₹80/-

NOVEMBER 2025

AGRICULTURE TODAY

The National Agriculture Magazine

VOLUME XXVIII | ISSUE 11 www.agriculturetoday.in

Mechanizing growth

EMPOWERING FARMERS

BL Agro
Pure Perfection

MOVING STRONGER

Progress.
Purpose. Prosperity.

At BL Agro, we are not just growing —
we're Moving Stronger.

With a legacy of innovation and integrity,
we continue to push boundaries across Agri-tech,
Fin-tech, and Dairy — ensuring farm-to-table
sustainability and nationwide nourishment.

We are

MOVING HAPPIER
Spreading health through Nourish and Bail Kolhu.

MOVING BOLDER
Leading with innovation in packaging, marketing, and products.

MOVING SMARTER
Committed to green energy, eco-initiatives, and sustainability.

LEADS connect TOGETHER. AHEAD. | BL KAMDHENU | LEADS ensured future | LEADS nexTech | LEADS agriGenetics

B.L. AGRO INDUSTRIES LTD., Head Office: B-31, Road No.2, Parsakhera Industrial Area Bareilly (U.P.)
Tel: 0581-2518300-399 | Fax: 0581-2518304 | EPBAX: 9927092630 | enquiry@blagro.org | www.blagro.org

Publisher & Printer – Dr. MJ Khan on behalf of M/s Concept Agrotech Consultants Limited, Published from 306 Rohit house Tolstoy Road New Delhi-110001 and printed by Everest Press E-49/8, Okhla Industrial Area-II New Delhi-110020
Phone No. 011-23731129 Fax No.011- 23731130
E-mail: editor@agriculturetoday.in
info@agriculturetoday.in

www.agriculturetoday.in

Page in the magazine: 60

BUILDING POLICY PATHWAYS FOR INCLUSIVE GROWTH THROUGH FARM MECHANIZATION

The advancement of farm mechanization in India represents a critical step toward achieving higher productivity, efficiency, and sustainability in agriculture. The full promise of this transformation depends largely on robust policy design and effective implementation.

India's mechanization drive must not only modernize farming operations but also make technology accessible and affordable to every farmer, regardless of region or scale.The Government of India has prioritized this through the Sub-Mission on Agricultural Mechanization (SMAM), aimed at "reaching the unreached." Under this mission, small and marginal farmers receive financial assistance of up to 50% on farm machinery, while special provisions for the North-Eastern states extend support up to 95% of project costs. The policy also encourages shared ownership models through Custom Hiring Centres (CHCs) and Farm Machinery Banks, thereby reducing the economic burden of individual machine ownership. These policy measures, supported under broader initiatives like Rashtriya Krishi Vikas Yojana and Digital Agriculture Mission, are transforming mechanization from an input into an integrated service framework. Beyond subsidies, policy interventions are addressing training, quality assurance, and standardization. Across states, thousands of farmers were trained between 2021 and 2025 under SMAM to operate and maintain advanced machines safely and efficiently. Institutions like the Farm Machinery Training and Testing Institutes (FMTTIs) and State Agricultural Universities play an expanded role in certifying equipment and inculcating operational skills.

India's mechanization levels remain uneven, with eastern and hill states lagging behind the national average. Addressing this requires stronger regional planning—linking mechanization with land consolidation, cropping systems, and agro-climatic conditions. Expanding the financial ecosystem through credit guarantees, tax benefits for sustainable machinery, and public-private partnerships can enhance adoption. Policymakers must further align mechanization goals with sustainability frameworks—such as promoting low-emission machines, renewable energy integration, and circular economy principles in agriculture. The next leap in agricultural policy must view mechanization as a strategic driver of inclusive growth. A well-coordinated policy approach—linking innovation, skill, finance, and infrastructure—can transform mechanization into a cornerstone of rural prosperity and national food security.

