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The Era of Smart Agriculture

The transformation of agriculture from a labour-intensive tradition to a data-driven science represents one of the most profound shifts in human history. Today, the global food system faces the unprecedented challenge of feeding a growing population while operating under the severe constraints of climate change, degrading soil health, and depleting water reserves. In this context, smart agriculture ceases to be a futuristic luxury; it becomes our primary mechanism for survival and sustainability. By integrating cutting-edge technologies like precision drone mapping, satellite telemetry, and IoT-driven soil sensors, modern farming is moving away from generic, blanket applications toward highly targeted interventions.

This technological evolution fundamentally changes how we view resources. Instead of treating entire fields uniformly, a smart agricultural framework allows farmers to treat every single acre as a distinct micro-ecosystem. Sensors can detect exact moisture deficits, pinpoint nutrient deficiencies, and predict pest outbreaks before they manifest visually. This level of precision significantly optimizes the use of inputs, ensuring that precious water and vital crop nutrients are applied only where and when they are absolutely necessary. Beyond the immediate economic benefits of reducing input costs, this paradigm shift minimizes chemical runoff and helps preserve the surrounding ecology.

The integration of artificial intelligence and machine learning is turning vast pools of raw field data into actionable intelligence. Predictive analytics can now guide sowing schedules aligned with shifting weather patterns, while automated machinery streamlines labour-intensive processes. The ultimate goal, however, extends beyond just increasing yields. True smart agriculture harmonizes productivity with conservation, ensuring that our food production systems are resilient enough to withstand the volatile environmental shifts of the twenty-first century.

Achieving this balance requires robust collaborative frameworks. By fostering public-private partnerships, streamlining rural digital infrastructure, and developing localized, vernacular data platforms, we can bridge the deep technical divide that currently limits widespread adoption. Empowering farmers with real-time insights turns vulnerable agrarian communities into active stakeholders of an innovative, tech-driven marketplace.

Crucially, this digital revolution must be inclusive. As we embrace these advancements, our focus must remain on making technology accessible, practical, and scalable for smallholders and large-scale enterprises alike, thereby securing a resilient, equitable, and food-secure future for generations to come.

Rajni Shaleen Chopra





From The Group Editor's Desk	03
From The CEO's desk	05
POLICY PUSH	
Sathi Portal : A True Companion For Farmers	26
PROSPERITY THROUGH DAIRY	
NCDFI, ASSAM RIFLES Partner to Strengthen Dairy Supply Chain in the Northeast	28
PATHWAYS TO PROSPERITY	
Smart Agriculture at the Core Distributed Processing As India's Missing Piece	31
AGRI-TECH ECOSYSTEM	
Why Farmer Readiness and Adoption Gaps Determine the Success of Agri Innovation	34
HEALTH AND WELLNESS ECONOMY	
Emerging Dynamics Of The Honey Sector Trends, Opportunities, and Challenges	36
FARM TECH	
Smart Technology Is Shaping The Future Of Agriculture	40
SOLAR AGRI TECH	
Solar Energy Transforming Rural Agriculture	45
SEEDING IT RIGHT	
Quality Seed A Farmer's Fundamental Right	48
SEAFOOD SUCCESS	
Smart Aquaculture: The Changing Dynamics of India's Shrimp Industry	50
GROWTH PATHWAYS	
Smart Agriculture In Indiabridging The Gap From Farm To Fork	53
FARM ROBOTICS	
Niqo Robotics Takes India-Built Physical AI Farming Platform to Europe at Bharat Innovates 2026	55

06

DR. SK MALHOTRA



10

MR. K PRASAD



12

MR. GAURAV SHARMA



16

PROF. DR. C. M. BIRADAR

20

MR. AMIT PATJOSHI



24

MR. SAPT RISHI GOENKA

From the CEO's desk

Precision Tools, Inclusive Growth



Smart agriculture is no longer a futuristic ideal — it's the practical pathway to resilient, productive, and climate-adapted farming across India. At its core, smart agriculture blends traditional knowledge with digital tools: sensors and IoT for real-time field monitoring, satellite and drone imagery for precision planning, data analytics for predictive insights, and finance and insurance products tailored to risk profiles. Together, these elements reduce input waste, boost yields, and make every rupee of investment work harder for farmers.

But technology alone won't transform agriculture. Adoption depends on accessibility, affordability, and trust. Smallholder farmers need intuitive tools, localized advisory services in regional languages, and interoperable systems that work with on-ground realities such as fragmented landholdings, seasonal labour patterns, and variable connectivity. Public-private partnerships, Farmer Producer Organisations, digital literacy drives, and inclusive financing must therefore run alongside technological deployment.

Smart agriculture also offers powerful climate action gains. By enabling optimized water use, precision nutrient management, and early-warning systems for pests and weather shocks, it helps reduce greenhouse gas emissions and builds adaptive capacity. At the same time, data-driven supply chain efficiencies can shorten routes to market, reduce post-harvest loss, and improve farmer incomes.

Policymakers and practitioners must emphasize human-centered design, capacity building, and ethical use of data. Ownership models that keep farmers in control of their data, and business models that share value fairly, will determine long-term success.

Equally important is building local innovation ecosystems. Agri-tech startups, research institutions, and extension services should collaborate to pilot context-specific solutions, validate them on-farm, and scale what works through FPOs and cooperatives. Training programs for youth and women in rural areas can create new livelihoods and accelerate adoption, while localized demonstration plots and peer-to-peer learning help translate technical concepts into everyday practice.

Scalable finance mechanisms and risk-sharing instruments will be critical to bridge the affordability gap for smallholders. Governments and lenders should design subsidised credit, outcome-based grants, and micro-insurance that lower entry barriers for climate-smart investments. Equally, transparent impact metrics and open data standards will attract responsible private capital and enable better policymaking. Ultimately, embedding participatory feedback loops—where farmers shape tools and policies—will ensure smart agriculture remains inclusive, equitable, and responsive to the real needs of India's diverse farming communities.

The true promise of smart agriculture lies in empowering farmers — not replacing them. When technology, institutions, and communities align, we can cultivate a healthier, more prosperous, and climate-resilient agricultural future for India.

Haris Khan

SMART HORTICULTURE PERSPECTIVES

Anchoring India's Horticultural Boom

The expansion of horticulture is a sign of its growing significance in India's development environment. This large group includes root and tuber crops, flowers, mushrooms, medicinal and fragrant plants, fruits, vegetables, nuts, and plantation crops. With government support, horticulture has expanded significantly, reaching 371 million tons of production in 2025–2026 and accounting for 35% of the AGDP from 12.5% of cropped land. Many success stories have not only bolstered economic development but has also encouraged a growing number of individuals to adopt horticulture as a means of livelihood. However, despite these accomplishments, challenges loom on the horizon. The need to meet the nutritional demands of a burgeoning population and fulfill export requirements places immense pressure on the sector.

Growing concerns about environmental sustainability are driving the adoption of eco-friendly horticultural practices which are smart enough to address challenges. The worldwide problems that horticulture faces include unpredictable weather patterns, harsh occurrences, and temperature swings, but adopting climate-resilient smart approaches shows promise. But with the introduction of cutting-edge technologies like GPS, sensors, and drones, farmers can now maximize resource utilization by getting real-time



About The **AUTHOR**

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information on crop health, weather, and soil conditions. Crops with enhanced characteristics, such as disease resistance and longer shelf life, are created through genetic modification and gene editing. E-commerce and online platforms facilitate market access and efficient supply chains by bringing producers and customers together directly.

Smart Approach

In order to make accelerated development, a thorough and systematic approach is necessary to predict the future of Indian horticulture. This strategy includes diversification and innovations, climatic resilience in relation to sustainable practices, precision horticulture, digital technology integration, post-harvest technology, supply chain management and a supportive legislative environment.

1. Continued efforts are needed to develop high yielding varieties and hybrids of different horticultural crops for different regions for wider adoption for cultivation by farmers in the various parts of the country. More than 2000 improved high yielding, high quality coupled with disease and pest resistant varieties and hybrids have been released by various institutes/universities for cultivation in diverse agro-climatic conditions of the country. Smart breeding tools

involve use of molecular markers for crop profiling, finger printing, molecular taxonomy, identification of duplicates, hybrids, estimation of genetic fidelity and tagging of genes for marker aided selections is gaining importance. Efforts are in progress at various institutions in India to tackle issues of managing disease resistance, resistance to insect pests, nutritional quality improvement and to extend shelf life of fruits and vegetables through development of transgenics.

2. Precision farming calls for efficient management of resources through location-specific hi-tech interventions. Hi-tech horticulture encompasses a variety of interventions such as micro irrigation, fertigation, protected/greenhouse cultivation, soil and leaf nutrient-based fertilizer management, mulching for in-situ moisture conservation, micro propagation, biotechnology for germplasm, genetically modified crops, use of biofertilizers, vermiculture, high-density planting, hi-tech mechanization, green food, soil-less culture, biological control etc. Precision farming application of fertilizers has been proved profitable than the recommendations based on package of practices. The crops where some of the components of precision farming have been practiced are banana, grape, pomegranate, capsicum, tomato, chilli, cashew and selected flowers.
3. There is need to integrate with digital technologies such as Internet of Things (IoT), artificial intelligence (AI), sensors, drones, and satellite imagery. Using digital equipment, tools, software, process, farmers can monitor their crops, orchards, soil, water, weather, post-production management of produce in real-time, enabling them to make more informed decisions about planting, irrigation, fertilization, pest management, harvest and



- post-harvest management of horticultural produce. This can help to reduce waste, improve yields, improve quality, and save costs.
4. For preventing the postharvest losses proper storage, cold preservation, packaging and transport methods with Hazard analysis Critical Control Point norms have to be given more thrust. Standardization of Modified Atmosphere Packaging and Storage systems with greater emphasis on safety (pesticide free), nutrition and quality is getting emphasis. Adding value to horticultural products through branding, packaging, processing, and product differentiation strategies can help capture higher margins and create a competitive advantage. Developing unique product attributes, promoting local or organic produce, and offering convenience to consumers through pre-cut or pre-packaged options are examples of value addition and differentiation.
5. Accurate market information and analysis enable value chain participants to make informed decisions. Understanding consumer preferences, market trends, and demand patterns helps in aligning production and marketing strategies accordingly. Market intelligence

will aid in identifying new market opportunities, exploring potential export markets, and adapting to changing consumer needs. Efficient coordination among different stakeholders, including input suppliers, farmers, processors, and retailers, is crucial for seamless flow and timely delivery of horticultural products. Optimizing transportation routes, ensuring proper storage and handling facilities, and minimizing product losses during transit are critical considerations in value chain management. Different horticultural crops are required to be promoted with a brand of peculiarity characters of nutrition and health care.

Barriers to wide adoption of smart horticulture technologies include high initial investment costs, low levels of digital literacy among farmers, inadequate infrastructure, data security and poor internet connectivity in rural areas

Smart Technological Interventions

Revolutionizing horticulture through the adoption of a holistic approach that includes horticulture-based cropping systems, high density planting systems, nutrient dynamics for efficient use, water use technology with high efficiency, clean planting material and seed technology, green horticulture technologies, plant health management system, protected cultivation, vertical farming, and mechanization are important applications required to accelerate horticulture's development in order to achieve the 2047 horticulture vision.

1. Farming system and cropping system approach for sustainable use of farm resources and reduced risks have been successfully demonstrated in perennial horticulture to maximize the output in different agro-climatic conditions but needs adoption by farmers.
2. High density planting technology has been standardized for many crops and also adopted by many fruit growers in India. It has become a success story in banana,

pineapple, citrus, papaya, mango, cashew and few other fruit crops. High density orchards not only have provided higher yield and net economic returns per unit area in the initial years, but also facilitated more efficient use of inputs. High density orchards are required to be adopted largely for yield and net economic enhancement per unit area.

3. Among various inputs, fertilizers alone account for 20-30% of the total cost of production, moreover, the efficacy of fertilizers applied in soil is low due to various losses and soil fixation. Site specific production, diagnostic and advisory recommendations to maximize nutrient use efficiency are being worked out. But the focus is required for the use of biofertilizers, VAM fungi, biological N fixers and other beneficial microbial agents for effective nutrient use efficiency.
4. Among various methods, micro irrigation has proved successful in exhibiting high water productivity by saving irrigation water from 25-60% in various orchard crops and vegetables with 10-60% increase in yield as compared to conventional

methods of irrigation. Micro irrigation is becoming popular in areas with water scarcity and salt problems. Fertigation requirement in various horticulture crops have been standardized to improve the nutrient and water use efficiency which increased from 120 to 290%. Micro-irrigation coverage is required to be enhanced from 14 to 30 million hectares by 2047.

5. Future commercial fruit growing will depend on successful use of rootstocks for better scion compatibility, canopy architecture, fruit quality, nutrient absorption, water use efficiency, biotic and abiotic stress tolerance, and adaptation under the influence of climate change. Citrus rootstock, Rangpur lime can adapt to water stress, calcareous soils and resist to Phytophthora. The use of rootstock (Dog ridge B and 110R) in grape cultivation has gained popularity, and almost all newer vineyards are being planted on stress tolerant rootstocks only.
6. India is best known as an exporter of organic tea and has niche market for spices and fruits and vegetables. Protocol for organic production may horticultural crops



have been worked out which include use of resistant varieties, management of soil vermin-compost and biofertilizer and management of disease and pests using biological control as well as bio-pesticides.

