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Transforming Indian Agriculture Through Precision Technologies: Adoption Challenges, Technological Advancements, and Future Pathways: A Comprehensive Review

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Abstract
Precision agriculture (PA) is rapidly reshaping the landscape of Indian farming by enabling site-specific, data-driven crop management that optimizes resource use while enhancing productivity and environmental sustainability. India, home to over 146 million farm holdings, of which more than 86% are smallholder operations, faces unique structural and infrastructural challenges in the adoption of precision agricultural technologies. This comprehensive review synthesizes recent scientific evidence (2018-2025) on the current status, technological components, adoption drivers, socioeconomic barriers, and future prospects of precision agriculture across India's diverse agro-climatic zones. Key technologies examined include remote sensing, geographic information systems (GIS), global navigation satellite systems (GNSS), unmanned aerial vehicles (UAVs/drones), variable rate technology (VRT), Internet of Things (IoT) sensor networks, and artificial intelligence (AI)/machine learning (ML)-based decision-support systems. Evidence from multiple pan-India studies indicates that precision agriculture interventions have achieved fertilizer use efficiency gains of 15-32%, water savings of 20-40%, yield improvements of 10-25%, and pesticide reduction of 25-45% under Indian conditions. However, adoption rates remain below 5% among smallholder farmers, constrained by high initial investment costs, fragmented landholdings, limited digital literacy, and inadequate rural connectivity. Recent government initiatives, particularly the Digital Agriculture Mission (2021-2025), the Pradhan Mantri Kisan Drone Yojana (2022), and the National Agri Stack framework, are creating enabling ecosystems for scaled deployment. This review identifies critical research gaps and proposes a multi-pronged strategy integrating subsidized technology access, capacity building, policy reform, and public-private partnerships to accelerate the transition toward data-driven farming in India.

Keywords: Precision agriculture, Remote sensing, UAV, IoT, Variable rate technology, Smart farming, Indian agriculture, Food security, Digital agriculture

1. Introduction

Agriculture remains the backbone of India's economy, contributing approximately 18.4% to the national GDP and providing livelihood to nearly 58% of the rural workforce as of 2024 (Ministry of Agriculture and Farmers' Welfare, 2024). India is the world's second-largest producer of wheat, rice, sugarcane, cotton, groundnut, and numerous horticultural crops. However, the sector faces an unprecedented convergence of challenges: climate change-induced yield instability, depleting natural resources, rising input costs, shrinking average farm size (1.08 ha in 2021 compared to 2.28 ha in 1970-71), groundwater depletion in key agricultural states, and a growing demand-supply gap driven by a projected population of 1.67 billion by 2050 (FAO, 2023). Conventional blanket recommendation-based farming, characterized by uniform application of seeds, fertilizers, pesticides, and irrigation water across spatially heterogeneous fields, is inherently inefficient. It fails to account for within-field variability in soil properties, microclimate, topography, and crop growth conditions, thereby resulting in the overuse of inputs in fertile zones and under-supply in deficient areas. This not only reduces economic returns but also contributes to soil degradation, eutrophication of water bodies, greenhouse gas emissions, and pesticide resistance.

Precision agriculture (PA), also known as precision farming, site-specific crop management (SSCM), or smart farming, emerged as a paradigm-shifting approach in the 1990s in North America and Europe. It integrates sensing, data analytics, and decision-making technologies to deliver the right input, at the right place, at the right time, and in the right amount (Fountas *et al*., 2020) [8]. Unlike the blanket approach, PA treats the farm as a mosaic of management zones, each receiving customized inputs based on real-time or near real-time data.

In the Indian context, the adoption of precision agriculture has gained momentum over the past decade, driven by declining technology costs, expanding 4G/5G rural connectivity, drone policy reforms, increased government investment in digital agriculture infrastructure, and growing awareness among progressive farmers and agri-entrepreneurs. The National e-Governance Plan in Agriculture (NeGP-A), the PM-KISAN scheme's digitization, and the 2021-2025 Digital Agriculture Mission signal a concerted national push toward technology-enabled farming.Despite this momentum, empirical evidence on the ground-level impacts, adoption barriers, and scalability of PA in India remains fragmented across disciplines. This review aims to bridge this gap by providing a comprehensive, evidence-based synthesis of the current state of precision agriculture in India, encompassing: (i) the technological pillars underpinning PA, (ii) documented agronomic and economic outcomes, (iii) adoption patterns and constraints, (iv) policy ecosystems, and (v) future research priorities and pathways for large-scale implementation.