Rajni Shaleen Chopra

CONTENT

VOLUME XXVIII | ISSUE 11 | NOVEMBER 2025

08 DR. T.R. KESAVAN

10 DR. P.P.S. PANGLI

16 DR. CHANDRASHEKHAR M. BIRADAR

20 DR. RADHEY SHYAM DIXIT

22 MR. BAHADUR ALI

28 MR. MARK KAHN

भारतीय कृषि एवं खाद्य परिषद्
INDIAN CHAMBER OF FOOD AND AGRICULTURE

India Agri Investment Summit 2025

20th Nov 2025 | The Lalit Hotel, Mumbai

Investing in the Future of Indian Agriculture

"Unlocking Opportunities for Growth, Innovation, and Sustainability."

About The Summit

*The **India Agri Investment Summit 2025** is a premier platform bringing together investors, policymakers, innovators, and agribusiness leaders to explore and accelerate investment opportunities across agriculture, food, and allied sectors.*

With India rapidly emerging as a global hub for agri-food trade and innovation, the Summit will foster collaborations, showcase sectoral opportunities, and facilitate strategic partnerships to strengthen the agri-investment ecosystem.

Register as Delegate

FOR MORE DETAILS, PLEASE CONTACT :

Ms. Bhawana Chaudhary | bhawana.chaudhary@icfa.org.in
Phn : +91 9289981654
Ms. Shruti Jaiswal | shruti.jaiswal@icfa.org.in | +91 9311983204

for more information please visit
www.agriinvest.icfa.org.in

From the CEO's desk

Fueling Farm Productivity Through Technology

The transformation of Indian agriculture over the last few decades has been remarkable, yet its future growth will hinge greatly on the pace and depth of mechanization. Farm mechanization holds the promise of making agriculture more efficient, productive, and climate-resilient—particularly in a country where over half the population still depends on farming for livelihood.

In recent years, India has witnessed a steady rise in mechanization, driven by expanding rural infrastructure, custom hiring centres, and a growing ecosystem of affordable technologies. From precision planters to drones, GPS-guided tractors, and sensor-based irrigation, new-age solutions are redefining traditional farm operations. Mechanization not only enhances labour productivity but also ensures timeliness in operations—critical for small and marginal farmers facing shrinking cultivation windows due to changing weather patterns. Government initiatives like the Sub-Mission on Agricultural Mechanization (SMAM), promotion of FPOs for machinery sharing, and schemes for gender-friendly equipment have significantly contributed to mechanization adoption. The private sector's entry through start-ups and agri-tech innovators has further opened opportunities for digitized machinery services, pay-per-use models, and sustainable mechanization clusters.

However, challenges remain. The uneven spread of mechanization across regions and crops continues to limit its overall impact. States like Punjab, Haryana, and western Uttar Pradesh have mechanization levels above 70%, while in the eastern and northeastern regions, adoption remains below 30%.

High equipment costs, fragmented landholdings, and inadequate repair and maintenance networks still deter farmers from embracing advanced technologies. The rush for high-horsepower tractors in unsuitable geographies without proper matching implements often leads to resource inefficiencies. To unlock the full potential of mechanization, India needs a multi-pronged approach—ranging from region-specific equipment design and manufacturing to strengthening farm machinery training institutions and scaling rental-based service models. It is equally critical to integrate mechanization into broader sustainability goals through low-emission engines, precision nutrient application, and renewable-powered equipment.

The road ahead is both challenging and promising. Mechanization should not be viewed merely as the introduction of machines, but as a strategic enabler of inclusive, efficient, and sustainable agriculture. With innovations now reaching even the remotest districts, the next leap in Indian farming will be defined by how effectively technology meets the evolving aspirations of its farmers.