7. There are several pests and diseases such as fruit fly, stem and fruit borer, bark eating, leaf gall midge, aphids, mites and moths and diseases like scab, powdery mildew, leaf spot, brown spot, gummosis, canker causing serious damage to various horticultural crops. Chemical control measures for various pests and diseases have been worked out at various centres, but there is need for eco-friendly practices. During the last two decades IPM has moved from a peripheral position to the central stage of horticultural production programmes. Several bio-control agents have been identified for various fruit crops but new bio-control agents from the native zone are required to be identified. Disease forecasting models developed are useful in determining the role of climatic factors in disease appearance and progression and devising suitable management strategy.
8. Protected cultivation is the practice of growing crops under a controlled environment using structures such as greenhouses, shade net houses, and polyhouses. This method of cultivation has become increasingly popular in Indian agriculture due to its ability to protect crops from adverse weather conditions, pests, and diseases. The area under protected cultivation covered so far in India is about 3 lakh hectare area which consists of 70-80% under permanent structures (greenhouse- polyhouse, glass house, shednet etc.) and 20-30% under low tunnels, mulching, flow check, anti-hail net, anti-bird net. Though India ranks 7th in the world for area coverage under

IoT, AI, robotics, and precision farming are examples of innovations that have increased yields while optimizing resource use and protecting the environment

- protected cultivation, but still it needs to make impact for creation of clusters of poly houses in the different agroclimatic regions.
9. Vertical farming is a method of growing crops in vertically stacked layers using artificial lighting and a controlled environment. This method of cultivation has become increasingly popular in Indian agriculture due to its ability to produce high yields of crops in a small space and with minimal environmental impact. Aquaponics and hydroponics are two modern methods of cultivation that have become increasingly popular in recent years particularly in areas with water scarcity. However, it is important to ensure that the equipment used for aquaponics and hydroponics is sustainable and does not have adverse effects on the environment.
10. 1Wherever the farming operations are mechanized the crop productivity is high. Several machines and tools have been developed to enhance the efficiency of farm operation in horticulture. India spends about 69.1 million USD for import and earns 67 million USD from export of 7 lakh tractors / yr. Our country needs to develop own capacity for making machinery for smart farming in horticulture. There is need to increase farm power availability from present level of 2kw/ha to 3.5kw/ha by the year 2047, in simple words the

mechanization is required to be increased from 30% to 75%. Smart and intelligent modernization for efficiency and prosperity needs focus. In recent years, robotics has been increasingly used in agriculture to improve efficiency, reduce labour costs, and increase productivity. Robots can be successfully employed for planting, harvesting, post-harvest handling, grading fruits and vegetables can increase efficiency and reduce labour costs.

The Way Ahead

A significant step toward more data-driven, sustainable, and productive agriculture has been the incorporation of smart technologies into horticulture. IoT, AI, robotics, and precision farming are examples of innovations that have increased yields while optimizing resource use and protecting the environment. These clever solutions guarantee better crop management, more informed decision-making, and real-time tracking of soil condition through automated irrigation. Nevertheless, the application of smart technologies in horticulture is still difficult despite the obvious benefits. Barriers to its wider adoption include high initial investment costs, low levels of digital literacy among farmers, inadequate infrastructure, data security and poor internet connectivity in rural areas. Much more focused interventions on capacity building, financial incentives, and infrastructure development are required to provide solutions for these challenges.



EMPOWERING AFRICA'S YOUTH, STRENGTHENING AGRICULTURE, SECURING THE FUTURE

At a time when food security has become one of the world's most pressing challenges, a remarkable initiative is taking shape between India and Africa—driven by the vision of a man who began his journey not in

boardrooms, but in the fields as a farmer.

Mr Karumanchi Prasad, Chairman of Prasad Seeds Private Limited (PSPL), started his career in 1978 as an agriculturist and seed grower. Through decades of hands-on experience, he witnessed the critical role that quality seeds, scientific production systems, and modern processing infrastructure play in improving farm productivity and farmer livelihoods.

From Farmer to Global Seed Industry Leader

Mr Karumanchi Prasad's Vision for Africa's Agricultural Transformation

What began as a small farming and seed-growing enterprise evolved into one of India's leading seed production, drying, processing, and storage infrastructure companies, with operations extending across Asia and Africa.

Throughout this journey, Mr Prasad remained committed to a simple belief:

"Agricultural transformation begins with quality seeds, but sustainable growth comes from developing people, knowledge, and entrepreneurship."

Today, that vision is reaching Africa.

Recognizing the enormous agricultural potential of Nigeria and the urgent need for stronger seed systems, Prasad Seeds has established Taraba Seeds Limited in Taraba State, Nigeria. The initiative aims to build a modern seed production and processing hub that will support farmers with quality seeds, improved technologies, and sustainable agricultural practices.

International Training Programme on Seed Education and Enterprise Development (SEED)

However, Mr Prasad believes that infrastructure alone cannot transform agriculture.

To create lasting impact, Prasad Seeds launched the International Training Programme on Seed Education and Enterprise Development (SEED) in partnership with the Institute of Public Enterprise (IPE), Hyderabad, and with the support of the Taraba State Government.

Under this programme, 30 young

About The **AUTHOR**

Mr Karumanchi Prasad is Chairman, Prasad Seeds Pvt. Ltd., one of India's biggest seed companies

“ The future of agriculture will not be built by infrastructure alone. It will be built by knowledgeable young people who can combine technology, entrepreneurship, and agriculture to create prosperity for farming communities. Our investment in these young trainees is an investment in Africa’s future. ”

Mr. Karumanchi Prasad

men and women from Taraba State, Nigeria, were brought to Hyderabad—widely recognized as India’s Seed Capital - to undergo intensive training in seed production, seed processing, quality management, artificial intelligence (AI), Internet of Things (IoT) applications in agriculture, agribusiness management, and entrepreneurship development.

Creating A New Generation Of Agricultural Leaders And Agri-Entrepreneurs

The objective was not merely to train participants but to create a new generation of agricultural leaders and agri-entrepreneurs capable of driving change in their communities.

After successfully completing the programme, the participants have returned to Nigeria equipped with practical skills, technical knowledge, and entrepreneurial capabilities that can contribute to strengthening the agricultural sector in Taraba State and beyond.

The initiative represents a unique

model of international cooperation, combining Indian expertise in seed technology with Africa’s vast agricultural potential. It is also a demonstration of how private-sector leadership can contribute to food security, youth empowerment, employment generation, and rural development.

Beginning of A Long-Term Mission

For Mr Karumanchi Prasad, this programme is more than a training initiative—it is the beginning of a long-term mission.

His vision is to help create a robust seed ecosystem in Africa by investing in infrastructure, technology, and, most importantly, people. By empowering young agricultural professionals and entrepreneurs, he hopes to contribute to a future where African farmers have access to quality seeds, improved productivity, and greater economic opportunities.

Undertaking The Agricultural Transformation Of Africa

As these young trainees return home carrying new knowledge and aspirations, they also carry forward

a larger vision—one that began in the fields of India and now seeks to support the agricultural transformation of Africa.

About Prasad Seeds Private Limited (PSPL)

Founded by Mr Karumanchi Prasad, PSPL has over four decades of experience in seed production, drying, processing, storage, and agricultural infrastructure development. The company operates across multiple countries in Asia and Africa and is recognized for delivering world-class seed solutions and turnkey agricultural infrastructure projects.

Speaking about his mission, Mr Karumanchi Prasad said, “The future of agriculture will not be built by infrastructure alone. It will be built by knowledgeable young people who can combine technology, entrepreneurship, and agriculture to create prosperity for farming communities. Our investment in these young trainees is an investment in Africa’s future.”



The Fertilizer Fault Line

NEW RESILIENCE PLAYBOOK FOR AGRIBUSINESS LEADERS



About the **AUTHOR**

Mr Gaurav Sharma leads Global Agribusiness Research at Accenture, advising industry leaders on the trends and innovations transforming global agriculture

Over the past few years, businesses have navigated a succession of shocks—from pandemic-driven disruptions and supply chain breakdowns to energy volatility, inflation, and geopolitical instability. Recent regional disruptions in the Middle East have exposed a deeper vulnerability: the dependence of critical global industries on a handful of strategic trade corridors and resource hubs.

Few sectors illustrate this more clearly than fertilizers, where regional disruption is rapidly cascading into a global challenge for agricultural productivity, food security, and supply-chain resilience. The result is a vulnerability that agribusiness leaders can no longer treat as a temporary supply problem. Below, I explain how this vulnerability is playing out across energy markets, fertilizer supply, and planting economics—and propose a new resilience playbook to help companies adapt.

Mapping Dependence on Middle East Fertilizer And Feedstocks

The Middle East accounts for around 30% of global fertilizer exports, with a dominant position in nitrogen and phosphates. Asia receives roughly 43% of Middle East exports of urea, diammonium phosphate (DAP) and monoammonium phosphate (MAP), while the Americas receive about 32% (Figure 1). India, a major agrarian economy sources around 40-45% of its urea and DAP imports from the region, whereas Brazil sources 40% of its urea imports from Middle East, all of which transit through the Strait of Hormuz.

Critically, the Middle East's dominance extends beyond finished fertilizers. The region controls around 14.5% of global LNG exports, 30% of global ammonia exports, and 50% of global sulphur exports — primarily the key feedstocks for nitrogen and phosphate fertilizers. Asia is the most dependent region, accounting for



Figure 1: Regional Split of Middle East Fertilizer Exports (% , 2024)

nearly 83% of the LNG imports and 64% of ammonia imports from the Middle East.

Around 75% of Middle East fertilizer exports and 85 to 90% of Middle East feedstock exports (LNG, ammonia, sulphur), pass through the Strait of Hormuz. With minimal rerouting capacity, disruption has propagated rapidly from maritime risk into gas availability, plant utilization, fertilizer prices and planting economics.

Cascading Impact: Feedstock disruption - Plant shutdowns - Supply crunch - Fertilizer price surge - Food security pressures

Natural gas, a key input in nitrogen fertilizer production, was among the first segments affected by the disruption. Volatility in energy markets increased input costs and created uncertainty across fertilizer supply chains, particularly for urea, given its significant exposure to production and export hubs in the Middle East. Temporary constraints in gas availability also affected fertilizer manufacturing in several markets, before conditions began to stabilize.

The impact varied across fertilizer categories. Urea experienced the greatest pressure due to its dependence on affected trade routes and production centers, while potash remained comparatively insulated because of its more geographically diversified supply base (Figure 2). The broader episode high-

“These developments represent a structural “stress test” of the fertilizer industry’s operating model – one that demands a new architecture for resilience, security, and sustainable growth”, says
Mr Naveen Singla, Managing Director,
Chemicals Practice at Accenture

lighted the interconnected nature of energy, fertilizer, and food systems, and underscored the importance of supply-chain resilience, diversified sourcing

strategies, and coordinated responses to help maintain agricultural productivity and food security during periods of geopolitical uncertainty.

Asymmetric Exposure, Shifting Advantage

Economies with combined feedstock and fertilizer import dependence such as Asia face direct physical supply shocks. On the other hand, diversified (or self-sufficient) systems primarily experience cost pressures.

India, an example of the former, faced an initial dual shock through constrained LNG and fertilizer imports. However, with careful planning, advance stocking, and efficient logistics management, the country is now in a comfortable position for Kharif season. Brazil’s Cape rerouting can add two to three weeks to cargoes and puts the country’s soy and corn cycle at risk. Europe faces manageable physical risk, as well as gas-driven cost pressure. And China remains largely insulated through coal-based urea capacity, with sulphur as the key gap.

These differences are reshaping strategic positioning. Regions with domestic feedstock advantage or Atlantic Basin access are likely to be better positioned to mitigate supply gaps. With CBAM lifting import prices, Europe is also finding renewed economics for domestic production, though gas costs remain the binding constraint.

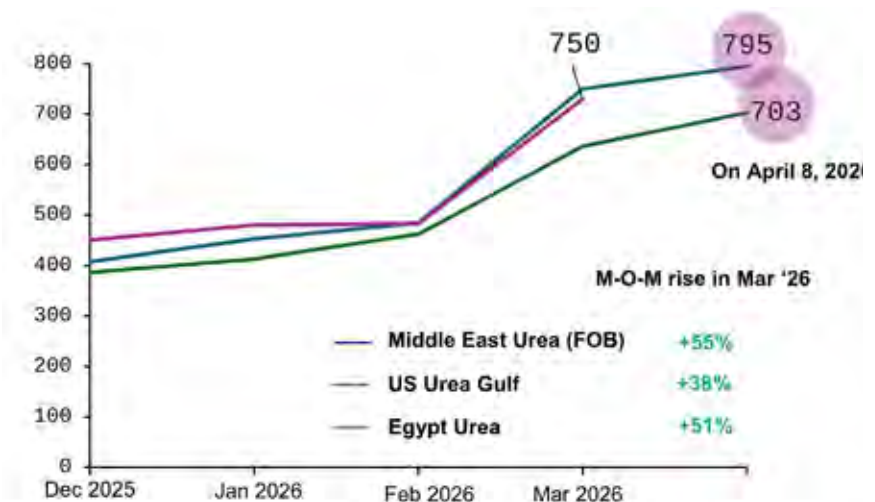


Figure 2: Urea Global Price Indices, US\$/ton



Create a New Resilience Playbook

For executives, managing the fertilizer supply shock requires more than last-minute procurement. To address potential disruptions, countries and companies are already taking decisive steps to build greater resilience. For example, India is rerouting via the Cape, while sourcing from nations across Africa, Europe, ASEAN and other Asia, and scaling nano-urea and green ammonia. Similar efforts are visible globally. Brazil is reviving domestic fertilizer production to reduce import dependency. Europe, meanwhile, is pivoting to North Africa and low-carbon fertilizer partnerships, and China continues to prioritize domestic supply security through export controls and running coal-based urea capacity at full utilization.



It is critical for companies to think of resilience as an enterprise-wide response, which will enable agribusinesses to successfully absorb, adapt, and lead as the prevalent disruptions reshape global fertilizer markets

“These developments represent a structural “stress test” of the fertilizer industry’s operating model—one that demands a new architecture for resilience, security, and sustainable growth”, says Mr Naveen Singla, Managing Director, Chemicals Practice at Accenture. Our research suggests that companies should prioritize the following five actions to create a new resilience playbook:

- **Reinforce supply-chain resilience.** Pursue end-to-end visibility (N-tier) of their supplier networks, as well as real-time, control-tower decision-making, multi-origin sourcing, and strategic stockpiles.
- **Build agile trade & logistics networks.** Enable rapid flexible rerouting, distributed storage and diversified freight strategies that eliminate single-node bottlenecks.
- **Institutionalize financial risk hedging.** Deploy structured commodity hedging, as well as data-driven, mature pricing capabilities that are proactive, AI-enabled, and granular. Create flexible contracts to absorb price volatility, too.

- **Scale competitive domestic production.** Expand capacity in low-cost feedstock regions.
- **Lead the green productivity transition.** Reduce fertilizer intensity through precision agriculture, green ammonia, bio- and nano-fertilizers, nitrogen fixation; by shifting to less N-intensive crops; and by scaling regenerative agriculture for structural demand reduction.