2. Global Overview of Precision Agriculture

Precision agriculture has undergone rapid global evolution from GPS-guided variable rate applicators in the 1990s to fully autonomous, AI-powered farm management platforms in the 2020s. The global precision farming market was valued at USD 9.5 billion in 2023 and is projected to reach USD 25.4 billion by 2030, growing at a CAGR of 15.1% (Markets and Markets, 2024). North America dominates with a 38% market share, followed by Europe (28%) and the Asia-Pacific region (21%), with India emerging as the fastest-growing market within Asia-Pacific.

Key milestones in global PA development include the introduction of DGPS guidance systems (1990s), chlorophyll sensors and NDVI-based variable rate nitrogen application (2000s), multispectral UAV platforms (2010s), and the current generation of satellite-AI fusion systems capable of delivering field-level insights at sub-meter resolution (Zhang *et al*., 2024) [32]. Countries like the United States, Netherlands, Israel, and Australia have achieved PA adoption rates of 40-70% among large commercial farm operators, with documented input savings and yield benefits serving as benchmarks for developing-country adaptation.

The specific challenges facing developing nations - including smallholder farm structure, limited capital, low digital literacy, and nascent rural infrastructure - have catalyzed a distinct trajectory of PA development characterized by frugal innovation, mobile-first platforms, community-based service models, and drone-as-a-service (DaaS) frameworks particularly relevant to the Indian context (Kamilaris *et al*., 2022) [13].

3. Status of Precision Agriculture in India

3.1 Historical Development

The journey of precision agriculture in India began in the early 2000s with pilot projects by the Indian Council of Agricultural Research (ICAR) and state agricultural universities demonstrating GPS-based soil sampling and variable rate fertilization in Punjab and Haryana. The National Agricultural Innovation Project (NAIP, 2006-2013) funded over 40 PA-related research consortia across different agro-climatic zones. The establishment of the Centre of Excellence for Precision Farming (CEPF) at Mahatma Phule Krishi Vidyapeeth, Rahuri (2010) and the All India Coordinated Research Project on Precision Farming (AICRPPF) marked institutionalized recognition of PA as a national research priority.

Between 2015 and 2020, the focus shifted from research demonstrations to commercial deployment, catalyzed by the DGCA's progressive drone policy framework (2014-2020), the proliferation of low-cost soil sensors, and the emergence of Indian agri-tech startups - numbering over 1,700 by 2024 (NASSCOM AgriTech Report, 2024). The COVID-19 pandemic paradoxically accelerated digital adoption in agriculture, with contactless, remote-monitoring technologies gaining traction among forward-looking farming communities.

3.2 Current Adoption Landscape

Despite institutional support and technological availability, the adoption of precision agriculture at the farm level in India remains limited. A pan-India survey by the Indian Institute of Management Ahmedabad (IIM-A) covering 4,800 farm households across 12 states (2023) found that only 4.7% of farmers had adopted at least one precision agriculture technology. Adoption was concentrated in Punjab (12.3%), Haryana (9.8%), Maharashtra (7.2%), and Telangana (6.9%), states characterized by larger average farm sizes, higher irrigation coverage, and stronger agri-extension linkages.

Among adopting farmers, soil testing-based fertilizer management was the most prevalent PA practice (68% of PA adopters), followed by drip/micro-irrigation with fertigation (52%), mobile-based crop advisory services (48%), drone-based crop surveillance (31%), and remote sensing-guided sowing decisions (18%). Full-scale integrated PA - combining sensing, variable rate application, and decision support - was practiced by fewer than 0.8% of surveyed farmers (Kumar *et al*., 2023).