Haris Khan

AGRICULTURE TODAY
The National Agriculture Magazine

AGRICULTURE TODAY GROUP

ANN
AGRI NEWS NETWORK

PRINT AND DIGITAL SUBSCRIPTION

SUBSCRIPTION TARIFF

S.No.	ONE YEAR 12 ISSUES	PRINT	DIGITAL
1.	Individual	800	400
2.	Student	500	250
3.	Organisation	1200	600
4.	Institute / Library	1200	600

To Keep Yourself Abreast with the Latest in Agriculture

Subscribe Now

Please call in +91 72900 88228 or Email : editor@agriculturetoday.in

| www.agriculturetoday.in/subscribe-magazine

RETHINKING FARM MECHANIZATION IN INDIA

Indian farmers and the way farming is practiced are constantly questioned by impressionable experts, who often advocate for land consolidation and adoption of equipment commonly used in developed nations. While such arguments may have had relevance in the 1980s, today we must think differently.

Farmers cannot be expected to shift goalposts endlessly. Their foremost concerns remain intact: fear of losing treasured land, struggling with meagre incomes, and coping with uncertainties created by both natural disasters and human-induced climate change.

Many experts assume that mere preaching can change farmer behaviour, but they forget that even farmers in advanced economies—those higher up in Maslow's hierarchy—accept only those changes that do not disrupt their way of farming. They rarely abandon past practices simply on the promise of higher returns.

We Need An Ecosystem Built Around Current Realities

Should we then blame Indian farmers, who still stand at the lowest step of Maslow's hierarchy, for being cautious? Certainly not.

What India needs is not blind replication of foreign models but an ecosystem built around current realities—fragmented farm holdings, rising numbers of small farms, and an operating environment dominated by capital expenditure rather than operating expenditure.

A fundamental question arises: Why must every farmer own expensive equipment? Take the example of the combine harvester. Few farmers own it directly. Instead, fleet operators buy and maintain harvesters, while farmers simply hire the service and pay per hectare harvested. This model thrives without subsidies because it is inherently profitable for service providers. If this can work for harvesters, why not extend it to other machinery?

Unfortunately, policy continues to focus on Custom Hiring Centres (CHCs) with subsidies on upfront invest-

About the **AUTHOR**

Dr. T.R. Kesavan is the Director and Group President at Tractors and Farm Equipment Limited (TAFE), a leading tractor and farm equipment manufacturer. He is a key figure in the agricultural machinery sector with over five decades of experience, known for his leadership in promoting farm mechanization and sustainable agriculture through technological innovation

ment. These models often fail, as subsidies create short-term incentives but do not build sustainable businesses. As experience shows, enterprises dependent on subsidies collapse, while models like harvester fleets—built on operational viability—survive and scale.

Addressing The Needs Of Farmers

Equipment tailored for small and fragmented farms – incorporating precision technology that saves seeds, fertilisers, pesticides, water, and energy, while preventing soil degradation. These are too expensive for individual farmers to own, but affordable for agri-service providers.

Digital farmer-to-farmer platforms – models like JFarm Services (JFS) already operate free of charge in 18 Indian states, connecting farmers for equipment rental. If supported and expanded by the Ministry of Agriculture and Farmers Welfare (MoA&FW), such platforms can enable transparent, cost-free digital ecosystems where farmers negotiate rentals directly. Unlike static government programs, private-managed platforms remain nimble and adaptive to evolving technology and farmer needs.

Shift from "lent to own" to "lent to rent (L2R)" – During COVID-19, this approach was piloted successfully with JFS in Tamil Nadu, Rajasthan, and parts of Uttar Pradesh, supporting farmers with less than two acres. The model ensures inclusivity by lowering entry barriers for the poorest farmers.

Integration of Next-Generation Technologies

Precision agriculture tools such as GPS-guided implements, variable-rate seeders, fertiliser applicators, and soil-mapping devices.

Drones and UAVs for crop scouting, mapping, spraying, and targeted inputs—enhancing efficiency while reducing chemical overuse.

Sustainable machinery like solar pumps, electric tractors, and battery-powered implements that cut diesel dependence and operating costs.

Mechanized value-chain tools—portable machines for grading, drying, and processing fruits and vegetables—to reduce post-harvest losses and improve market quality.

