leveraging ICAR research on watershed management and dryland farming techniques.

3.4.6 National Food Security Mission (NFSM)

- Launched in 2007, NFSM is a flagship scheme aimed at increasing production of staples such as rice, wheat, pulses, coarse cereals, and commercial crops through area expansion, productivity enhancement, and technology transfer. In addition to demonstrations and input support, NFSM funds initiatives like Seed Hubs for pulses and oilseeds to ensure timely availability of high-yielding, disease-resistant varieties developed by research institutions. These hubs, hosted at ICAR institutes and State Agricultural Universities, accelerate seed multiplication and dissemination.

3.4.7 National Pest Surveillance System (NPSS)

- Launched as a national platform leveraging AI and geospatial data, the system is designed to provide district level pest forecasts, pre-emptive alerts, and early warnings building an intelligent surveillance infrastructure to enhance readiness and response.

3.5 Drones in Agriculture

3.5.1 Namo Drone Didi Scheme

- The Namo Drone Didi Scheme is aimed at providing drones to Women Self Help Groups (SHGs) for providing rental services to farmers for the application of liquid fertilisers and pesticides. Under this scheme, a Central Financial Assistance is provided to the women SHGs for purchase of drones as a package (including basic drone with spray assembly for spraying liquid fertilisers and pesticides, drone carrying box, standard battery set, downward facing camera, dual-channel fast battery charger, battery charger hub, anemometer, pH meter and 1-year onsite warranty on all items).

3.5.2 Drone Subsidies under SMAM

- The government has amended the guidelines of Sub-Mission on Agricultural Mechanization (SMAM), with a provision of providing subsidy for the purchase of agricultural drones by farmers, agricultural graduates, FPOs, Custom Hiring Centers (CHCs) and State Agricultural Universities.

3.6 Farm Level Extension

3.6.1 National Interactive Digital Platform

- MoA&FW has signed an MoU with Digital Green under PPP framework for developing a National Interactive Digital Platform to strengthen extension system. The platform will host a digital library of curated multi-format multi-lingual content, help extension workers access and deliver curated content to farmers on time and upskill the vast network of extension workers for agriculture, horticulture, fisheries, livestock and rural livelihood missions through certified online courses.

3.6.2 Kisan Suvidha mobile application

- Launched to facilitate dissemination of information to farmers on the critical parameters such as weather, market prices, plant protection, input dealers (seed, pesticide, fertilizer), farm machinery, soil health card, cold storages and godowns, veterinary centers and diagnostic labs.

3.6.3 Krishi Yantra

- Central Institute of Agricultural Engineering, Bhopal (ICAR-CIAE) under Indian Council of Agricultural Research (ICAR) has developed a "Krishi Yantra" app to augment research, operations and technology dissemination process in the field of agricultural engineering.

- In addition, a web portal has been made available by ICAR-CIAE on their website where option of interaction between user and specialists is available to ensure that appropriate mechanization technology is selected by the entrepreneurs.

3.7 Infrastructure Development and Credit Facilitation

3.7.1 National Agriculture Market (e-NAM)

- e-NAM is a digital platform that connects APMCs across India, enabling farmers to sell produce through transparent online auctions. This reduces the influence of intermediaries and improves price realization for producers. The platform supports real-time price discovery and competitive bidding.

- By digitizing the trading process, e-NAM enhances market efficiency and reduces transaction costs. Buyers can access produce from multiple markets, improving supply chain flexibility. The system also supports quality grading and certification, essential for building trust in digital transactions.

3.7.2 Agriculture Infrastructure Fund (AIF)

- AIF provides long-term financing for the development of post-harvest infrastructure and community farming assets. It supports investment in scientific storage systems such as silos, cold chains, and processing units.

- The fund offers interest subvention and credit guarantees, making capital more accessible to entrepreneurs and FPOs. By enabling decentralized infrastructure development, AIF strengthens local value chains.

3.7.3 Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyan scheme (PM-KUSUM)

- PM-KUSUM is a flagship initiative aimed at integrating renewable energy into agricultural operations. The scheme promotes the installation of solar-powered pumps and grid-connected solar systems to reduce dependence on conventional energy sources.