The opportunity for industry leaders is to build on these market-level actions and institutionalize them through company-level operational capabilities. While focusing on these capabilities, it is critical for companies to think of resilience as an enterprise-wide response, which will enable agribusinesses to successfully absorb, adapt, and lead as the prevalent disruptions reshape global fertilizer markets.

***Special thanks to Reshu Rathi and David Kimble for their contributions to this research.**

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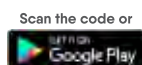
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SMART AGRICULTURE TO ECO-SMART AGRICULTURE

Building Climate Shock Absorbers in Indian Agriculture

Smart agriculture is often understood as sensors, satellites, drones, apps, artificial intelligence and precision advisories. These tools are valuable, but in the age of climate extremes they are not enough. A sensor can warn that the soil is dry and land is degraded; it cannot make the soil hold more water and restore. A forecast can

warn of a long wet-spell or dry-spell; it cannot create drainage, root depth or biological resilience. The burning issue before Indian agriculture is therefore not only how to make farming more digital, but how to make agriculture more shock-absorbing and climate resilience.

The climate signal is clear. Rising temperatures and more frequent droughts are no longer distant concerns. Heat waves, super El Niño-like risks, early or delayed monsoon onset, sudden downpours and cloudbursts, prolonged dry spells, and extended wet spells are now part of farmers' lived reality. In many regions, rainfall comes in fewer but heavier events, followed by long gaps. Within the same season, a crop may face waterlogging one fortnight and drought stress the next. Conventional

agriculture - with exposed soil, shallow roots, declining organic matter, reduced agro-biodiversity, fewer farm trees, and limited integration of native livestock - has become highly dependent on external inputs and is poorly prepared for this new climate reality.

This calls for a paradigm shift from input-intensive agriculture to Eco-Smart Agriculture. Eco-Smart Agriculture combines modern science with the intelligence of living ecosystems and agroecology. It integrates natural farming, tree-based agriculture, livestock-centered circularity, soil biology, on-farm and in-soil water harvesting, biodiversity, local seed systems and market intelligence. Its aim is to increase the shock-absorbing capacity of farms, villages, landscapes and livelihoods.



About the **AUTHOR**

Prof. Dr. Chandrashekhar M. Biradar is an Earth System Scientist, and Green Growth Architect with over three decades of experience across 50+ countries. He is the Founder, Global Green Growth Community of Practices. His work spans tree-based agriculture, natural farming, agroecology, multifunctional agroforestry, biodiversity conservation, dryland restoration, geospatial intelligence, functional food systems and sustainable land and water management. With 550+ publications and leadership and advocacy roles across major global institutions, he advances climate-resilient, nature-positive, One Health, NetZero and green growth pathways for living landscapes and rural prosperity

The First Shock Absorber

Living soil is the first shock absorber. Healthy soil is not an inert medium to hold fertilizer; it is a living sponge with a web of life. Natural farming practices such as mulching, cover crops, crop diversity, Jeevamrit, Beejamrit, composting, bio-inputs and reduced chemical as physical disturbance help rebuild microbial life, soil aggregation and organic matter. Such soils allow rainwater to infiltrate, store moisture during dry spells and reduce crusting and erosion during heavy rainfall. When roots, microbes, fungi and organic residues work together, the farm becomes less dependent on every rainfall event.



The Second Shock Absorber

Plant diversity is the second shock absorber. Monocropping is highly vulnerable because one climate shock can damage the entire field. Eco-Smart systems use mixed crops, intercropping, relay-cropping, functional cover cropping, pre-monsoon dry sowing, year around green cover, pulses, millets, oilseeds, green manures, fodder and tree species to spread risk. If one crop suffers, another survives. Diversity also supports beneficial insects, pollinators, natural pest regulation and nutritional security. In the emerging climate, diversity is not a romantic idea; it is an economic insurance strategy.



The Third Shock Absorber

Tree-based agriculture is the third shock absorber. Trees are climate infrastructure. Their deep roots access moisture from lower soil layers, recycle nutrients, reduce wind speed, buffer heat, improve infiltration, prevent soil erosion and create cooler microclimates. Agroforestry with fruit trees, fodder trees, timber trees, medicinal plants, boundary plantations, living fences and food forests can convert exposed farms into living landscapes. In drylands, tree-based food systems using coconut, tamarind, custard apple, ber, jamun, moringa, amla, karonda, native banana, and hardy native fruit bearing and vegetable species can generate income while strengthening resilience.



The Fourth Shock Absorber

Nandi Krishi and native livestock-based circularity are the fourth shock absorbers. Livestock, especially indigenous cattle and Nandi-based systems, can become the biological engine of regenerative farming. Dung, urine, crop residues and farm biomass can be converted into compost, liquid bio-inputs, biochar blends, biogas, bio-CNG and enriched soil amendments. This reduces dependence on costly external inputs, creates local employment and closes nutrient cycles. Nandi Krishi is not merely about cattle protection; it is about rebuilding a circular rural economy where animals, soil, crops, trees and farmers support one another.

The Fifth Shock Absorber

Water wisdom is the fifth shock absorber. In an era of long dry and wet spells, every farm must be redesigned as a rainfall-receiving system. Soil water, farm ponds, contour bunds, trenches, half-moons, recharge pits, grass strips, percolation structures and drainage channels should become standard components of climate-resilient agriculture. The goal is simple: slow the water, spread the water, sink the water and safely drain excess water.

Technology has an important role, but it must serve this ecological transition. Remote sensing can monitor crop stress, soil moisture, land surface temperature, tree cover and biomass. Sensors can track microclimate, irrigation needs and soil conditions. Digital platforms can



The coming decades will test agriculture with heat, drought, floods and biological stress. The farms that survive will not be the most chemical-intensive or mechanised alone, but the most living, diverse, rooted and adaptive

support advisories, traceability, carbon credits, biodiversity credits, market linkages and FPOs. However, the real smartness lies in combining digital intelligence with ecological intelligence. A drone image of a hot field should lead us to ask: why is this farm so hot, bare and biologically weak?

Eco-Smart Agriculture also improves farmer economics. Reduced input costs, diversified products, better survival under

climate shocks, local value addition and functional food markets can create stable incomes. Millets, pulses, moringa, curry leaf, medicinal plants, native fruits, desi cow products, compost, bio-inputs and agroforestry products can open new livelihood pathways. Climate resilience must not be treated only as an environmental agenda; it is a farmer prosperity agenda.

The future of smart agriculture in India and the world should move beyond gadget-driven efficiency towards ecosystem-driven resilience. We need climate-smart villages, natural farming clusters, tree-based food corridors, Nandi Krishi circular economy hubs, agro-processing centres and digital platforms that reward farmers for restoring soil, water, biodiversity and carbon.

The Tests That Lie Ahead

The coming decades will test agriculture with heat, drought, floods and biological stress. The farms that survive will not be the most chemical-intensive or mechanised alone, but the most living, diverse, rooted and adaptive. Eco-Smart Agriculture can make every farm a climate shock absorber, every village a resilience hub and every farmer a steward of green growth and transition to netzero.

On the eve of World Day to Combat Desertification and Drought, the message is clear: restoring degraded land through Eco-Smart Agriculture is no longer optional, it is the foundation for climate resilience, farmer prosperity and a living planet.



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- ✓ National Co-operatives Convention
- ✓ Thematic Seminars
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- ✓ ACABCs Meet



Focus Areas



Agricultural
Technology



Smart Farming



Mechanization



Agri-Innovation



Food Systems



Agribusiness Investment



Rural Development



Sustainable Agriculture

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PALLADIUM CONNECTING FARMERS TO MARKETS, FINANCE, AND RESILIENT FUTURES

Building the Next Decade of Rural Transformation



For decades, agricultural development has been synonymous with increasing productivity. Better seeds, improved irrigation, mechanisation, and enhanced farming practices have undoubtedly helped raise agricultural output across developing economies. Yet a persistent challenge remains that millions of smallholder farmers continue to experience income volatility, vulnerability to shocks, and limited economic mobility.

Productivity alone does not guarantee prosperity; what matters is the system within which that productivity operates. A farmer may harvest more

produce, but without reliable market access, affordable finance, strong institutions, and effective tools to manage climate risks; higher output will not necessarily translate into higher incomes.

Across many agricultural economies, farmers are producing more than ever before, yet income growth often remains stagnant. The challenge is no longer simply helping farmers grow more—it is ensuring they can capture greater value from what they produce.

As agriculture evolves, the focus must shift beyond yields toward building integrated, resilient rural economies. This means enabling farmers to participate competitively in markets, access opportunities for value addition, and benefit from fair and efficient value chains.

The future of rural transformation lies in strengthening these interconnected systems—linking farmers not only to better technologies, but also to markets, finance, institutions, and climate-

About the **AUTHOR**

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resilient growth pathways that support sustainable and inclusive livelihoods.

The Productivity Paradox

Across many agricultural systems, productivity gains have outpaced income gains. Smallholder farmers often face fragmented landholdings, weak bargaining power, limited access to formal markets, post-harvest losses, and fluctuating commodity prices. These structural constraints prevent them from capturing the full value of their production.

Addressing this challenge requires a shift from a farm-level perspective to a systems-level approach. Agricultural development must strengthen the entire ecosystem surrounding farmers - from aggregation and logistics to market intelligence, financial services, and enterprise development.

The most successful rural development programmes are therefore not those that simply increase production, but those that create pathways for farmers to participate more effectively in value chains and retain a larger share of value generated across the agricultural economy.

Markets: The Missing Link in Rural Prosperity

For many farmers, the greatest challenge is not growing crops—it is selling them profitably and consistently. Connecting farmers to markets requires much more than establishing buyer-seller linkages. It demands a holistic approach to addressing constraints across the value chain—strengthening aggregation systems through farmer collectives and FPOs, improving quality standards and grading practices, enhancing storage and logistics infrastructure, and building long-term, trust-based commercial relationships with buyers.

At the same time, digital platforms are emerging as critical enablers of this transformation. Initiatives such as FPO Odisha portal, e-NAM (National Agriculture Market), ONDC (Open Network for Digital Commerce), and various digital market registries are improving market transparency, enabling efficient buyer discovery, and providing scalable access to diverse markets. When combined with strong on-ground systems, these platforms can significantly enhance price realization, reduce information asymmetry, and create more resilient market linkages for farmers.

This philosophy has been central to Palladium's market systems approach. Through the Promotion and Stabilization of Farmer Producer Organizations (PSFPO) initiative, producer organizations strengthened their engagement with formal markets, expanded participation in digital trading platforms, and improved access to institutional buyers. The results included stronger market integration, improved price realization, and greater commercial viability for farmer collectives. The initiative has delivered transformative impact by

The Bihar Aquaculture Improvement Program, led by Palladium, clearly illustrates this approach. Under this program, we are fostering women-led aquaculture enterprises and enabling women's participation across the aquaculture value chain



scaling farmer outreach, reducing costs, and unlocking export-led growth.

Since May 2024, Odisha FPOs have collectively exported 352.58 MT of horticultural produce to international markets. Exports increased from 140.8 MT in FY 2025–26 to 175 MT in FY 2026–27 (to date), representing an increase of around 25% over the previous year.

These exports have been facilitated by 40 FPOs spanning 15 districts of Odisha, with produce reaching markets in England, Ireland, Greece, France, Germany, Italy, Sweden, Belgium, Poland, the UAE, and Qatar. Through these export channels, farmers have realized 45–60% higher prices, demonstrating the potential of organized farmer collectives to access premium global markets and strengthen their integration into international value chains.

Transformation of Agriculture through Market-led Interventions in the North-Eastern Region (TAMI-NER)

Similarly, under the Transformation of Agriculture through Market-led Interventions in the North-Eastern Region (TAMI-NER), a Gates-funded project, our efforts focused on strengthening producer enterprises, unlocking investments, and creating market opportunities across diverse value chains. By improving access to infrastructure, finance, and market

networks, farmers were able to move beyond primary production and participate in higher-value segments of the agricultural economy. The initiative strengthened rural livelihoods by empowering 9,500 farmers, 60% of whom were women, through training, infrastructure support, and enhanced market access. It facilitated market linkages for approximately 500 MT of produce valued at over Rs 2 crore across selected value chains in Assam, Meghalaya, and Arunachal Pradesh, resulting in an estimated 15–20% increase in producer incomes. Additionally, more than 50 agri-entrepreneurs were supported, alongside the mobilization of Rs 27 crore in public investment for infrastructure development and Farmer Producer Organizations (FPOs). A further - 600 crore investment pipeline positions the region as an emerging agri-business hub, driving inclusive growth, productivity enhancement, and long-term market integration across Northeast India.

These experiences reinforce an important lesson: markets do not work for smallholders automatically. They must be intentionally strengthened so that farmers can compete, grow, and prosper.

Building Institutions That Outlast Projects

Sustainable rural transformation depends on institutions that create

lasting value beyond project timelines. Farmer Producer Organizations, Self-Help Groups, and community-based enterprises enable collective action by helping farmers aggregate produce, reduce costs, access finance, and secure better market prices. However, true success lies not in their formation but in building commercially viable, self-sustaining businesses.

Palladium's experience shows that strong governance, ecosystem-level management, working capital, market access, and clear business models are critical. When these align, farmer institutions evolve into engines of rural entrepreneurship, job creation, and inclusive, long-term economic growth. In Odisha, this approach transformed a fragmented landscape into a robust ecosystem of nearly 1,800 registered FPOs, with improved legal compliance and active shareholder participation, demonstrating that institution-building delivers measurable outcomes.

Climate Resilience as an Economic Opportunity

Climate resilience is no longer just an environmental concern—it is an economic necessity. For smallholder farmers, it means making confident decisions amid uncertainty, supported by access to climate insights, risk management tools, diversified incomes, and resilient farming systems. The most impactful approaches combine



profitability with sustainability, including regenerative agriculture, improved soil health, reduced post-harvest losses, and efficient use of water and inputs.

These strategies enhance productivity while protecting ecosystems, helping farmers maintain yields under climate stress. Emerging opportunities such as voluntary carbon markets can also generate new income streams by rewarding sustainable practices. Climate-smart agriculture is therefore not just about adaptation—it enables resilient livelihoods and long-term economic growth.