RECOMMENDATIONS

- Instead of individual ownership, farm mechanization in India should focus on service-based models where farmers access equipment through rentals, aligning with the reality of fragmented land holdings and reducing financial burden
- This approach necessitates the development of specialized, precision technology equipment tailored for small farms and the establishment of digital platforms to connect farmers with service providers.
- Policy should be realigned to support sustainable rental models over subsidized purchases, while integrating next-generation technologies like precision tools, drones, and sustainable machinery.
- Must avoid subsidising machinery as these became affluent farmer's tools, underutilised and also leads to malpractices.

The future of Indian farm mechanization lies not in ownership of machines but in access to them through sustainable service-based models

Policy Realignment

Schemes like SMAM must move beyond lip service and translate into genuine support for equipment rentals, rather than subsidizing unsustainable purchases. States must also be encouraged to play a more proactive role in enabling service-based models.

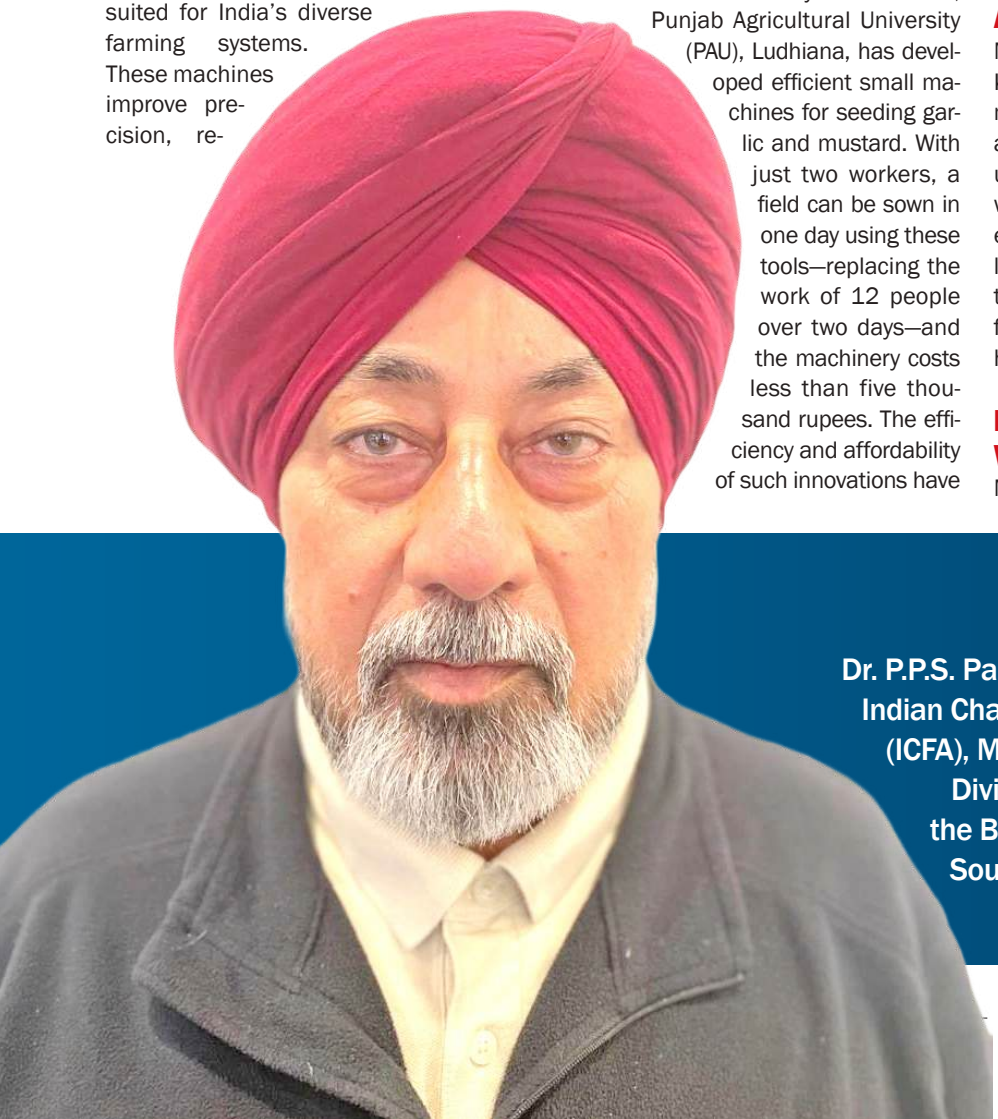
Access to Mechanization Through Sustainable Service-Based Models