- By enabling farmers to generate their own electricity, PM-KUSUM not only reduces input costs but also creates opportunities for income generation through surplus power sale to the grid.

3.8 Processing and Value Addition

3.8.1 Pradhan Mantri Kisan Sampada Yojana (PMKSY) under MoFPI

- The Pradhan Mantri Kisan Sampada Yojana (PMKSY) is a comprehensive package of incentives designed to create and modernize food processing infrastructure with efficient supply chain management from farm gate to retail outlet. It offers financial incentives for the creation and expansion of processing units and agro-processing clusters. The scheme encourages the adoption of advanced technologies in processing, packaging, and cold storage, thereby enhancing value addition and reducing wastage.

3.8.2 MoFPI's Formulation of Micro Food Enterprises scheme

- This scheme supports Farmer Producer Organizations (FPOs) and micro enterprises in developing primary processing infrastructure. It facilitates grassroots-level adoption of basic processing technologies and equipment, empowering small-scale agri-businesses to participate in formal value chains and improve product quality.

3.8.3 Production Linked Incentive (PLI) Scheme for Food Processing

- The Production Linked Incentive (PLI) Scheme for Food Processing aims to attract large-scale investment and promote innovation in food manufacturing. The scheme targets food manufacturing entities that meet stipulated minimum sales and are willing to invest in expanding processing capacity and branding abroad. It incentivizes investment in four major product segments—Ready to Cook/Ready to Eat foods (including millet-based products), processed fruits and vegetables, marine products, and mozzarella cheese. The scheme also supports branding and marketing abroad through grants for in-store branding, shelf space renting, and promotional activities. The scheme enhances competitiveness, scalability, and export potential of food enterprises by supporting technology-led transformation.

3.8.4 Animal Husbandry Infrastructure Development Fund (AHIDF)

- AHIDF provides financial support for infrastructure development in the livestock sector. Under AHIDF, an interest subvention is provided for establishing dairy and meat processing units, animal feed plants, veterinary vaccine and drug manufacturing facilities, technologically assisted breed improvement farms, animal waste to wealth management units and primary wool processing infrastructure. Additionally, a credit guarantee is also provided to projects falling within the MSME category. AHIDF strengthens backward linkages and improves productivity and quality in animal husbandry operations.

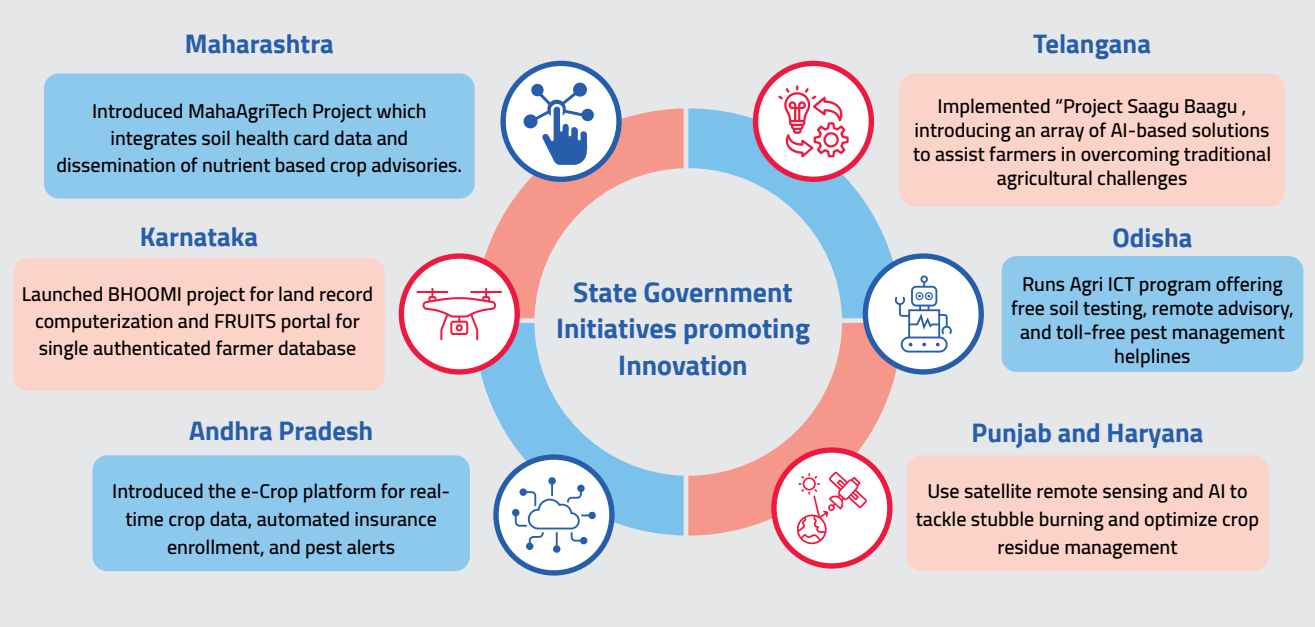
3.8.5 Pradhan Mantri Matsya Sampada Yojana (PMMSY)