Crucially, climate resilience is now linked to market competitiveness. Buyers and supply chains increasingly demand traceability, quality assurance, and verifiable sustainable standards. Farmers adopting climate-smart practices are better positioned to meet these requirements, access premium markets, and secure long-term contracts. Transparent, climate-resilient supply chains reduce risk for buyers while creating clear incentives for farmers to invest in sustainability—aligning environmental stewardship with economic opportunity.

Unlocking Capital for Rural Transformation

Access to finance remains a key barrier to agricultural growth, as smallholders struggle to secure capital for expansion, mechanisation, and value addition. Viewed as high risk, agriculture is underserved by lenders. Blended finance—combining public and private investment—along with strong institutions and market linkages can unlock scalable, inclusive rural growth.

Experience from Odisha under the PSFPO initiative further illustrates this opportunity. Formal credit access among Farmer Producer Organisations expanded significantly—from just 34 FPOs in FY19–20 to 612 FPOs in FY25–26—while sanctioned credit volumes increased 77-fold over the same period. The emergence of dedicated lending products, alongside stronger engagement from banks, NABKISAN, and other financial institutions,



In Odisha, this approach transformed a fragmented landscape into a robust ecosystem of nearly 1,800 registered FPOs, with improved legal compliance and active shareholder participation, demonstrating that institution-building delivers measurable outcomes

highlights that smallholder collectives can evolve into credible, investment-ready enterprises when supported by robust governance systems and market linkages

Women at the Centre of Agricultural Growth

At Palladium, women are not beneficiaries of development—they are central to the design and success of our transformation models across sectors. We recognize that no pathway to sustainable rural development can succeed without placing women at its core. Our experience on ground consistently demonstrates that when women gain access to leadership roles, entrepreneurship opportunities, finance, skills, and markets, the impact extends far beyond individual livelihoods—strengthening families, enterprises, and local economies. The Bihar Aquaculture Improvement Program, led by Palladium, clearly illustrates this approach. Under this program, we are fostering women-led aquaculture enterprises and enabling women's participation across the aquaculture value chain.

Enabling Policy Systems

To bridge the gap between institutional finance and on-ground impact requires robust enabling policy systems that create a conducive ecosystem for

scale. This includes streamlined digital registries for traceability, efficient export facilitation systems, and business-friendly regulatory frameworks that reduce friction for farmer enterprises. Strong policy support not only improves market access but also enhances transparency, trust, and investment readiness across agricultural value chains. In this context, PSFPO's work—particularly in strengthening export pathways, advocating FPO-centric policy support, and building integrated ecosystem linkages - offers a compelling model for how coordinated policy frameworks can unlock sustainable and scalable agricultural growth.

The Next Decade of Rural Transformation

The next decade offers a chance to redefine agricultural success beyond output alone. The focus must shift to higher farmer incomes, resilient systems, strong institutions, and wider economic participation. Progress lies in integrating market access, climate resilience, entrepreneurship, institutional capacity, and innovative finance into one cohesive ecosystem. When aligned, farmers transition to enterprises, communities withstand shocks, and growth becomes inclusive. The future of rural development will depend on connecting farmers to markets and sustainable opportunities.

Smart Irrigation, Smarter Yields

Technological Advances in the Irrigation Sector



PREMIER Drip Irrigation in crop field

For generations, the heartbeat of Indian agriculture has been tied to the rhythm of the monsoons and the labour-intensive practice of flood irrigation. But if we walk through our rural heartlands today, we will notice a change. We can see less water running in open channels and more pipes snaking through the rows of crops. This isn't just a trend; it is a fundamental shift in how we grow our food.

The move toward micro-irrigation—specifically drip and sprinkler systems—is the single most important revolution currently unfolding in Indian fields. It is a transition from "flooding the land" to "feeding the plant."

The Power of "Per Drop, More Crop"

Why are so many farmers making the switch? The answer is as simple as it is compelling: efficiency.

Traditional flood irrigation often

results in nearly half of the water being lost to evaporation or runoff before it even reaches the roots. In contrast, drip irrigation delivers water—and liquid fertilizers—directly to the plant's root zone, drop by drop. Sprinkler systems, meanwhile, mimic natural rain, providing uniform



About the **AUTHOR**

Mr. Sapt Rishi Goenka works at the intersection of water, technology, and growth, steering the next chapter of PREMIER™, a legacy brand under Group Premier with a manufacturing heritage dating back to 1965. He also supports PREMIERWORLD®, the Group's experiential amusement and water technology arm and working on projects and diversifications

coverage for larger crops like wheat and maize.

By adopting these systems, farmers aren't just saving 30–50% of their water; they are seeing a significant boost in crop quality and yield. With less water used for weeds (which no longer get the moisture they need to thrive) and better nutrient absorption, farmers are finding that their land is becoming more productive than ever before.

A Nationwide Push: Government and Farmer Synergy

While the benefits are clear, this revolution is being supercharged by powerful support from the top. Today, only about 10–12% of India's net irrigated area is covered by micro-irrigation, leaving a vast opportunity for growth.

To bridge this gap, both the Central and State governments have made micro-irrigation a national priority. Through the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), the government is providing substantial subsidies—often covering 45% to 55% of the installation costs for small and marginal farmers. Many states, particularly those in the west and south, are layering additional incentives on top of this, making these systems more affordable than ever (up to 100% subsidy). It is a partnership between the government and the tiller, designed to ensure that modern farming isn't just for the large-scale grower, but for every farmer who wants to excel.

How PREMIER Is Helping In This Advancement

At Premier Irrigation Technologies Private Limited (formerly known as Premier Irrigation Adritec Private Limited), we believe that the true success of technology lies in how well it is understood and adopted at the grassroots level.

As the first micro-irrigation company in India, established in 1965, we have spent the last 60 years refining our craft. Our journey has been about more than just manufacturing pipes and nozzles; it has been about democratizing knowledge and innovation. With a



PREMIER Subsurface Drip irrigation in Assam Tea Estate

legacy spanning six decades, we have proudly served farmers across every corner of the nation through a robust PAN-India presence, while successfully executing complex, large-scale projects in collaboration with governments, cooperatives, and international partners across the globe.

We know that a product is only as good as the farmer's ability to use it. That is why we launched our flagship initiatives, Krishi Seva and Krishi Diksha.

- Krishi Diksha is our way of "learning together." We conduct knowledge-sharing programs where we educate farmers on the science of micro-irrigation - explaining how to maintain their systems, how to optimize water use, and how to transition to fertigation.
- Krishi Seva represents our commitment to "exceptional service." We don't just sell a system and walk away; we act as a partner in the farmer's journey, providing the technical support and hand-holding needed to ensure their farm thrives long after the installation is complete.

Our goal is simple: to make sure every farmer has the tools and the confidence to succeed. As we like to say, "*Chalo Banaye Mitti Sona*" - let's work together to turn the soil into gold.

The Road Ahead

The tools of this revolution—the drippers, the sprinklers, and the smart controllers—are ready. They are rugged, they are affordable, and they are proven. As we continue to face the challenges of water scarcity, the shift to micro-irrigation is no longer an option; it is a necessity for a sustainable future.

To every farmer reading this: the technology is in your hands, the support is behind you, and the potential of your land is waiting to be unlocked. The future of Indian agriculture isn't just coming—it's growing, one drop at a time.

Sathi Portal: A True Companion For Farmers

As the kharif approaches, farmers across the country look up to the sky with hope, waiting for the monsoon clouds to gather. With preparations for the Kharif season nearly complete, they begin sowing the seeds of their dreams in fertile soil. However, the process of purchasing seeds often exposes them to multiple challenges—ranging from inflated prices and counterfeit seeds to artificial shortages.

These issues have long resulted in the exploitation and financial loss of farmers. Recognizing this, the Agriculture Department of Maharashtra has consistently taken steps to safeguard farmers' interests. Strict action has been taken against offenders, including recent cases in districts like Nandurbar and Dhule, where individuals involved in the sale of fake seeds were penalized.

Yet, addressing problems after they occur is not enough. The need of the hour is a preventive, transparent, and robust system that ensures farmers are not deceived in the first place. The SATHI portal (Seed Traceability, Authentication and Holistic Inventory) marks a transformative step in modernizing India's seed ecosystem. Developed by the Government of India and NIC, SATHI brings

end-to-end digital integration across the seed lifecycle—covering production, certification, traceability, and distribution—ensuring transparency, efficiency, and accountability at every stage.

End-To-End Digital Integration Across The Seed Lifecycle

SATHI Portal strengthens India's seed production and supply system, recognizing quality seed as the backbone of agricultural productivity. High-quality seeds alone can boost farm output by 10–25%, making their timely availability crucial for farmers' income and food security. The SATHI portal (Seed Traceability, Authentication and Holistic Inventory) marks a transformative step in modernizing India's seed ecosystem.

Developed by the Government of India and NIC, SATHI brings end-to-end digital integration across the seed lifecycle—covering production, certification, traceability, and distribution—ensuring transparency, efficiency, and accountability at every stage. It also helps maintain required Seed Replacement Rates across crop types to meet production goals. By enabling real-time monitoring and better coordination, SATHI aims to

reduce delays and improve planning. Overall, it is a major step toward sustainable agricultural growth and improved farmer outcomes. It aims to eliminate malpractices and bring transparency into the seed supply chain.

Currently, In Maharashtra the portal has onboarded 1105 certified seed-producing companies, 1400 truthfully labeled seed companies, 209 seed processing units and Over 85000 registered seed dealers.

About the **AUTHOR**

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SATHI : Seed Traceability and Compliance in India

Four Phases of Implementation

The implementation is being carried out in four phases:

Phase 1: Seed production (breeder, foundation, and certified seeds) (Seed-Trace)

Phase 2: Sale and Distribution of seeds (Inventory)

Phase 3: TL- Rapid Deployment Flow. (In TL seed only to record final production details)

Phase 4: TL- Holistic Flow (For TL seed complete entry is required.)

Maharashtra Takes The Lead

Maharashtra has emerged as a leading state in effectively implementing this initiative. Recent updates to the SATHI system have made seed tracking and sales more efficient for producers and dealers. A new lot-based tracking system (for kharif 2026) removes the need to scan individual seed bags, saving time and effort. Integration with business software like Tally ensures smoother record-keeping and operations for dealers. QR codes can now include crop-specific Package of Practices, giving farmers useful guidance.

Benefits of Mobile App and Portal

The “SATHI-SaleEasy” mobile app enables quick and easy seed sales for dealers. Additionally, the portal now allows simplified submission of monthly

Form-D reports, improving compliance and reporting efficiency.

The SATHI Portal acts as a powerful tool to protect farmers from fraud and ensure access to quality seeds. Its key benefits include:

- **Transparency in Transactions:** All registered entities operate under government supervision, ensuring accountability.
- **QR Code Verification:** Each seed packet carries a QR code that farmers can scan using a smartphone to verify authenticity before purchase.
- **Regulated Sales:** Only registered dealers are authorized to sell seeds, eliminating unauthorized and illegal sellers.
- **Prevention of Fake Seeds:** The system makes it nearly impossible to sell counterfeit or expired seeds.
- **Control Over Supply Chain:** From production to distribution, every step is monitored, reducing the chances of artificial shortages and price manipulation.

Integration of Farmer ID

The integration of Farmer ID through AGRISTACK in SATHI portal ensures complete traceability of seed distribution. Every purchase made by a farmer is digitally recorded, making the system more transparent and accountable. This linkage eliminates duplication and ensures that benefits reach genuine farmers. It also ensures that subsidies are directly transferred to eligible farmers.

At a time when agriculture faces challenges from substandard and spurious seeds, SATHI emerges as a powerful tool to safeguard farmers' interests and strengthen trust in the system. Beyond being just a digital platform, it reflects a broader shift where technology—alongside innovations like Artificial Intelligence and gene editing—is actively reshaping governance.

By empowering stakeholders and delivering real, on-ground impact, SATHI is driving a new era of innovation and inclusivity in Indian agriculture.

Beyond being just a digital platform, it reflects a broader shift where technology – alongside innovations like Artificial Intelligence and gene editing – is actively reshaping governance and agricultural practices

PROSPERITY THROUGH DAIRY

NCDFI, **ASSAM RIFLES** Partner to Strengthen Dairy Supply Chain in the Northeast

*Purpose to Strengthen Supply of Milk and Milk
Products through Dairy Cooperatives*





National Cooperative Dairy Federation of India Ltd. (NCDFI) and Assam Rifles signed a Memorandum of Agreement (MoA) in New Delhi to further strengthen cooperation for the supply of milk and milk products through the dairy cooperative network.

The MoA was exchanged by Brig Sachinder Tiwari, SM, Brig (Adm), Directorate General Assam Rifles and Shri Srinivas Sajja, MD, NCDFI, in the august presence of Lt Gen Vikas Lakhera, AVSM, SM, Director General, Assam Rifles, and Dr. Meenesh Shah, Chairman, NCDFI & NDDB. The occasion marked an important milestone in expanding the role of dairy cooperatives in meeting the requirements of Assam Rifles.

During the previous year, NCDFI facilitated contracts with Assam Rifles for the supply of UHT milk by Amul (Gujarat) and Nandini (Karnataka), Whole Milk Powder by Warana Milk Union (Maharashtra), and fresh milk by Manipur, Mizoram and Tripura Milk Unions. Based on the satisfactory performance and reliable supplies by dairy cooperatives, Assam Rifles has expanded the range of milk and milk products being procured from the cooperative sector.

Accordingly, in addition to the previous year's contracts, Malt Based Food and Cheese are now being supplied by Amul, while fresh milk and butter are being supplied by WAMUL (Assam), Dimaipur (Nagaland), Bhagirathi (West Bengal) and Alwar (Rajasthan) Milk Unions. The supplies under the arrangement are presently catering primarily to Assam Rifles units and establishments in the Northeastern States, along with their offices in Kolkata and New Delhi.

Creating Meaningful Market Opportunities For Dairy Cooperatives

The MoA reflects the shared commitment of NCDFI and Assam Rifles towards ensuring a dependable supply of quality milk and milk products to Assam Rifles units, while also creating meaningful market opportunities for dairy cooperatives and their farmer members, with particular emphasis on strengthening dairy development and farmer empowerment in the Northeastern region.