The future of Indian farm mechanization lies not in ownership of machines but in access to them through sustainable service-based models. Digital platforms, precision technologies, and AI-enabled solutions can democratize access, reduce costs, and empower even the smallest farmers. The time has come to catch the bull by the horn and build an ecosystem that works with, not against, the realities of Indian agriculture.

Post-harvest logistics and supply chains remain another vast area of reform, but that is a discussion for another day.

THE ROLE OF FARM MECHANISATION IN ERADICATING NUTRITIONAL HUNGER

Farm mechanisation holds a transformative role in eradicating nutritional hunger and ensuring food security in India. In the coming decade, it will play an increasingly vital part in improving agricultural productivity, reducing drudgery, and achieving balanced nutrition for all. Mechanisation is not simply about replacing manual labour—it is about making farming more efficient, sustainable, and income-generative for small, marginal, and large farmers alike. Small-scale mechanical agricultural machinery, powered manually or by low-horsepower engines, is ideally suited for India's diverse farming systems. These machines improve precision, reduce time, and lower production costs. For small and fragmented landholdings, which make up the majority of Indian farms, such low-cost mechanisation options are both practical and affordable.



Innovations in Small Farm Machinery

Agricultural universities and innovative machinery manufacturers across the country have made remarkable progress in developing simple equipment for sowing, hoeing, seeding, pruning, and planting. These solutions are designed keeping in mind regional cropping patterns and farmer affordability. For instance, Punjab Agricultural University (PAU), Ludhiana, has developed efficient small machines for seeding garlic and mustard. With just two workers, a field can be sown in one day using these tools—replacing the work of 12 people over two days—and the machinery costs less than five thousand rupees. The efficiency and affordability of such innovations have the potential to revolutionize farm operations across the country.

Battery-operated pruning and spraying devices for orchards represent another innovation with immense potential. These tools make it easier to manage large fruit trees while reducing risks, saving labour, and improving precision in pesticide and nutrient application. State agriculture departments and the 76 agricultural universities across India should actively promote such technologies to strengthen farm mechanisation at the grassroots level.

Role of Media and Farmer Awareness

Mass communication channels like DD Kisan can play an important role in promoting farm mechanisation. Linking such awareness programs with manufacturing units and local demonstration centres would help strengthen support for farmers of all categories—small, marginal, and large. Private television channels and digital media platforms can also be used to feature success stories of farmers who have benefited from mechanisation.

Post-Harvest Mechanisation and Value Addition

Mechanisation should not be limited to

About the **AUTHOR**

Dr. P.P.S. Pangli is a Board Member of the Indian Chamber of Food and Agriculture (ICFA), Member of the Agro Chemicals Division of FICCI and President of the Borlaug Farmer Association for South Asia. He can be reached at ppspangli@gmail.com

production alone. Simple post-harvest tools—such as fruit pluckers, vegetable graders, and low-cost packaging units—can dramatically reduce losses and improve the market value of farm produce. These innovations ensure that fruits and vegetables reach consumers in better condition, improving both farmer incomes and nutritional outcomes.

Efficient fruit pluckers, for instance, help prevent damage to fruits during harvesting, thereby maintaining market quality and reducing waste. Similarly, low-cost grading and packaging systems, supported through government incentives, can make Indian produce more competitive globally.

Empowering Farmer Producer Organizations (FPOs) to establish on-farm processing and direct marketing channels would further enhance farm incomes while strengthening local food systems.