- Launched in 2020, PMMSY aims to accelerate fisheries development and modernize aquaculture practices. The scheme focuses on creating brood banks, hatcheries, and seed multiplication units for commercially important fish species, while promoting advanced technologies such as cage culture in reservoirs, biofloc systems for intensive aquaculture, and Recirculating Aquaculture Systems (RAS) for high-density fish farming.

3.9 State Government Initiatives Promoting Technology and Innovation

Besides the initiatives taken by the Government of India, various state governments have also launched pioneering initiatives to foster innovation in agriculture by leveraging advanced technologies such as Artificial Intelligence (AI), remote sensing, and digital platforms aimed at enhancing productivity, improving resource management, and providing real-time support to farmers. Exhibit 5 captures select initiatives/programs/policies undertaken by select states to drive this transformation.

Exhibit 5: Initiatives by select State Governments for promoting technology and innovation in agriculture



Source: http://mrsac.maharashtra.gov.in/agritechgis/, Saagu Baagu 2.0 – Department of Information Technology, Electronics & Communications, https://karshak.ap.gov.in/ecrop, https://agri.odisha.gov.in, https://landrecords.karnataka.gov.in/

3.9.1 Karnataka – Unified Farmer Database and Market Reforms

- Karnataka pioneered agri-digitization through initiatives like the BHOOMI project for land record computerization and later the FRUITS portal (Farmer Registration and Unified Beneficiary Information System). FRUITS creates a single authenticated farmer database, assigning unique IDs linked to land records, enabling seamless delivery of schemes and credit. Banks use this system to verify crop loan eligibility without physical documents. Karnataka also implemented a Unified Market Platform (UMP) in 2014, bringing all APMCs online for transparent e-trading—later integrated into the national e-NAM. The state actively partners with tech firms for pilots in crop analytics, remote sensing, and blockchain-based traceability.

3.9.2 Telangana – AI for Agriculture and Digital Crop Management

- Telangana has positioned itself as a leader in AI-driven agriculture through the AI4AI program and the Saagu Baagu project, which leverages AI-based advisory chatbots, automated soil testing, and digital marketplaces. Pilots have demonstrated significant impact—21% higher yields and doubled farmer incomes in chilli cultivation[25]. The state also introduced a Digital Crop Booking system for real-time crop data and deployed AI-powered pest detection tools in partnership with Wadhwani AI. Investments in IoT-based smart irrigation and blockchain for seed supply chains further underscore Telangana's commitment to tech-enabled farming.

[25] https://www.weforum.org/impact/ai-for-agriculture-in-india/

3.9.3 Maharashtra – Agritech Policy and Remote Sensing

- Maharashtra launched the Maha Agri-Tech project with ISRO for satellite-based crop monitoring and damage assessment. Building on this, the state unveiled the Maha Agri-AI Policy (2025–2029) with an INR 500 crore[26] outlay to mainstream AI in agriculture. Key components include AI and AgriTech Innovation Centers, geospatial analytics, drone-based spraying, and predictive crop disease models. The policy also provisions innovation grants, farmer training, and DBT incentives for technology adoption, aiming to improve resource-use efficiency and climate resilience.