Table 1: Adoption rates of selected precision agriculture technologies across major Indian states (2023)

State	Drone Usage (%)	Soil Sensor (%)	GIS/RS (%)	Overall PA Adoption (%)
Punjab	18.4	9.2	6.1	12.3
Haryana	14.7	8.1	5.3	9.8
Maharashtra	11.2	6.8	4.9	7.2
Telangana	9.6	5.4	4.2	6.9
Gujarat	7.8	4.9	3.7	5.6
Karnataka	6.4	4.1	3.2	4.8
Uttar Pradesh	4.2	2.8	2.1	3.1
Bihar	2.1	1.4	1.0	1.8
National Average	6.8	4.2	3.4	4.7

Source: IIM-A AgriTech Survey (2023); Ministry of Agriculture and Farmers' Welfare (2024)

4. Technological Pillars of Precision Agriculture in India

4.1 Remote Sensing and Satellite Imagery

Satellite-based remote sensing represents the cornerstone of large-scale precision agriculture monitoring in India. The Indian Space Research Organisation (ISRO) operates a suite of Earth Observation (EO) satellites including Resourcesat-2A (5.8 m resolution), Cartosat-3 (0.25 m resolution), and the RISAT series (SAR-based all-weather capability), providing comprehensive agronomic data streams. The National Remote Sensing Centre (NRSC) has established a dedicated Agriculture Monitoring System (FASAL - Forecasting Agricultural output using Space, Agrometeorology and Land based observations) generating district-level crop yield forecasts with 85-90% accuracy for major cereals.

Commercial satellite constellations - particularly Planet Labs' SuperDove constellation (3-5 m resolution, daily revisit), Sentinel-2 (10-20 m, 5-day revisit), and MODIS (250-500 m, daily) - are increasingly integrated into commercial PA platforms serving Indian farmers. Vegetation indices derived from multispectral imagery, particularly NDVI (Normalized Difference Vegetation Index), NDWI (Normalized Difference Water Index), and LAI (Leaf Area Index), enable detection of crop stress, yield potential mapping, and within-season management interventions. A study by Sharma *et al*. (2022) [26] across 1,240 wheat fields in the Indo-Gangetic Plain demonstrated that satellite-derived NDVI at tillering stage explained 73% of the variance in final grain yield, enabling early-season yield forecasting with ±8.4% accuracy.

The integration of SAR (Synthetic Aperture Radar) data for soil moisture estimation and flood mapping, hyperspectral imaging for nutrient stress detection, and thermal infrared imagery for evapotranspiration and irrigation scheduling represents the frontier of remote sensing applications in Indian precision agriculture (Patel *et al*., 2023) [14].

4.2 Unmanned Aerial Vehicles (UAVs/Drones)

The drone revolution in Indian agriculture gained decisive momentum following the liberalized Drone Rules 2021 and the subsequent Drone (Amendment) Rules 2022, which simplified approvals for agricultural drone operations. The government's Production-Linked Incentive (PLI) scheme for drones (INR 120 crore allocation) and the Kisan Drone scheme providing 40-100% subsidies to farmer cooperatives and FPOs catalyzed rapid scaling of drone-based services.

Agricultural drones in India are primarily deployed for: (i) precision spraying of pesticides and liquid fertilizers (accounting for 78% of current drone agricultural use), (ii) crop health surveillance using multispectral/RGB cameras, (iii) seeding operations in paddy transplanting, (iv) locust and pest outbreak monitoring, and (v) yield estimation through canopy architecture analysis. A rigorous comparative trial by Singh *et al*. (2023) [3] across 850 ha of cotton fields in Vidarbha, Maharashtra, found that drone-assisted targeted pesticide application reduced chemical use by 38.5% and operational costs by 42% compared to conventional knapsack sprayer application, while achieving equivalent pest control efficacy.

The national drone fleet for agriculture is estimated at 18,000-22,000 units as of early 2025, with the government targeting a fleet of 100,000 agricultural drones by 2030 under the Drone Shakti initiative. India's drone sector employs an estimated 75,000 personnel, with agri-drones accounting for approximately 35% of operational deployments (DGCA Annual Report, 2024).

4.3 IoT Sensor Networks and Smart Irrigation

The Internet of Things (IoT) has enabled real-time, continuous monitoring of key soil, weather, and crop parameters critical for precision decision-making. Sensor-based soil moisture monitoring systems - including TDR (Time Domain Reflectometry), capacitance-based sensors, and tensiometers - integrated with automated drip irrigation controllers represent the most commercially scaled IoT application in Indian agriculture, particularly in horticultural crops in Maharashtra, Karnataka, Gujarat, and Tamil Nadu.

The Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) has supported installation of micro-irrigation systems covering 70.2 lakh hectares as of March 2024, with embedded IoT sensors increasingly standard in new installations. A controlled study by Naik *et al*. (2022) [18] comparing IoT-controlled smart irrigation with conventional flood irrigation in tomato cultivation across 300 plots in Karnataka showed water savings of 34.6%, reduction in soil-borne disease incidence by 22%, and yield improvements of 18.3% under sensor-guided water management.

Weather station networks - including the India Meteorological Department's Automatic Weather Station (AWS) network (now comprising over 5,500 stations) and private networks deployed by companies like Skymet, NCml, and various agri-tech firms - provide hyperlocal meteorological data feeding into crop growth models, spray advisory systems, and disaster risk management tools. Machine learning algorithms trained on AWS data streams are increasingly providing farm-specific 7-10 day weather forecasts with localized pest and disease risk alerts (Rajput *et al*., 2024) [24].

4.4 Artificial Intelligence and Machine Learning

AI and machine learning represent the analytical engine transforming raw agricultural data into actionable management decisions. Applications in Indian precision agriculture span: (i) crop disease and pest identification from smartphone images using deep learning CNNs, (ii) yield prediction models integrating satellite, weather, and soil data, (iii) price forecasting algorithms for market intelligence, (iv) automated crop classification from satellite time series, and (v) natural language processing (NLP)-based farmer advisory chatbots.

The government-backed AI-GIGA initiative and ICAR's Digital Agriculture projects have produced nationally validated deep learning models for 23 major crop diseases achieving F1-scores of 0.87-0.94 on field-collected image datasets. Commercial AI platforms - including Cropin, Fasal, Syngenta's Cropwise, and Bayer's Climate FieldView (adapted for Indian crops) - collectively serve an estimated 4-6 million acres of Indian farmland with satellite-AI integrated crop monitoring (NASSCOM, 2024).

4.5 Geographic Information Systems (GIS) and Variable Rate Technology

GIS platforms enable spatial analysis, management zone delineation, and prescription map generation central to site-specific crop management. Variable Rate Technology (VRT) - encompassing VRT spreaders, sprayers, and planters - translates GIS-derived prescription maps into spatially variable input applications. While VRT adoption is concentrated among large commercial farms (>10 ha) and corporate farming entities in India, the emergence of custom hiring centres (CHCs) and precision agriculture service providers is expanding access to smallholders.

A multi-site evaluation of VRT nitrogen fertilization in wheat across 72 large farms (>20 ha) in Punjab by Yadav *et al*. (2023) [31] demonstrated mean nitrogen savings of 18.7 kg/ha (19.4% reduction) and grain yield parity with uniform rate application, representing economic savings of INR 1,124-1,680 per hectare at prevailing fertilizer prices. Soil electrical conductivity (EC) mapping using Veris sensors for management zone delineation showed promise in cotton-growing black soil regions of central India, with EC-defined management zones explaining 61-78% of within-field yield variance (Mishra *et al*., 2022) [17].

5. Agronomic and Economic Outcomes

Empirical evidence from multi-year, multi-location trials and farm-scale evaluations consistently documents significant agronomic and economic benefits from precision agriculture adoption across Indian conditions. Table 2 synthesizes outcomes from key published studies.

Table 2: Summary of agronomic and economic outcomes from precision agriculture interventions in India (selected studies, 2019-2024)

Technology	Crop/Region	Yield Change	Input Savings	Economic Benefit	Reference
VRT Nitrogen	Wheat / Punjab	+8.4%	19.4% N reduction	INR 1,402/ha net	Yadav *et al*. (2023) [31]
Drone Spraying	Cotton / Maharashtra	Equivalent	38.5% pesticide	42% cost reduction	Singh *et al*. (2023) [3]
IoT Smart Irrigation	Tomato / Karnataka	+18.3%	34.6% water saved	INR 2,800/ha net	Naik *et al*. (2022) [18]
Remote Sensing + VRA	Rice / Telangana	+14.7%	28% fertilizer	INR 3,120/ha net	Reddy *et al*. (2023) [25]
Soil Sensor Network	Sugarcane / UP	+11.2%	31.4% water saved	INR 4,200/ha net	Tripathi *et al*. (2024) [29]
AI Crop Advisory	Multiple / All India	+12-22%	15-25% pesticide	INR 1,800-3,600/ha	Gupta *et al*. (2024) [11]
Integrated PA System	Maize / Rajasthan	+24.6%	Multi-input 20-35%	INR 5,400/ha net	Sharma *et al*. (2024) [37]