Speaking on the occasion, Lt Gen Vikas Lakhera, AVSM, SM, appreciated the consistent efforts of NCDFI and the participating dairy cooperatives in meet-

ing the requirements of Assam Rifles. He observed that the timely availability of quality milk and milk products is important for the welfare of personnel deployed across different locations, particularly in the Northeastern region. He further noted that Assam Rifles, being a force deeply associated with the North-east and widely regarded as the "Friends of the Northeastern People", has taken this initiative not only to ensure reliable supplies for its personnel but also to support the larger cause of empowering dairy farmers through cooperative institutions of the region. He expressed confidence that the MoA would further strengthen this meaningful institutional arrangement and contribute to a mutually beneficial relationship between the forces and the farming community.

The arrangement is expected to generate business of approximately Rs 44 crore annually for participating dairy cooperatives

Growth Pathways for Dairy Cooperatives

Dr. Meenesh Shah said that the association with Assam Rifles is a matter of pride for the dairy cooperative sector. He stated that NCDFI has had the privilege of facilitating supplies of milk and milk products to the Indian Army and ITBP for the last four decades, and the partnership with Assam Rifles further strengthens this trusted association with national institutions. He added that such initiatives reflect the capability of dairy cooperatives to efficiently serve the requirements of Defence and paramilitary forces, while also creating assured market opportunities for cooperative dairies and their farmer members, particularly in the Northeastern states.

Dr. Meenesh Shah also presented Certificates of Gratitude to the officials of Assam Rifles in recognition of their support and trust in the dairy cooperative network. Certificates of Appreciation were also presented to the participating dairy cooperatives in recognition of their role in undertaking supplies of milk and milk products to Assam Rifles, and for their commitment towards ensuring timely, reliable and satisfactory service.

The partnership is expected to further encourage the participation of dairy cooperatives from different regions of the country in meeting the requirements of Assam Rifles, particularly across the Northeastern region and related establishments, while strengthening the cooperative dairy sector's contribution towards national service, self-reliance and farmer welfare.

About NCDFI

National Cooperative Dairy Federation of India Ltd. (NCDFI) is the apex organisation of dairy cooperatives in India, representing a wide network of State Dairy Federations and District Milk Unions, collectively connected with lakhs of dairy cooperative societies and millions of milk producer members.



The initiative will benefit both producers and consumers, supporting regional economic development and dairy self-reliance

Key Highlights of the MoA

Under the proposed MoA, dairy cooperatives from the Northeastern Region will supply fresh milk to 72 Assam Rifles units located across the seven states in the Northeast – Assam, Manipur, Mizoram, Nagaland, Tripura, Meghalaya, and Arunachal Pradesh, as well as Assam Rifles establishments in Delhi and Kolkata.

Dairy products such as UHT Milk and Whole Milk Powder (WMP) are being supplied at five locations, while products such as Cheese and Malt-Based Food are being supplied at seven locations by member dairy cooperatives including Amul (Gujarat), Nandini (Karnataka), and Warana (Maharashtra).

The MoA will provide a long-term institutional framework to strengthen and expand these supplies. This will ensure greater penetration of fresh milk into remote and border areas, enhance supply chain efficiency, and create opportunities for dairy cooperatives.

The arrangement is expected to generate business of approximately Rs 44 crore annually for participating dairy

cooperatives. The initiative will benefit both producers and consumers, supporting regional economic development and dairy self-reliance.

An assured institutional market of this scale provides confidence to dairy cooperatives to expand milk procurement from local farmers. Increased and sustained demand enables cooperatives to offer better milk procurement prices, thereby directly enhancing the income of dairy farmers. It also encourages investments in milk collection infrastructure, chilling facilities, transportation, and dairy development activities, leading to a stronger and more resilient dairy value chain.

The MoA will significantly expand market access for dairy cooperatives and their farmer members by facilitating the supply of fresh milk and dairy products to remote and strategically important border locations, many of which currently have limited access to fresh milk.

The assured demand from Assam Rifles will encourage cooperatives to increase milk procurement from local farmers, bringing more dairy producers into the organized cooperative network. This will create sustainable marketing opportunities for farmers, improve their income security. The benefits of this initiative will extend beyond Assam Rifles personnel and positively impact the civilian population across the Northeastern Region. The initiative will provide a sustainable source of income for dairy farmers, strengthen rural livelihoods, generate local employment, and contribute to the overall growth of the dairy sector in the Northeast.

Historically, many areas in the region have largely depended on UHT milk and milk powder due to limited availability of locally produced fresh milk. With increasing milk procurement by local dairy cooperatives and the development of a robust dairy supply chain, consumers will have access to fresh, locally sourced milk.

Smart Agriculture at the Core

DISTRIBUTED PROCESSING AS INDIA'S MISSING PIECE

India grows food on a scale that ought to be the envy of the world. Yet far too much of that abundance never reaches a plate in a form that holds its value, its nutrition, or the farmer's dignity. Post-harvest losses and the thin reach of processing are not technical footnotes. They are the quiet, daily erosion of rural incomes, the reason a good season can still leave a family exposed, and the structural gap that stops the country from converting

farm output into higher-value products and lasting prosperity.

Recent national assessments continue to show losses that vary sharply by crop and by region. Fruits and vegetables, perishable and roughly handled, suffer the most, with wastage running anywhere from 5 to 16 percent. The annual bill is now valued at over Rs 1.5 lakh crore. Yet, despite these losses, food insecurity has declined, with

undernourishment falling to 14 percent compared to 20 percent in 2010.

The challenge becomes even more apparent when viewed through the lens of processing. India produces approximately 290 million metric tonnes of fruits and vegetables every year, yet only a small fraction of

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this output undergoes processing. While food processing levels in several developed economies range between 40 and 60 percent, India's overall food processing penetration remains at roughly 10 percent. In the case of fruits and vegetables, the number is even lower, estimated at around 4 percent. This gap represents one of the largest untapped opportunities in Indian agriculture—not only to reduce losses but also to create value, improve farmer incomes and strengthen the country's position in global food supply chains.

Protecting Farmers' Interests

The human cost is intimate. A farmer who has nursed a crop for months gets a narrow window to sell it. With no processing or cold storage within reach, the only realistic move is to sell fast, at whatever the market will pay that day. Call it a distress sale, but it is not a glitch a single subsidy can correct. It is the predictable result of a system that parks processing capacity and quality infrastructure far from where the food is

The missing link in India's growth story is not just production but the ability to add more value to what is already produced

actually grown.

Policy, to its credit, has tried. Over the past decade, schemes for cold storages, pack houses and primary processing units have been launched and scaled, supported by public investment and financing initiatives. Yet access to processing and quality infrastructure remains limited across many agricultural clusters. As a result, a significant share of produce continues to move through the value chain with limited opportunities for preservation, value addition or market diversification.

Closing the gap means rethinking processing as something distributed and modular, planted next to production clusters rather than miles away. A small unit that can sort, grade, wash, process and preserve produce at the village or cluster level rewrites the economics of farming. Beyond reducing losses, it creates opportunities for value addition closer to the farm, allowing agricultural produce to move beyond raw commodity markets and into higher-value supply chains. It lets a grower time the sale, reach higher-value buyers, and join chains that actually pay for quality and consistency.

This is where cluster-based approaches can play an important role. The challenge is often not the absence of processing capacity, but the lack of visibility, financing, market access and coordination required to utilize that capacity effectively. Connecting demand with the right processing ecosystem can significantly improve efficiency across the value chain.





Technology-Driven Demand-Supply Matchmaking Engine

At Agrify, we have identified clusters of MSME processors across India located close to the farming regions across the supply chains in which we operate. By building a technology-driven demand-supply matchmaking engine, we are able to determine the most efficient sourcing locations, identify the most suitable processing partners within these clusters, and connect them with market demand. This approach not only improves processor utilization and market access for farmers but also helps optimize the landed cost for the end brand by reducing unnecessary logistics and supply chain inefficiencies. The result is a more resilient and efficient value chain where value addition happens closer to the source of production.

When processing sits close by, losses can be cut by up to 50%, and farmers can earn 20-30% more by avoiding distress sales. The incentive to invest in better agronomy and careful handling rises, because the payoff is visible and quick.

Access to finance remains important, but capital alone is rarely enough. Small processors and farmer groups also require operational capabilities, market linkages and reliable demand to build sustainable businesses. The models

that make it are those that combine financing with technical assistance and market access to ensure that processing capacity is converted into real economic value.

The missing link in India's growth story is not just production but the ability to add more value to what is already produced. While reducing post-harvest losses is important, the real opportunity lies in facilitating processing and value addition through production clusters supported by accessible finance and stronger market linkages. When farmers gain access to these capabilities,

they are not just preserving produce for longer, they are improving quality, accessing better markets and capturing more of the value created after harvest.

The reward is not abstract. It means stronger rural incomes, more resilient supply chains and a food ecosystem that converts abundance into lasting prosperity. For a country that already produces at scale, the next chapter of agricultural growth will not be defined solely by how much more it can grow, but by how effectively it can process, preserve and create value from what it already produces.



WHY FARMER READINESS AND ADOPTION GAPS DETERMINE THE SUCCESS OF AGRI INNOVATION



by reducing subjectivity. Decentralised storage solutions can extend shelf life and provide flexibility in selling decisions. Data-driven advisories can support more informed choices around timing and pricing.

However, their effectiveness depends on how well they

India's agri-tech ecosystem has seen steady momentum in recent years, with a growing range of solutions spanning AI-led grading, sensor-based monitoring, and post-harvest management. This reflects not just technological progress, but also a broader shift in how agricultural challenges are being approached.

Yet, the challenge is no longer about building these solutions. It is about whether they are being used consistently and at scale at the farm level.

The gap between what is being built and what is being used is becoming increasingly visible, driven largely by how well these solutions align with the realities in which they are expected to operate.

The Post-Harvest Constraint

For most farmers, the period immediately after harvest remains the most time-sensitive phase of the agricultural cycle. Without timely access to sorting, storage, or market linkages, produce begins to lose value rapidly—sometimes within hours.

This often results in distress sales,

where the priority shifts from maximising returns to avoiding further loss. Over time, this cycle not only affects farmer incomes but also introduces inefficiencies across the broader value chain, impacting everything from price stability to supply consistency.

What matters, therefore, is not just the availability of better tools, but whether they can be accessed and used at the moment decisions are being made.

Many of the solutions required to address this challenge already exist. Scientific grading can improve price discovery

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integrate into existing systems.

When grading solutions are not available within close proximity, farmers continue to rely on traditional methods. When storage solutions are perceived as complex or unreliable, adoption remains limited. When data is not translated into clear, actionable guidance, it risks adding complexity rather than enabling better decisions.

These are not gaps in innovation. They are gaps in system design and delivery—and they shape how, and whether, adoption happens at scale.

The Real Drivers of Adoption

Technology adoption in agriculture, therefore, is shaped by a set of practical, often interdependent realities.

Value needs to be visible and immediate, typically reflected in improved income or reduced loss. Trust is built locally, through peer experience and demonstrated outcomes rather than external communication. Affordability plays a critical role, particularly in contexts where income cycles are uncertain and risk appetite is low. And proximity determines whether a solution can be used at all—if it is not within reach, it is unlikely to be adopted.

When these conditions are not addressed together, even well-designed

The strongest driver of adoption remains economic value. When the benefit is clearly visible and directly experienced, the need for persuasion reduces significantly

innovations struggle to move beyond pilot stages. This is why many solutions demonstrate promise in controlled or limited deployments, but face challenges when scaled.

Adoption is not a one-time transition, but a process built through repeated use, consistent outcomes, and local validation. Solutions must work reliably in real-world conditions, where variability in infrastructure, climate, and access is the norm rather than the exception.

Equally, on-ground engagement plays a critical role. Farmer Producer Organizations (FPOs), local partners, and demonstration-led models help bridge the gap between awareness and confidence. When farmers see tangible results within their own communities—whether through better price realisation or reduced losses—adoption becomes more organic and sustained.

Ultimately, the strongest driver of adoption remains economic value. When

the benefit is clearly visible and directly experienced, the need for persuasion reduces significantly.

India's agri-tech ecosystem already has a strong base of innovation, supported by entrepreneurs, institutions, and enabling networks. The next phase will depend on how effectively these capabilities are aligned with the realities of the farm.

The focus must now move from building solutions in isolation to embedding them within the agricultural system in ways that are practical, reliable, and accessible. Farmer readiness, therefore, is not a peripheral consideration—it sits at the centre of whether innovation translates into impact.

Because ultimately, the success of agri innovation will not be defined by what is developed, but by what is consistently adopted on the ground and creating real economic value for farmers.



EMERGING DYNAMICS OF THE HONEY SECTOR

Trends, Opportunities, and Challenges

India is the second largest honey producer in the world, with 1,46,000mt of honey output in the year 2024, with 7.3% of the world's share of honey. It's a sector teeming with opportunities and needs a coming together of multiple stakeholders to transform the landscape to benefit everyone in the honey value chain. Driven by changing consumer preferences, sustainability concerns, technological advancements, and evolving trade dynamics, honey is no longer viewed merely as a wellness product but also as a contributor to biodiversity conservation and rural livelihoods.

In the domestic and international market, an important trend in the sector is the growing demand for natural, functional and wellness

foods. As consumers increasingly seek alternatives to refined sugar and artificial sweeteners, honey has gained recognition as a natural sweetener with well-known and scientifically established nutritional and health benefits. This shift is being driven by a growing awareness about premium, organic, monofloral, forest, and region-specific honey varieties. The rise of clean-label products and growing interest in food authenticity have further strengthened honey's position within the health and wellness economy.

industry. Consumers are increasingly willing to pay premium prices for specialty products such as organic, medicinal, and infused honey, as well as bee-derived

Product Differentiation And Value Addition

Product differentiation and value addition are creating new opportunities across the

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products including beeswax, propolis, royal jelly, and bee pollen. This trend is particularly visible in the international market where India exported 1,00,773MT of honey valued at \$206.5mn in the year 2024-25. The expanding use of these products in the food, nutraceutical, pharmaceutical, and cosmetic sectors is opening new revenue streams for businesses and beekeepers. E-commerce and direct-to-consumer channels have further enabled producers to access wider markets and build stronger brand identities.

Technology is emerging as an important enabler for the honey sector, but its full potential is yet to be realised owing to the highly fragmented nature of beekeeping in India. Honey authentication, analysis of residues, digital traceability and improvements in supply chain management will contribute to increased transparency and consumer trust, and provide opportunities for greater market access and regulatory compliance.