Other State Initiatives

- **Andhra Pradesh:** Introduced the e-Crop platform for real-time crop data, automated insurance enrollment, and pest alerts; promotes Zero-Budget Natural Farming with digital certification.
- **Punjab and Haryana:** Use satellite remote sensing and AI to tackle stubble burning and optimize crop residue management.
- **Kerala:** Developed RFID/barcode-based traceability systems for vegetables and spices to boost export competitiveness.
- **Odisha:** Runs AgriDias program offering free soil testing, remote advisory, and toll-free pest management helplines.
- **Northeastern States:** Implement mobile apps for organic cluster management under MOVCDNER and connect tribal farmers to e-commerce platforms.

[26] https://krishi.maharashtra.gov.in/Site/Upload/Pdf/MahaAgri%20AI%20Policy%202025%20-%202029%20English.pdf

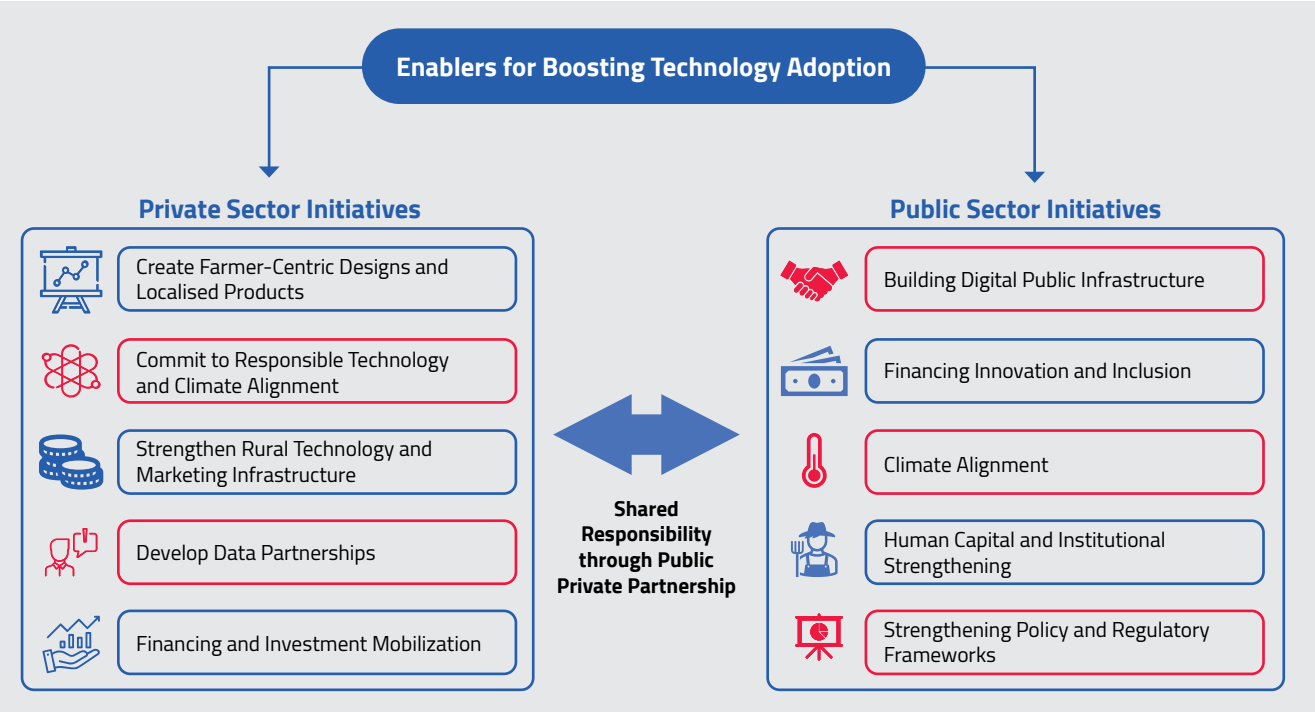
4 Enablers for Boosting Technology Adoption

Technology is rapidly reshaping the contours of India's food and agri-ecosystem, transforming every stage of the value chain- from input to market. Technological innovations such as next-generation seed and crop protection technologies, AI-driven crop analytics, IoT-enabled precision farming, drone-based services, and blockchain-enabled traceability amongst others are redefining how food is produced, transported, and consumed. These technologies are helping farmers and agri-enterprises reduce costs, improve productivity, enhance quality assurance, and make food systems more transparent and resilient.