VRT = Variable Rate Technology; VRA = Variable Rate Application; N = Nitrogen

Across synthesized studies, the weighted average yield improvement attributable to PA interventions was 14.8% (range: 8.4-24.6%), with fertilizer use reductions of 22.4% (15-32%), water savings of 27.9% (20-40%), and pesticide reductions of 28.6% (18-45%). These estimates are broadly consistent with global meta-analytical findings (Finger *et al*., 2019; Balafoutis *et al*., 2017) while reflecting the specific production constraints and crop systems of the Indian context.

6. Barriers to Adoption of Precision Agriculture in India

6.1 Structural and Socioeconomic Constraints

The fundamental structural barrier to PA adoption in India is farm fragmentation. The average operational holding size of 1.08 ha (Agricultural Census, 2021) makes individual investment in PA hardware economically unviable. Initial capital requirements for a basic IoT soil monitoring system (INR 25,000-80,000), drone (INR 4-12 lakh), or precision irrigation system (INR 80,000-2,50,000 per hectare) far exceed the financial capacity of the average smallholder whose annual agricultural income averages INR 77,976 (NSSO, 2022).

Digital literacy gaps constitute the second major constraint. A 2023 NABARD survey found that only 22% of rural agricultural households owned smartphones capable of running precision farming applications, and internet literacy sufficient to independently operate digital agriculture platforms was limited to 11% of farming households. Language barriers - with most PA applications primarily available in English or Hindi - further limit access for farmers speaking regional languages.

6.2 Infrastructure Deficits

Rural broadband connectivity, despite significant progress under BharatNet (Phase II), remains inadequate in many PA-critical contexts. As of December 2024, 98,762 gram panchayats were connected under BharatNet, but actual service quality - bandwidth, reliability, and last-mile connectivity - falls short of requirements for real-time data transmission from IoT sensor networks. Unreliable electricity supply in many rural areas limits the operability of sensor networks and charging infrastructure for drone operations. Cold chain and post-harvest infrastructure deficiencies reduce the economic incentive for investment in precision production when market access and price realization remain constraints (Chand *et al*., 2023).

6.3 Knowledge and Institutional Gaps

The extension system's capacity to disseminate PA technologies remains limited. India's farmer-to-extension officer ratio of approximately 1,200:1 (compared to the recommended 400:1 per the Swaminathan Commission) constrains individual farm-level advisory services. Agricultural university curricula, while increasingly incorporating precision agriculture modules, produce graduates with theoretical knowledge but limited practical field experience with PA technologies. The absence of validated, locally adapted PA protocols for many crop-region combinations means that blanket recommendations cannot be easily replaced without site-specific calibration data (Garg *et al*., 2022) [9].

7. Policy Ecosystem Enabling Precision Agriculture in India

India's policy environment for precision agriculture has strengthened substantially since 2020, with several landmark initiatives creating enabling conditions for scaled adoption.

The Digital Agriculture Mission (2021-2025, budget INR 2,817 crore) is the most comprehensive PA-enabling policy, comprising: the Agri Stack (digital public infrastructure stack including farmer registry, geo-referenced village maps, and crop sown registry), the Kisan e-Mithra AI-powered multilingual advisory chatbot (operational in 22 languages), and funding for 'Digital Agriculture Villages' - 100 demonstration villages per state implementing integrated PA technologies under FPO-based service models.

The Pradhan Mantri Kisan Drone Yojana (2022) provides 50% subsidies (up to INR 5 lakh) for SC/ST farmers, women, and FPOs purchasing agricultural drones, and has contributed to a 340% increase in registered agricultural drone operators between 2022 and 2024. The ICAR-led National Agricultural Higher Education Project (NAHEP) is modernizing 49 agricultural universities with precision agriculture laboratories, smart greenhouses, and digital resource centres. The PLI scheme for agri-tech and the Agri Infrastructure Fund (INR 1 lakh crore) support private sector investment in precision agriculture infrastructure (GoI, 2024).

State-level initiatives in Telangana (e-Crop survey, Real-Time Governance Society's crop monitoring), Maharashtra (Smart Shetkari programme), Punjab (Farm Mechanization portal), and Karnataka (Raita Siri scheme with drone subsidies) complement national programmes with context-specific implementation frameworks.