The sector is also seeing the gradual introduction of smart beekeeping technologies, such as hive-monitoring systems, IoT-enabled sensors, digital traceability platforms and data-driven colony management tools. These innovations assist beekeepers in monitoring hive temperature, humidity,

colony activity and bee health, allowing timely intervention and improving productivity.

Influence of Climatic Parameters

The research conducted in Tamil Nadu found that bee foraging activity is closely influenced by climatic parameters such as temperature, humidity, rainfall, and wind speed. During the study period, bees exhibited their highest foraging

16%, highlighting how environmental conditions directly affect colony productivity and resource gathering. These findings reinforce the need for hive-monitoring technologies that track temperature, humidity, and colony activity in real time, enabling beekeepers to respond proactively to changing climatic conditions and improve colony health and honey yields.

The Role of New Technologies

New technologies, such as artificial intelligence, blockchain and advanced analytics, could further strengthen quality assurance, traceability and accountability throughout the honey value chain. But benefits of their efforts can be achieved at scale only when beekeepers are organized through structured clusters, cooperatives, FPOs and producer networks that facilitate larger adoption of technology, capacity building and knowledge sharing. Technology can be a game changer in improving honey production and colony health and making the sector consistent with the wider goals of smart and sustainable agriculture, provided there is appropriate policy support and extension services.

The global market continues to offer significant export opportunities. Growing demand for natural sweeteners,

With the right policies, investments, and partnerships, the honey industry can strengthen its contribution to rural livelihoods, biodiversity conservation, food security, and economic growth

activity when average temperatures ranged between 18.85°C and 32.31°C and relative humidity averaged 67.79%. The research also observed that nectar collection accounted for nearly 43% of total foraging activity, while pollen collection contributed around



increasing health consciousness, and declining honey production in several developed economies are creating favourable conditions for exporters. India, with rich floral diversity, a large beekeeper base, has the potential to double its production.

Despite these opportunities, the sector faces several challenges. One of the most pressing concerns is the need for stronger laboratory infrastructure and advanced testing capabilities. As domestic and international quality standards become increasingly stringent, access to accredited laboratories equipped with modern technologies for honey authentication, residue analysis, and quality assessment has become essential. Limited testing capacity can increase compliance costs, create delays, and restrict market access. Investment in scientific research and state-of-the-art testing facilities is therefore critical for enhancing sector competitiveness. Alongside testing infrastructure, stronger source-level quality assurance and digital traceability systems are essential for ensuring authenticity, maintaining consumer trust, and meeting evolving global standards.

Bee health represents another major challenge. Climate change, pesticide exposure, habitat degradation, pests, and diseases continue to affect colony health and productivity. Yet bee health remains an underdeveloped area within many agricultural support systems. There is an urgent need for dedicated

research on bee diseases, improved access to scientifically validated treatments, stronger veterinary support for apiculture, and regular monitoring of colony health.

Environmental sustainability is equally important. Bees play a vital role in pollination, agricultural productivity, and ecosystem health. However, declining biodiversity, changing climatic conditions, and unsustainable agricultural practices continue to threaten pollinator populations. Protecting forage resources, promoting pollinator-friendly farming, and conserving natural habitats will be essential to ensuring the long-term sustainability of both beekeeping and food production systems.

The sector also faces challenges related to value-added processing and market development. While honey-based

products offer significant opportunities for increasing incomes and expanding market access, many small and medium enterprises face barriers related to infrastructure, technology adoption, financing, product innovation, and regulatory compliance.

Need to Set Up National Honey Sector Task Force

The need of the hour is the establishment of a National Honey Sector Task Force comprising representatives from government ministries, regulatory agencies, honey associations, beekeeper organizations, research institutions, testing laboratories, academia, non-governmental organizations, and industry stakeholders. Such a think tank can provide strategic direction, facilitate policy coordination, and develop practical solutions to emerging challenges. Dedicated working groups can focus on priority areas such as honey quality, traceability, bee health, climate resilience, market access, research, innovation, and beekeeper welfare.

At the heart of any policy must lie the interest of the beekeeper and the bees on one end, and the consumer interest on the other. With the right policies, investments, and partnerships, the honey industry can strengthen its contribution to rural livelihoods, biodiversity conservation, food security, and economic growth while building a resilient and globally competitive ecosystem for the future.





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SMART TECHNOLOGY IS SHAPING THE FUTURE OF AGRICULTURE

In a smart world of smarter humans and smart technology, how can agriculture be an exception? Hence, smart agriculture is a necessity now. With a growing global population, the demand for food is increasing rapidly. However, more important is the higher demand for healthy food, which seems difficult to cultivate without embracing smart farming technologies. Agricultural systems are under tremendous pressure to achieve high production, healthy produce, and food carrying fewer chemical residues at the same time, due to issues like climate change and the scarcity of natural resources. Because of these con-

siderations, there is a pressing need for efficient and sustainable agricultural methods that may increase output while preserving resources and safeguarding the environment. The agricultural industry is quickly implementing modern technology and scientific methods to address these issues, which has led to the development of the concept of "smart agriculture."

Integrated Approach

In order to optimize agricultural operations, smart agriculture is an integrated approach to farming that combines scientific knowledge, innovation, and practical solutions to help farmers make better decisions and improve productivity. Through precision farming techniques, digital advisory platforms, real-time crop monitoring, and sustainable agricultural inputs, farm-

ers can optimize resource use, increase yields, and reduce their environmental impact.

It does this by utilizing modern tools like sensors, precision farming methods, soil diagnostics, plant diagnostics, digital advisory systems, biotechnology, artificial intelligence, and data analytics. Giving farmers access to real-time data about their crops and soil conditions is one of the main benefits of smart agriculture. Farmers may make well-informed decisions about irrigation, nitrogen management, pest control, and crop protection through routine monitoring and scientific analysis.

Smart farming practices are being promoted in India by a number of agritech enterprises. Among these, Cytolife Agritech Pvt. Ltd. Mumbai has become a farmer-centric company committed to providing the farming community with science-based agricultural solutions. Agri-Diagnostics, Agri-Advisory, Agri-Academy, Agri-Processing, and Agri-Inputs are the company's five main verticals.

To assist farmers in understanding the condition of their fields, Cytolife conducts soil and plant health analyses through its Agri-Diagnostics division. Sustainable crop production is supported and accurate nutrient management is made possible by this scientific evaluation.



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Connected Sensors, Digital Technologies

A key aspect of smart agriculture is the use of connected sensors and digital technologies that help farmers better understand what is happening in their fields. Modern farms can utilize soil pH sensors, temperature and humidity sensors, rainfall and moisture monitoring systems, and other smart devices to collect real-time information about crop and soil conditions.

This data is transmitted directly to mobile applications or cloud-based platforms, allowing farmers to monitor their fields remotely and make informed decisions at the right time. By providing accurate and timely insights, these technologies help optimize the use of water, fertilizers, and other resources, leading to improved crop health, higher yields, and more sustainable farming practices.

Globally, wherever farming is being done with smart technologies, they are harvesting better profitability. In the context of the Indian agriculture space, this concept of smart agriculture is just at a nascent stage, but the speed of its adoption is commendable. The government's support, featuring the availability of high-tech tools and technologies, subsidies on them, and proper training, provides some of the basic support system leverage to beneficiaries.



Often, farmers are in a dilemma, believing that if they apply fewer chemical fertilizers and pesticides, then crop yields will be lower. This assumption can be rooted out by the application of smart technologies available at their fingertips

Helping Farmers Economically

Once farmers start accessing these tools and technologies, they become used to them, and their cost of cultivation will be significantly reduced with an increase in profitability per unit area. Simultaneously, their harvest will be much more nutritive, healthy, and fortified.

We visualize that, in the next five to ten years, even the value of farm produce will be decided based on the nutritive value it carries. It is very much possible with the incorporation of smart agriculture technologies.

Smart agriculture is a necessary requirement of today's world, considering the connection between agriculture and human health. Many times, farmers are in a dilemma, believing that if they apply fewer chemical fertilizers and pesticides, then crop yields will be lower. This assumption can be rooted out by the application of smart technologies available at their fingertips.

Precision farming is urgently needed to save wastage, regulate the judicious use of agri-inputs, and protect human health, which is most precious. I remember one research paper from the FAO mentioning that 95% of human health genesis is in the soil and plants. We witness in every house that expenditure on medicine is higher than expenditure on food.

Therefore, let's bring smart agriculture to every doorstep of the sons of the earth.



The Capital of Labour

Why India's Growth Narrative Must Return to Chaudhary Charan Singh's Vision

By managing MSME reforms through corporate prisms and ignoring the liquidity-driven safety nets of rural cottage industries, contemporary policy risks paralyzing the soul of self-reliance

In the contemporary discourse on India's political economy, the metric of success has increasingly become captured by metropolitan Gross Domestic Product (GDP), automated manufacturing indices, and the financial health of large corporate balance sheets. Yet, this heavy tilt toward centralized, capital-intensive growth creates a structural blind spot. It invites a sobering return to the economic philosophy of former Prime Minister Chaudhary Charan Singh, whose defining insight remains an unassailable

truism: the trajectory of Indian prosperity is irrevocably tied to its agrarian topography.

Chaudhary Charan Singh was far more than a formidable leader of the peasantry; he was an original economic theorist. Writing at a time when the nation was captivated by Nehruvian heavy industrialization, he offered a sophisticated, indigenous critique of both Western capitalism and Soviet-style state statism. He recognized that in a densely populated, capital-scarce, and labour-surplus nation like India, importing alien models of hyper-automation would inevitably lead to structural unemployment and wealth concentration. His alternative was a meticulously conceptualized Decentralized Rural Economy—a model that seeks to optimize low capital investments to unlock maximum employment.



About the **AUTHOR**

Mr. Bishan Nehwal is an environmentalist and community leader prominently recognized for his contributions to large-scale afforestation and urban ecological restoration. He has played a vital role in steering the One Million Trees initiative, a collaborative citizen and corporate movement aimed at reviving native biodiversity, combating rapid urbanization, and restoring degraded landscapes across regional urban hubs in India





Interestingly, this was not an exercise in utopian romanticism. The very blueprint of rural industrialization that Singh advocated for post-Independence India was mirrored by China in the 1980s. Through its Town and Village Enterprises (TVEs) and agrarian reforms, Beijing built its global manufacturing hegemony from the countryside up, proving that the road to becoming a global workshop begins in small clusters, not giant monopolies.

Interdependence Between Agriculture And Small-Scale Cottage Industries

A core pillar of Singh's doctrine, famously detailed in his seminal work 'India's Economic Policy: The Gandhian Blueprint', was the unbreakable interdependence between agriculture and small-scale cottage industries. As demographic pressures inevitably shrink landholding sizes, farming alone cannot absorb the rural workforce.

Today, while the state promotes well-intentioned frameworks like 'One District One Product' (ODOP), the underlying policy execution often seeks to formalize and subordinate small, decentralized agro-processing units under corporate supply chains. To evaluate these shifts through Singh's framework is to

realize that true empowerment does not mean converting a self-reliant rural entrepreneur into a low-wage contract supplier for a metropolitan conglomerate.

The traditional sugar and handloom belt of Western Uttar Pradesh—encompassing Meerut, Muzaffarnagar, Baghpat, Shamli, and Saharanpur—serves as a living laboratory for this decentralized model. While a highly automated, capital-intensive sugar mill requires hundreds of crores in investment to generate a few hundred formal jobs, the thousands of traditional kolhus (oil and cane expellers) and local crushers in this cluster provide direct, seasonal livelihood to nearly 100,000 rural workers right at their doorsteps. This informal agro-processing ecosystem generates a cumulative annual turnover estimated between Rs 1,200 crore and Rs 1,500 crore, contributing a critical 0.8% to 1.2% to Uttar Pradesh's

manufacturing and agro-processing GSDP.

By converting raw sugarcane into jaggery, organic khandsari, and molasses locally, the cluster achieves a 30% to 40% value addition. Crucially, this premium is retained within the rural ecosystem rather than being drained into urban corporate headquarters. Beyond direct labor, the downstream economics sustain over 2 lakh families by feeding local transport networks, gunny-bag manufacturing, rural repair garages, and local market intermediaries (aarhatiyas).

Vulnerabilities Of Small-Scale Operators

Singh's opposition to the 'Inspector Raj' and rigid state licensing was rooted in a deep understanding of the vulnerabilities of small-scale operators. Today's shift toward aggressive digital compliance, complex formalization,

The state must decouple rural MSMEs from burdensome compliance, protect decentralized value-addition clusters, and recognize that economic democracy requires the equitable distribution of wealth-generating capacity



and rigid regulatory frameworks often acts as a regressive tax on the small rural entrepreneur who lacks the legal architecture to navigate state bureaucracy.

Furthermore, policy-makers frequently overlook the vital macroeconomic role played by the kolhu economy's signature feature: instant cash liquidity. A smallholder farmer facing immediate, non-negotiable expenses—whether for emergency healthcare, social obligations, or the swift purchase of rabi seeds and fertilizers—cannot afford to wait on the long-delayed payment cycles of large corporate mills. The spot-cash mechanism of the local crusher acts as an informal financial buffer. If regulatory heavy-handedness dismantles this informal liquidity bridge, the chronic crisis of 'sugarcane arrears' that plagues major mills will metastasize into the deep countryside, forcing small operators out of business and pushing smallholders deeper into debt traps.

In Singh's view, these cottage units were the farmer's ultimate 'security shield.' The existence of decentralized, independent buyers running parallel to large corporate mills ensures a healthy, competitive market equilibrium. It deprives large monopolies of

monopsony power, forcing them to weigh the risk of farmers diverting their crop to local kolhus if payments are delayed or weights are manipulated.

Urgent Policy Corrective

As India attempts to navigate the headwinds of jobless growth and widening rural-urban inequality, the economic philosophy of Chaudhary Charan Singh ceases to be an archival artifact and becomes an urgent policy corrective. Real self-reliance (Atmanirbhar Bharat) cannot be achieved by merely optimizing the ease of doing business for top-tier corporate lobbies while tightening the regulatory noose around the informal

survival structures of the countryside.