However, scaling and mainstreaming agri-technology adoption remains a significant challenge. Barriers such as limited awareness, fragmented digital infrastructure (limited internet connectivity, power supply etc.) in rural areas, inadequate digital literacy, fragmented value chains, and the high cost of technology, its integration into the existing production systems and inadequate after sales service continue to slow the pace of transformation. Further, access to affordable finance and data interoperability often constrain technology diffusion at scale.

The true potential of technology driven transformation lies in building an enabling environment that fuels scale, inclusion, and long-term impact. An enabling ecosystem — comprising robust digital infrastructure, supportive regulatory frameworks, capacity building, and collaborative partnerships — is critical to bridge the gap between technology/innovation and its on-ground impact. Building an enabling environment ensures that technology does not remain confined to pilots or a few progressive regions but becomes a catalyst for systemic change across the entire value chain. To fully harness the potential of Agtech, the policy, regulatory, institutional and data-infrastructure environ needs to evolve. Exhibit 6 illustrates the key initiatives by private and public sectors that together could create an enabling ecosystem for scaling agri-tech adoption across India's food and agriculture value chain.

Exhibit 6: Initiatives for building an enabling ecosystem for agri-tech adoption



Source: Industry, YES BANK Analysis

4.1 Private Sector Initiatives

4.1.1 Create Farmer-Centric Designs and Localised Products

- Develop products that are affordable, language-adaptive, gender inclusive and compatible with local environment.
- Develop cost-benefit assessment tools to help farmers evaluate and identify trade-offs for tech-enabled versus conventional farming methods.
- Use co-creation models — designing with farmers— by collaborating with FPOs and rural cooperatives.
- Integrate AI and IoT with vernacular interfaces, voice bots, and offline functionality to suit smallholder and rural use cases.

4.1.2 Commit to Responsible Technology and Climate Alignment

- Commit to sustainability-aligned innovations — promoting low-carbon inputs, circular economy models, and renewable-powered agri-systems.
- Embed ESG metrics and impact measurement into agri-business operations to align with global sustainability frameworks. Use traceability and digital monitoring to enhance ESG disclosures and farmer compliance with sustainability-linked outcomes.
- Participate in climate-tech pilots aligned with India's National Mission for Sustainable Agriculture (NMSA) and LiFE (Lifestyle for Environment) initiatives. Collaborate with government and multilateral agencies to pilot climate-resilient digital models for smallholders.

4.1.3 Strengthen Rural Technology and Marketing Infrastructure

- Partner with telecom and logistics companies to deploy rural digital service hubs — shared facilities for drone operations, sensor calibration, soil testing etc.
- Co-invest in last-mile service networks with local entrepreneurs (AgriTech Saathis, drone operators, FPO-led input centers).
- Strengthen FPO and cooperative digital platforms for collective marketing and procurement.
- Deploy blockchain traceability solutions for quality compliance (domestic and export).
- Build smart logistics and cold-chain systems using real-time visibility tools.
- Integrate with eNAM and ONDC to create digital-first, transparent marketplaces.

4.1.4 Develop Data Partnerships

- Collaborate with AgriStack and Digital Public Infrastructure (DPI) initiatives to build interoperable digital solutions.
- Adopt open APIs and data-sharing protocols consistent with India's emerging Digital Personal Data Protection Act (DPDPA) to ensure privacy and trust.
- Develop analytics layers — crop risk profiling, credit scoring, soil-health — that can plug into government and banking platforms, strengthening agri-finance ecosystems.
- Create partnership models to provide multiple products and end to end solutions to farmers through single app.

4.1.5 Financing and Investment Mobilization

- Anchor AgriTech Venture Funds and Corporate Innovation Accelerators, providing patient capital to early-stage solutions in mechanization, climate risk modeling, and traceability amongst others.
- Participate in PPP models for infrastructure creation — such as agri-data exchanges, cold-chain logistics, and AI-powered extension services. Build multi-stakeholder demonstration projects showcasing end-to-end digital interventions — from advisory to procurement.
- Develop climate-smart financing instruments and carbon credit marketplaces linked to verified emission reductions.