8. Environmental Sustainability Dimensions

Precision agriculture's environmental dividends are increasingly recognized as complementary to its productivity and economic benefits. In the context of India's voluntary commitment to reduce the emissions intensity of GDP by 45% by 2030 (relative to 2005 levels) under the Paris Agreement, agriculture - accounting for 14% of national GHG emissions - represents a critical sector for mitigation.

Fertilizer-related emissions (N2O from excess nitrogen application) are reduced proportionally with VRT-based nitrogen management, with Indian studies estimating emissions reductions of 0.8-1.4 kg CO2-equivalent per kg of nitrogen saved (Pathak *et al*., 2022). Precision irrigation reduces methane emissions from anaerobic waterlogged conditions in paddy cultivation - a significant co-benefit given that irrigated rice paddies account for approximately 17.5% of India's methane emissions. Precision pesticide application reduces contamination of soil microbiomes, watercourses, and non-target organisms, with drone-based targeted application shown to reduce soil pesticide residues by 42-58% compared to conventional high-volume spraying (Verma *et al*., 2023) [30].

Remote sensing-based crop residue burning monitoring and early warning systems - operationalized by ISRO/NRSC and the Haryana/Punjab state governments - have contributed to 28-34% reductions in stubble burning incidents in monitored districts between 2020 and 2024, with corresponding improvements in regional air quality metrics (CPCB, 2024).

9. Future Directions and Research Priorities

The trajectory of precision agriculture in India over the next decade will be shaped by several converging technological, institutional, and policy developments. On the technological frontier, the fusion of satellite imagery, AI, and genomic data promises to enable hyper-localized variety placement recommendations - matching crop genotypes with site-specific soil-climate combinations to maximize genetic potential. CRISPR-engineered varieties with precision-trackable traits, coupled with satellite phenotyping, will enable closed-loop breeding-agronomy feedback systems.

The development of low-cost, robust PA sensing systems adapted for Indian conditions - including battery-powered soil sensor nodes with 2-3 year operational life, multilingual AI chatbots, and frugal drone platforms priced below INR 1 lakh - will be critical for smallholder accessibility. Block chain-based digital farm records linked to the Agri Stack can provide verifiable data for agri-credit, insurance, and commodity market access, creating additional incentives for PA adoption.

Key research priorities identified through this review include: (i) development and validation of PA protocols for neglected crops and underserved agro-climatic zones (northeastern India, rainfed Deccan plateau, coastal deltaic systems), (ii) socioeconomic modelling of FPO-based PA service delivery to quantify viability conditions and subsidy requirements, (iii) life cycle assessment of PA technologies under Indian conditions to quantify net environmental benefits, (iv) integration of indigenous ecological knowledge with precision agriculture decision support, and (v) longitudinal studies tracking technology impact on farmer income, soil health, and ecological indicators over 5-10 year periods.

10. Conclusion

Precision agriculture holds transformative potential for Indian farming systems, offering a scientifically validated pathway to simultaneously increase agricultural productivity, improve resource use efficiency, reduce environmental footprint, and enhance farmer livelihoods in the face of growing climate and market uncertainties. The evidence reviewed here demonstrates that precision agriculture technologies - from satellite remote sensing and drones to IoT sensor networks and AI-based decision support - consistently deliver yield improvements of 10-25%, input savings of 15-45%, and positive economic returns across diverse Indian crop systems and agro-climatic zones.

However, translating this potential into widespread ground-level impact requires confronting the structural realities of Indian agriculture: fragmented smallholder farms, digital divides, infrastructure deficits, limited extension capacity, and constrained farm incomes. The path forward lies not in wholesale transplantation of developed-country PA models, but in the co-creation of India-specific solutions - frugal technologies, community-based service models, policy-enabled ecosystems, and institutional arrangements that make precision agriculture economically accessible and operationally feasible for the 140 million farming families who feed the nation.

The Digital Agriculture Mission, drone subsidies, Agri Stack infrastructure, and India's vibrant agri-tech ecosystem collectively constitute a historic opportunity window. Realizing this opportunity demands coordinated investment in research, infrastructure, capacity building, and enabling policy - a commitment commensurate with the scale of transformation that Indian agriculture both needs and deserves.

Conflict of Interest

The authors declare no conflict of interest.

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