To truly honour the legacy of Chaudhary Charan Singh, Indian planning must pivot away from closed-room, metropolitan-centric modelling. The state must decouple rural MSMEs from burdensome compliance, protect decentralized value-addition clusters, and recognize that economic democracy requires the equitable distribution of wealth-generating capacity. The soul of the nation's economy does not reside in its economic enclaves; it breathes in the fields, barns, and cottage industries that sustain the Indian hinterland.



Solar Energy

Transforming Rural Agriculture

From solar pumps to solar-powered rural productivity, Maharashtra can build a new model of farmer self-sufficiency and balanced growth.

Maharashtra's agriculture story has always been shaped by land, labour, rainfall and market access. But in today's changing climate and economic environment, one more factor has become equally important: reliable and afford-

able energy at the farm level.

For years, many farmers planned their irrigation around uncertainty. Grid electricity was often irregular, available at inconvenient hours or insufficient when it was needed most. Diesel pumps offered an alternative, but at a recurring cost that directly affected farm margins. In agriculture, timing determines yield. A delay in irrigation, especially during critical crop stages, can change the eco-

nomics of an entire season.

This is where solar energy is beginning to alter the foundation of rural agriculture. Solar-powered agriculture pumps have already changed the way farmers access irrigation. But the next opportunity is even larger. Maharashtra should now look at solar not only as an irrigation solution, but as a complete farm-level energy and productivity platform.

About the **AUTHOR**

Mr Gopal Kabra is Chairman & Managing Director of GK Energy Ltd, a prominent public-listed engineering, procurement, and commissioning (EPC) company specializing in sustainable renewable energy solutions. Founded in 2008 by Mr Kabra, the firm has established a strong footprint in the clean energy landscape, focusing on driving solar adoption across diverse sectors



Maharashtra's Solar Leadership

Maharashtra has taken a national lead in farm-level solarisation. Hon'ble Chief Minister Shri Devendra Fadnavis publicly announced on 3 June that Maharashtra has installed 10 lakh+ off-grid solar pumps, the highest in India, accounting for 64% of India's total 15.62 lakh solar pumps.

This is not merely an installation milestone. It represents one of the largest distributed clean-energy deployments directly linked to farmers anywhere in the country. Every solar pump installed on a farm reduces dependence on uncertain electricity supply and recurring diesel expenditure. More importantly, it places clean energy directly in the hands of the farmer.

From Irrigation Security to Farm Productivity

The first and most visible benefit of solar pumps is irrigation security. A farmer who has access to solar-powered irrigation can plan watering based on crop requirement rather than grid availability. This improves decision-making and reduces operational uncertainty.

Solar pumps also reduce energy recurring costs. For small and marginal farm-

Maharashtra has demonstrated leadership in solar agriculture by installing more than 10 lakh off-grid solar pumps

ers, this matters deeply. Savings from diesel or unreliable paid energy sources are not only financial savings; they become working capital for seeds, fertilisers, labour, drip systems, farm improvement and household stability.

Water Management and Solar as Stored Water

Water management is an important part of Maharashtra's solar agriculture opportunity. Much of the state faces periodic water stress, and therefore the question is not only how much water is available, but how efficiently and predictably it can be used.

Solar-powered irrigation makes this possible because the farmer gets de-

pendable daytime energy at the farm. When solar pumps are paired with drip irrigation, sprinkler systems, filtration, fertigation, timers, water-level sensors and soil-moisture monitoring, irrigation becomes more scientific and less wasteful. This helps farmers extend limited groundwater further and improve crop planning.

DC Power, Small Inverters and Off-Grid Storage

Since solar pumps generate DC power, there is a clear opportunity to develop approved DC-based farm energy systems. Some farm uses can directly run on DC power, while others may require a small DC-to-AC inverter.

A limited-capacity inverter, properly integrated with the solar pump system, can support small approved agricultural loads. This should not be designed as an unrestricted household power supply. It should be a farm-focused solution with safety protection, load limitation, earthing, metering and monitoring.

Solar for Post-Harvest Value Addition

The real economic opportunity in agriculture lies not only in production, but also in what happens after harvest.

Farmers often lose value because produce must be sold immediately, stored poorly or transported without proper handling. Solar can directly support post-harvest infrastructure at village, FPO and farmer-cluster level. Solar-powered post-harvest opportunities include, Solar micro cold storage, Solar pre-cooling chambers
Solar dryers for onion, chilli, turmeric, tomato, fruits and spices, etc.

The Role of Policy, Subsidy and Execution

None of this would have been possible without sustained government support. PM-KUSUM and Maharashtra's state solar pump schemes introduced subsidy structures that made installation financially viable for farmers who could never have afforded it otherwise. These schemes extended well beyond early adopters, reaching farming communities in geographies where the economics of conventional irrigation had always been difficult.

Maharashtra's execution capability was also demonstrated at a national and global level when MSEDCL achieved a Guinness World Records milestone for installing the highest number of solar agriculture pumps in a defined period. This achievement was not only about

numbers; it reflected the strength of planning, field coordination, vendor participation, beneficiary mobilisation and administrative follow-through. It showed that when policy intent is matched with ground-level execution, farm-level solarisation can be delivered at scale.

Need for a Solar Productive Use Add-On Policy

Maharashtra has already created scale in solar agriculture pumps. The next policy opportunity is to create a Solar Productive Use Add-On Policy. Such a policy can define how solar pump systems may be used for additional approved agricultural purposes without compromising safety, scheme discipline or intended use. The policy can include: Certified auxiliary DC output from solar pump systems, Approved small inverter models for agricultural loads, Modular battery storage for essential farm use, Load limitation based on pump capacity, Mandatory safety protection, earthing and isolation, Remote monitoring and metering amongst other measures.

This framework will help farmers use solar more productively while ensuring that the system remains disciplined and agriculture focused.

Parting Thoughts

Maharashtra has already demonstrated leadership in solar agriculture by installing more than 10 lakh off-grid solar pumps. The next step is to build on this foundation and convert farm-level solar assets into engines of productivity and self-sufficiency.

The farmer should not only receive water from solar power. They must receive energy independence, water security, farm protection, storage, processing capability and better value for produce.

The solar opportunity for Maharashtra in agriculture today is thus not limited to pumps. It is about creating a solar-powered rural economy - one that strengthens farmers, reduces pressure on the power ecosystem and supports balanced growth from villages to towns, from towns to cities, and from cities to larger growth journey of Maharashtra.



QUALITY SEED

A FARMER'S FUNDAMENTAL RIGHT

Getting good quality seeds is no longer just a choice for those who can afford it – it is a fundamental right for every single farmer. A good seed is not just a regular item you buy in the market. It comes packed with modern technology, a guarantee of high quality, and regular guidance in the field



to help change the life of rural families and protect the people who grow our food.

When a farmer does not get safe and high-quality seeds, their right to earn a good living is taken away. Companies and government systems must stop treating good seeds as a luxury item.

Instead, they must see it as a basic necessity for rural development.

About the **AUTHOR**

Mr Sharad Deshpande is the CEO of SeedUber, steering a team of industry veterans to deliver end-to-end business solutions for modern seed development and commercialization. He is a specialized Seed Technologist with over 40 years of association in the Indian seed industry, and has contributed to growth across field, vegetable, and flower crops nationwide

How Good Seeds Increase Harvests

The quickest way to help small farmers grow financially is to help them shift from old, weak seeds to modern, high-quality varieties. When a farmer, a co-operative society, or a government program replaces ordinary seeds with certified, high-yielding ones, the increase in crop production is seen almost immediately. This sudden jump in harvest protects the farmer from bad weather, lack of timely rain, and sudden pest attacks that used to destroy entire villages in the past.

Using these High-Yielding Varieties (HYVs) or hybrid seeds changes everything in the field by utilizing water and fertilizers much better, giving farmers a clear +15% to 20% increase in their total harvest. This extra gain is not just a number on paper; it is the real turning point that takes a farmer from simply surviving to actually making a good profit. With these advanced seeds, farmers do not have to just sit and rely on luck or weather. The extra money from this better harvest helps small farmers invest back into their land, send their children



to good schools, and save money for future emergencies.

The Two Pillars of Support

True success in farming cannot come just by selling a packet of seed. A big mistake in many past agricultural programs was that high-quality seeds were distributed, but no one taught the farmers how to grow them properly. When seeds are just dropped in a village without any local help, the crop fails. Modern seed systems solve this problem. They do not disappear after selling the seed; instead, they stay to help the farmer through two main pillars: education and strict rules. This ensures that the right to quality seed actually helps the farmer on the ground.

Pillar 1: Field Support and Education

The first pillar is all about sharing knowledge and giving continuous help directly on the field, bringing laboratory science straight to the farmer's land. It helps the farmers through three simple steps:

- **Farming Advice:** Good seed companies provide step-by-step guidance on the correct way to plant, including how much distance to keep between crops, the right time for sowing, and the exact amount of fertilizer to use. This ensures the seed grows to its full potential.
- **Demonstration Plots:** By setting up small trial plots in the village, companies show farmers exactly how the seed performs under local weather and soil conditions before

they spend any money. This builds real trust among the villagers.

- **Smart Pest Management:** Instead of forcing farmers to buy expensive and harmful chemical pesticides, field experts teach natural, safe, and balanced ways to protect the crops from insects. This keeps the soil healthy for years to come.

Pillar 2: Strict Market Rules and Safety

The second pillar focuses on keeping the market honest, building trust, and protecting the farmer from getting cheated. Without strict laws, the promise of a "quality seed" means nothing, as local shops can easily fool innocent buyers. This pillar works through three main functions:

- **Stopping Fake Seeds:** In rural markets, fake or duplicate seeds can completely ruin a farmer's entire year of hard work and savings. Modern systems use simple verification methods—like scratch codes on the bag or mobile SMS checks—to stop fake seeds from being sold.

- **Strict Purity Checks:** Government and monitoring bodies enforce strict rules to make sure that the seeds are clean and have a very high germination rate (meaning almost every seed sprouts into a healthy plant). This removes the risk of crops failing due to bad quality or mixed trash in the bag.
- **Fair Price Monitoring:** To stop big companies from charging too much money and to make sure that even the poorest farmers can buy these seeds, authorities keep a close eye on retail prices. Fair pricing ensures that no farmer is left behind.

A Complete Solution for Our Farmers

By treating the sale of seeds as a long-term partnership rather than a one-time business deal, modern seed systems create a safe environment for agriculture. The relationship does not end at the shop counter; it actually begins there. If we want global food security, our farmers must be treated as valuable partners who deserve the best inputs and full protection.

With this setup, farmers are neither cheated by bad shopkeepers nor left alone without knowing how to cultivate their crops. When the system actively supports the grower, the entire farming community becomes stable. Giving every farmer access to these right resources is the only way to ensure they can live a prosperous, sustainable, and dignified life.

Combining high-quality seed technology with strong field education and protective laws turns a simple seed into a powerful tool for rural growth and social justice

Smart Aquaculture

THE CHANGING DYNAMICS OF INDIA'S SHRIMP INDUSTRY

India's shrimp industry is one of the most remarkable success stories in Indian agriculture. Shrimp is India's largest seafood export product and the country is among the world's leading producers and exporters. Behind this success are hundreds of thousands of farmers, most operating small and medium-sized farms across Andhra Pradesh, Gujarat, Odisha, Tamil Nadu and West Bengal.

Despite its scale and economic significance, shrimp farming remains one of the most unpredictable forms of agriculture. Unlike traditional farming, the crop is underwater and largely invisible. Farmers make substantial investments in seed, feed, power and labour, yet often have limited visibility into what is happening inside the pond until a problem becomes apparent. By then, corrective action may be difficult or impossible.

Over the last decade, the industry has also become more intensive. Pond

densities have increased, biosecurity challenges have grown and disease outbreaks can spread more quickly across farming clusters. As a result, improving predictability has become just as important as improving productivity.

This is where smart farming is beginning to transform the industry.

One of the most important lessons we learned while working with shrimp farmers is that every farm is already generating valuable operational data. The question is where to find it. While much of the industry focused on deploying additional sensors, we discovered that the most scalable source of farm intelligence was electricity itself.

Every critical activity on a shrimp farm—aeration, feeding, pumping and harvesting—creates a distinct electrical signature. By monitoring power consumption patterns, it becomes possible to understand how a farm is operating in near

real time without requiring farmers to fundamentally change how they work.

Today, connected power infrastructure allows farmers to receive instant alerts when aerators stop unexpectedly, identify equipment failures before they become crop

failures and improve energy



About the **AUTHOR**

Mr Pavan Kosaraju is the Founder & CEO of AquaExchange, an agritech startup focused on transforming the aquaculture sector, specifically shrimp and fish farming. The company leverages IoT-Powered Smart Farming Technology and other technologies to address long-standing inefficiencies in the aquaculture supply chain, aiming to improve profitability and sustainability for small and medium-scale farmers

efficiency. More importantly, it creates a continuous stream of operational data that helps farmers make better decisions throughout the crop cycle.

Electricity is also one of the largest operating expenses on a shrimp farm after feed. Across many farms, poor power factor and inefficient equipment utilisation lead to significant wastage. Technologies such as automatic power factor correction, which have long been used in industrial settings, are now helping shrimp farmers reduce electricity costs while improving the reliability of farm operations.

Feeding is another area undergoing significant change. Feed typically accounts for nearly 60-70 percent of farm operating costs and labour availability has become increasingly challenging in most shrimp-farming regions. Automatic feeders are helping farmers address both problems simultaneously. By distributing feed more consistently and at higher frequencies, they improve feed utilisation while reducing dependence on manual labour. As costs have come down and subscription-based deployment models have emerged, adoption has



accelerated across farming clusters.

Artificial intelligence is also beginning to play a role in crop management. Advances in image analysis and farm intelligence are enabling faster interpretation of shrimp health indicators, water conditions and operational patterns. However, the real value of AI lies not in automation alone but in helping farmers make better decisions earlier. In shrimp farming, timing often determines profitability.

Detecting a problem a few days earlier can mean the difference between a successful harvest and a significant loss.

Perhaps the most significant transformation is taking place in access to finance and insurance.

Historically, shrimp farmers have struggled to access formal financial services despite operating one of India's most valuable agricultural export sectors. The challenge was never a lack of demand for credit. The challenge was





a lack of visibility. Banks, NBFCs and insurers had limited access to reliable information about how farms were being managed once a crop was stocked.