4.2 Public Sector Initiatives

4.2.1 Building Digital Public Infrastructure

- Accelerate rural broadband and 5G rollout for digital inclusion.
- Upgrade warehousing, cold chains, and logistics infrastructure with IoT and GPS-based visibility.
- Integrate AgriStack with allied databases — soil health, weather, satellite imagery — creating a "One Nation, One Farm Data" platform.
- Create geospatial and sensor networks for real-time monitoring of crop health, soil quality, and water use.
- Provide reliable power supply to enable digital solutions to function seamlessly.

4.2.2 Financing Innovation and Inclusion

- Create a Digital Agriculture Credit Enhancement Fund under NABARD to support FPOs and cooperatives adopting precision farming, IoT, traceability systems and other relevant technologies.
- Introduce risk-sharing and guarantee schemes for AgriTech start-ups and FPOs.
- Link government programs (PMFBY, PMKSY, FPO Mission) with digital adoption incentives.
- Offer tax incentives or concessional financing for private R&D focused on technological innovations, including genomics, automation, mechanisation, bio-input innovations and agri-digital tools.
- Promote state-level Agri Innovation Missions to test localized tech solutions.

4.2.3 Human Capital and Institutional Strengthening

- Establish Digital Agriculture Learning Hubs at KVKs and extension centers.
- Integrate extension service with digital tools, AI-powered chatbots, interactive voice systems, and hyper-local advisory content in regional languages to reach farmers efficiently
- Provide certification for rural youth as "AgriTech Service Providers", building a workforce for drone handling, data mapping, and AI advisory delivery.

4.2.4 Climate Alignment

- Build a National Monitoring and Evaluation Framework for tracking digital adoption and its impact.
- Integrate climate-risk and weather analytics into agricultural planning.
- Link carbon accounting systems to credit and insurance frameworks for sustainable farming incentives.

4.2.5 Strengthening Policy and Regulatory Frameworks

- Develop a National Digital Agriculture Policy aligned with AgriStack and the Digital Agriculture Mission.
- Create a National AgriTech Coordination Council to harmonize inter-ministerial and state-level efforts.
- Establish AgriTech Innovation Sandboxes under MeitY and MoAFW for testing blockchain-based traceability, agri-fintech, and AI models without immediate compliance burdens.
- Simplify drone licensing, satellite-data sharing, and IoT import procedures under a single-window AgriTech Facilitation Portal.
- Encourage Outcome-Based Pilots — where subsidies and partnerships are tied to measurable improvements in yield, water-use efficiency, or income.
- Build a National Agri Data Governance Framework ensuring farmer consent, privacy, and interoperability.

4.2.6 Shared Responsibility through Public Private Partnership

Beyond this, Public–Private Partnerships (PPPs) can act as catalytic platforms to bring innovation, efficiency, and scalability into the agricultural ecosystem. The public sector's vast reach and policy-making power, combined with the private sector's agility, technological prowess, and market orientation, can create transformative outcomes. A structured PPP framework with clear data governance, IP sharing norms, and result-based incentives can ensure that innovations reach the grassroots sustainably and inclusively.

Abbreviations

ABI	-	Agribusiness Incubation Centres
AgriSURE	-	Agri Fund for Start-Ups & Rural Enterprises
AHIDF	-	Animal Husbandry Infrastructure Development Fund
AI	-	Artificial Intelligence
AIF	-	Agriculture Infrastructure Fund
AIM	-	Atal Innovation Mission
ANNAM	-	Alliance for Next-Gen Nourishment through Agriculture Modernization
APEDA	-	Agricultural and Processed Food Products Export Development Authority
APMC	-	Agricultural Produce Market Committee
AYUSH	-	Ayurveda, Yoga & Naturopathy, Unani, Siddha, and Homeopathy
CGWB	-	Central Ground Water Board
CHC	-	Custom Hiring Centers
CIAE	-	Central Institute of Agricultural Engineering
DBT	-	Direct Benefit Transfer
DSS	-	Decision Support System
DST	-	Department of Science & Technology
FPO	-	Farmer Producer Organizations
GDP	-	Gross Domestic Product
GI	-	Geographical Indication
GPS	-	Global Positioning System
GVA	-	Gross Value Added
IBEF	-	India Brand Equity Foundation
ICAR	-	Indian Council of Agricultural Research
IoT	-	Internet of Things
IoE	-	Internet of Everything
MoAFW	-	Ministry of Agriculture and Farmers Welfare
MoFAH&D	-	Ministry of Fisheries, Animal Husbandry and Dairying
MoFPI	-	Ministry of Food Processing Industries
NM ICPS	-	National Mission on Interdisciplinary Cyber Physical Systems
IIT	-	Indian Institute of Technology