Operational data is beginning to change that equation. Data generated from farm infrastructure, equipment utilisation and crop operations can provide a more accurate understanding of farm performance and risk. This allows financial institutions to move beyond collateral-based lending and towards operationally informed underwriting. The same visibility is also enabling the development of insurance products that were previously difficult to offer at scale.

In many ways, aquaculture is demonstrating how digital infrastructure can create financial inclusion. When farm operations become visible, risk becomes measurable. When risk becomes measurable, access to finance improves.

Two broader trends are further strengthening the sector's outlook. The first is traceability. Global seafood buyers increasingly expect visibility into how and where shrimp is produced. Digitally connected farms make traceability easier to implement and more reliable

The future of India's shrimp industry will not be determined solely by expanding pond area. It will be determined by how effectively we improve productivity, predictability and traceability on existing farms. Smart farming is making that possible by turning previously invisible farm operations into actionable intelligence

to verify.

The second is policy support. The creation of a dedicated Ministry of Fisheries, Animal Husbandry and Dairying in 2019, along with programmes such as the Pradhan Mantri Matsya Sampada Yojana (PMMSY), has brought unprecedented institutional focus to the sector. Investments in infrastructure, formal credit and the broader Blue Economy are creating a stronger foundation for long-term growth.

What is particularly encouraging is that technology adoption is no longer being driven by subsidies or experimentation. Farmers are investing in these solutions because they are seeing measurable returns. Lower power costs, improved feed efficiency, better operational control and improved access to financial services are generating

value that is visible within a single crop cycle. As in most farming communities, adoption spreads through trust. Farmers believe what they see working on neighbouring farms.

The future of India's shrimp industry will not be determined solely by expanding pond area. It will be determined by how effectively we improve productivity, predictability and traceability on existing farms. Smart farming is making that possible by turning previously invisible farm operations into actionable intelligence.

For farmers, that means better outcomes. For lenders and insurers, it means better risk assessment. And for India, it means strengthening its position as one of the world's most competitive and trusted seafood-producing nations.



SMART AGRICULTURE IN INDIA

Bridging the Gap from Farm to Fork

India's agricultural sector is going through a meaningful shift. Facing pressure from climate change, groundwater depletion, and persistent post-harvest losses, the country is turning to smart agriculture as a practical framework, not just to grow more food, but to grow it more precisely, preserve it better, and move it more efficiently. For that to work, smart farming practices and an intelligent supply chain must function as one connected system.

Precision at the Field Level

Smart farming in India has moved well beyond pilot programmes. The Digital Agriculture Mission (DAM), approved by the Union Cabinet in September 2024 with an outlay of Rs. 2,817 crores, anchors the government's ambitions in this space. Its centrepiece, AgriStack, assigns every farmer a unique ID linking land records, crop history, and financial data, reducing the paperwork involved in accessing loans or government schemes. The target is 110 million farmer IDs by 2026-27.

About the **AUTHOR**

Mr Ajay Kakra is a seasoned agribusiness leader with more than 25 years of diverse experience spanning agri-inputs, agricultural finance, consulting, investments, infrastructure development, warehousing, and logistics. He has worked extensively with corporates, government agencies, farmer producer organizations, PSUs, service providers, and other stakeholders to design and implement solutions that address key challenges in the agricultural sector





Satellite technology is now central to how India monitors its crops. The Krishi Decision Support System (Krishi-DSS), launched in August 2024, is a geospatial platform built on imagery from ISRO's RISAT-1A and VEDAS satellites, delivering real-time data on crop conditions, weather, water resources, and soil health to planners and farmers. ISRO's CROP framework, developed by the National Remote Sensing Centre, monitors crop sowing, growth, and harvest stages in near real-time using optical and synthetic aperture radar data, and has already generated accurate wheat acreage and yield estimates across eight major states.

On-the-ground crop intelligence is advancing through private innovation. Platforms built on AI and IoT sensors now deliver field-specific advisories on irrigation and pesticide timing based on micro-climatic data pulled from a farmer's own plot, rather than generalised regional estimates. One Bengaluru-based startup uses farm-level sensor networks to monitor humidity, temperature, and plant stress in real time and has reportedly saved billions of litres of water across tens of thousands

Smart Agriculture in India will succeed when it works as a system rather than a set of separate initiatives

of acres. Hyper-local agronomy platforms combine soil data, crop cycles, and live weather inputs to give farmers structured guidance on nutrition and pest management.

Soil health is where some of the most underreported innovations are happening. A Chandigarh-based agritech company has developed an AI-powered rapid quality assessment device using Near-Infrared (NIR) spectroscopy and computer vision that analyses commodity quality in under 30 seconds at the point of transaction. A separate breakthrough from IIT Kanpur, now commercialised under an MoU, applies the same NIR approach to deliver instant, reagent-free soil nutrient analysis directly to a smartphone, cutting out weeks of lab waiting time.

Water Conservation

Water conservation at the soil level has also attracted a notable Indian innovation. A Rajasthan-based startup

has created a 100% biodegradable super-absorbent polymer made from fruit peel waste, including orange and banana peels, that when mixed into soil absorbs approximately 50 times its weight in water. Field data shows around 40% water savings, 20% fertiliser savings, and crop yield increases of 10-15%. The product, which nourishes soil with micronutrients as it degrades, has reached over 12,000 farmers and raised a USD 17.8 million Series B round in September 2025.

Water conservation at the crop level is equally critical. Direct Seeded Rice (DSR), promoted by state agriculture departments as a smart farming practice, bypasses the water-intensive transplanting of paddy seedlings. DSR can reduce water use in paddy cultivation by up to 30%, while lowering methane emissions and cutting cultivation costs. Punjab has moved 2.53 lakh acres under the technique in 2024-25, with farmers receiving Rs. 1,500 per acre

as an incentive. Scaled nationally, this is a meaningful lever for groundwater preservation across India's rice belts.

Post-Harvest Infrastructure: Where Gains Are Still Lost

All of this progress is undermined if produce deteriorates before it reaches the consumer. A 2022 study commissioned by the Ministry of Food Processing Industries and carried out by NABARD Consultancy Services estimated India's annual post-harvest losses at Rs. 1.53 trillion (approximately USD 18.5 billion). Loss rates reach up to 15% for fruits and 11.6% for vegetables.

India currently has 8,653 cold storage facilities with a total capacity of 39.42 million tonnes, but over half is concentrated in three states and roughly 70% is dedicated to potatoes, leaving most perishables with little organised cold chain access. The government has announced plans to expand storage capacity by 70 million metric tonnes through Rs. 1.25 trillion in private investment over five years.

The Electronic Negotiable Warehouse Receipt (e-NWR) system, managed by the Warehousing Development and Regulatory Authority (WDRA), is the most farmer-centric reform in this space. Stored produce earns a digital receipt banks accept as loan collateral, giving farmers the ability to wait for better prices rather than selling at a loss. The government reinforced this in FY 2024-25 with a Credit Guarantee Scheme



for e-NWR-based pledge financing. The National Logistics Policy (NLP) of 2022 targets reducing logistics costs from 13-14% of GDP to 8% by 2030, with AI, IoT, and real-time cargo tracking through its Unified Logistics Interface Platform as core tools. India loses an estimated 5-10% of perishable produce in transit due to temperature mismanagement, making smarter logistics infrastructure as urgent as storage expansion.

The Case for Integration

Smart Agriculture in India will succeed when it works as a system rather than a set of separate initiatives. The satellite platforms, soil sensing tools, water-saving innovations, and post-harvest reforms each address a real gap. Their combined impact is only realised when data flows between them and the farmer at the centre can engage with them without managing complexity.





Niqo Robotics Takes India-Built Physical AI Farming Platform to Europe at Bharat Innovates 2026

Handpicked among 120 innovators for the Government of India's flagship deep-tech conclave, Niqo signals how Made-in-India farm robotics is moving from Indian fields to global markets.

Niqo Robotics, a Physical AI company building intelligent agricultural robots for global farms, has been selected to represent India at Bharat Innovates 2026, the Government of India's flagship innovation conclave. Taking place in Nice from 14 to 16 June, the conclave brings together 120 deep-tech

innovators screened from more than 2,000 applicants, spotlighting India-built technologies with the potential to scale globally. The event was inaugurated by the Hon'ble Prime Minister of India, Shri Narendra Modi, and the President of France, Emmanuel Macron.

Niqo joins the cohort as the only precision-AI farm robotics company on the delegation, marking a significant

moment for India's deep-tech ecosystem and the global rise of India-built agricultural robotics. Its selection reflects the core vision of Bharat Innovates: to take India-incubated, Made-in-India deep-tech companies to global markets and show how they can solve some of the world's most urgent productivity, sustainability and labour challenges.

"Being selected to represent India at Bharat Innovates, and to do so as the only precision-AI farm robotics company among 120 deep-tech innovators, is a proud moment for the team," said Jaisimha Rao, Founder and CEO of Niqo Robotics. "But our story is ultimately a

Indian deep-tech is moving from lab-led innovation to commercially deployed products capable of competing in demanding international markets

global one. We built Niqo to prove that Physical AI can be a real business. We're arriving in Europe with a platform that already pays for itself for the farmer: no subscriptions, no hidden costs, just a machine that delivers ROI from day one. Platforms like Bharat Innovates are important because they give Indian deep-tech companies a credible bridge into global markets. For us, it is a chance to show that India can build Physical AI products that are technically advanced, commercially ready and relevant for farmers anywhere in the world. We are looking to bring on the right strategic investors and partners who can help us scale this model across Europe, Australia and other global agricultural markets."

For Niqo, France is a particularly relevant starting point because of its strong agricultural base, deep farming heritage and central role in Europe's agritech ecosystem. As one of Europe's most important agricultural markets, it offers a meaningful entry point for technologies that can help farms improve productivity, reduce input intensity and transition towards more sustainable models.

Farm Robotics

Built in India for global agriculture, Niqo's platform reflects how Indian deep-tech is moving from lab-led innovation to commercially deployed products capable of competing in demanding

international markets. The company's intelligent weeding systems are already commercially deployed in the United States and India, with Europe and Australia emerging as the next priority markets for its Physical AI farming platform.

At a time when many global farm robotics players continue to prioritise scale over sustainable economics, Niqo is charting a different path, one

built on capital efficiency, farmer ROI and commercially viable deployment from the outset. Niqo is demonstrating that farm robotics can move beyond long development cycles and high-burn deployment models to deliver measurable farmer ROI from the outset.

Bharat Innovates Opens Doors For India-Built Deep-Tech

Niqo's presence at Bharat Innovates in Nice marks the company's formal entry into the European conversation, where rising labour costs, tightening restrictions on chemical herbicides and pressure to improve sustainability are driving demand for precision



About the **AUTHORS**

Ms Arha Padman
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Indian engineering can move beyond domestic problem-solving to shape global categories such as farm robotics and Physical AI. Its systems help growers reduce input costs, improve precision, lower chemical usage and maintain soil health

automation. France also offers a strong testbed for the next generation of farm automation, with a farming ecosystem that is both deeply rooted in tradition and increasingly focused on precision, sustainability and productivity.

Bharat Innovates gives Niqo more than global visibility. It creates a practical market-access platform at a critical stage of the company's expansion, bringing Indian deep-tech startups into direct conversations with European investors, chambers of commerce, policy stakeholders and ecosystem partners. Alongside India's broader push to strengthen deep-tech through funding support, ecosystem building and global market access, platforms such as Bharat Innovates are helping companies like Niqo move from India-built innovation to global commercial scale.

Approaching profitability: A Rare Path In Farm Robotics

As farm robotics companies worldwide work to translate innovation into commercially viable businesses, Niqo's core AI-enabled weeding business is now approaching self-sustainability, a milestone few in the category have reached. The company attributes this to growing commercial traction, repeat demand and a model built around disciplined economics rather than scale at any cost.

Niqo's farmer-first model is built around a one-time purchase with no recurring subscription fees, backed by 24/7 service support and locally stocked spare parts, allowing growers to adopt advanced automation without the burden of hidden or ongoing platform charges.

An Intelligent Farming Platform, Not Just A Single Machine

At the core of Niqo's next phase of growth is Niqo Sense, the company's proprietary AI camera platform that can be integrated across multiple machine form factors and retrofitted onto existing farm equipment. The platform combines AI at the edge with a dual-tank, twin-nozzle architecture to perform weeding, thinning and beneficial spraying in a single pass, reducing the need for multiple machines and repeated field operations.

India's Next Farming Leap: Physical AI Robots

Niqo's growth reflects a larger shift in Indian agriculture and Indian deep-tech. After the Green Revolution and the era of tractorisation, Indian agriculture is now ready for its next leap: intelligent, AI-enabled farming systems that can improve productivity, reduce input intensity and help farmers respond to labour and sustainability pressures. Niqo is poised to lead this farm robotics

revolution as a Made-in-India startup building for both Indian and global farms.

Designed in India and deployed across demanding agricultural environments internationally, Niqo's field robots show how Indian engineering can move beyond domestic problem-solving to shape global categories such as farm robotics and Physical AI. Its systems help growers reduce input costs, improve precision, lower chemical usage and maintain soil health.

For Niqo, the India opportunity remains central. The company is bullish on India's readiness for Physical AI in agriculture, while the Government of India's support for Made-in-India deep-tech startups is creating a stronger ecosystem for companies building frontier technologies. This convergence marks an inflection point: India-built innovations are no longer only solving for India,

The company plans to build on this foundation by expanding into new crops, new applications and new geographies through its broader Physical AI platform.

About Niqo Robotics

Niqo Robotics is a Physical AI company building intelligent agricultural robots for sustainable farming worldwide. Founded by Jaisimha Rao, a Carnegie Mellon-trained engineer and former BlackRock professional, Niqo develops AI-powered weeding, thinning and precision spraying systems that help growers reduce costs, cut chemical usage and address labour challenges in farming. Powered by Niqo Sense, its proprietary AI camera platform, Niqo's products are commercially deployed across the United States and India. The company is headquartered in Bengaluru, with U.S. operations in Dover, Delaware, and dealer networks across California and Arizona. Niqo is a Series B company backed by investments from Fulcrum Global Capital, Omnivore, Bidra Innovation Ventures, Blume Ventures, BEENEXT and FMC Corporation.

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