INR	-	Indian Rupee
IP	-	Intellectual Property
ISRO	-	Indian Space Research Organisation
PM KUSUM	-	Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan
KVK	-	Krishi Vigyan Kendras
MIDH	-	Mission for Integrated Development of Horticulture
NABARD	-	National Bank for Agriculture and Rural Development
e- NAM	-	National Agricultural Market
NCIP	-	National Crop Insurance Portal
NFC	-	Near-Field Communication
NFHS	-	National Family Health Survey
NFSM	-	National Food Security Mission
NGO	-	Non-Governmental Organization
NMSA	-	National Mission on Sustainable Agriculture
NPSS	-	National Pest Surveillance System
OFC	-	Optical Fibre Cable
ONDC	-	Open Network for Digital Commerce
PIB	-	Press Information Bureau
PLI	-	Production Linked Incentive Scheme
PMFBY	-	Pradhan Mantri Fasal Bima Yojana
PMKSY	-	Pradhan Mantri Kisan Sampada Yojana
PMMSY	-	Pradhan Mantri Matsya Sampada Yojana
PPP	-	Public Private Partnership
QR Code	-	Quick Response code
RAFTAAR	-	Remunerative Approaches for Agriculture and Allied Sector Rejuvenation
RAS	-	Recirculating Aquaculture Systems
RDI	-	Research, Development, and Innovation
RFID	-	Radio-Frequency IDentification
RKVY	-	Rashtriya Krishi Vikas Yojana
SHG	-	Self Help Groups
SMAM	-	Sub Mission on Agricultural Mechanization
SMS	-	Subject Matter Specialist
TIH	-	Technology Innovation Hubs
UAV	-	Unmanned Aerial Vehicles
USD	-	United States Dollar
VRT	-	Variable Rate Technology

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At a Glance - A New Generation Private Sector Bank

At YES BANK, we are driven by a deep purpose and relentless commitment to our customers.

Headquartered in Mumbai, YES BANK is the 6th largest private sector Bank in India offering full-fledged banking solutions with its comprehensive bouquet of product and services, digital solutions catering to Retail, MSME, Wholesale and Rural segments. The Bank has a pan India presence with 1,255 branches, 235 BCBOs and 1,331 ATMs (including CRMs and BNAs) in over 300 districts in India.

The Bank operates its Brokerage business through YES SECURITIES, a wholly-owned subsidiary of the Bank. The Bank has a pan-India presence including an International Banking Unit {IBU) at GIFT City in the Ahmedabad district, Gujarat and a Representative Office in Abu Dhabi. Through a growing pan-India presence, we empower our customers to achieve their full potential and serve India's future businesses.

The Bank's vision rests on three strategic pillars:

Universal Banking with Granular Focus: Maintain our role as a universal bank while concentrating on refining and expanding each business segment.

Digital Leadership and Relationship Banking: Leverage our established digital market leadership to serve the new-age economy and future value pools, ensuring we also support and capture transactional business.

Employee-centric Culture and Efficient Processes: Prioritise an employee-focussed culture, streamline processes, and develop a scalable technology infrastructure.

YES BANK has consistently fostered a strong sustainability ethos within its culture, enabling it to respond effectively to evolving ESG expectations, regulations, and opportunities. The Bank continuously monitors ESG and climate developments, collaborating with stakeholders to integrate key sustainability themes and practices into its operations.

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