Training, Skill Development and Capacity Building

Effective adoption of mechanisation requires skill development and continuous learning. It is encouraging that universities like PAU have set up Farmer Clubs for regular interaction between researchers and farmers. These interactions foster a valuable exchange—farmers learn about new technologies while scientists receive field-level feedback to refine their innovations.

Farm mechanisation is not just about machines—it is about dignity, efficiency, and empowerment for every farmer

The establishment of Skill Development Centres and hands-on training within PAU's Incubation Centre is another major step toward empowering farmers with practical skills. Short-term mechanisation courses should be organized regularly across all 76 agricultural universities, tailored to local cropping patterns. Such programs can help farmers operate, maintain, and repair machinery—ensuring the sustainability of mechanisation initiatives.

Strengthening Institutional

Policy and Financial Support for Mechanisation

Access to affordable credit remains a key enabler of mechanisation. Currently, most banks provide loans mainly for tractors and harvesters, with repayment terms limited to five to seven years. To align with global standards, banks should offer long-term financing for farm implements at low interest rates with repayment terms of at least 10 years. A temporary waiver on import duties for agricultural implements for the next decade would also make international technologies more accessible and competitive, giving Indian farmers access to state-of-the-art tools.

Strengthening Institutional Support and Technology Transfer

Government initiatives such as PAMETI (Punjab Agricultural Management and Extension Training Institute), established by the Ministry of Agriculture, serve a crucial role in bridging knowledge gaps. By training in-service employees from cooperatives, agriculture departments, and rural banks, PAMETI helps ensure that new research and tested technologies reach farmers promptly. The ICAR-CIPHET (Central Institute of Post-Harvest Engineering and Technology), established under ICAR, is similarly improving the design, durability, and affordability of farm equipment. Strengthening collaboration among these institutions can accelerate the technical support and field-level adoption of innovative solutions.

Sustainable Mechanisation: Lessons from Global Models

India must adopt a long-term, region-specific agricultural policy to promote diversification and reduce dependence on a few crops. Strengthening Geographical Indication (GI) tags for globally valued commodities such as basmati rice, spices, and tea will enhance their market recognition and protect farmers' interests internationally.

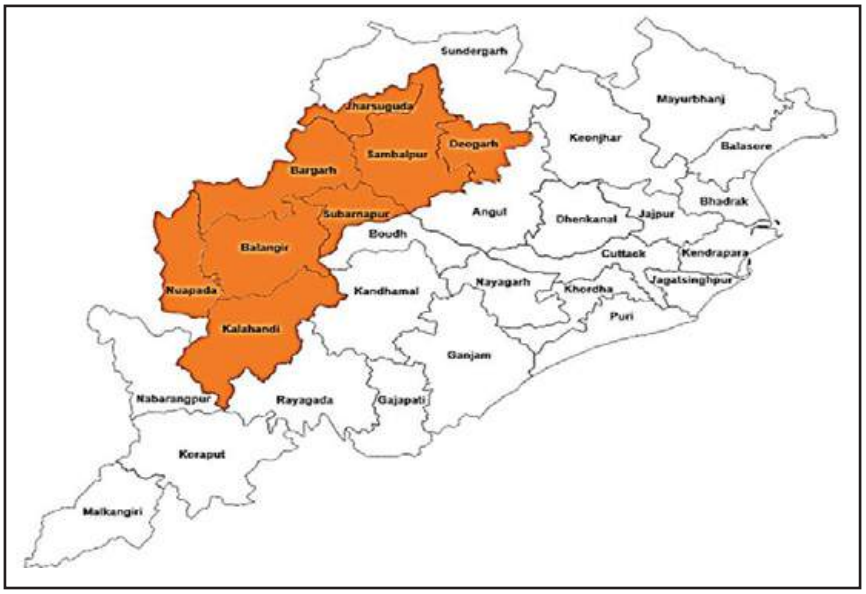
Collaborative Efforts for a Hunger-Free South Asia

The Borlaug Farmer Association for South Asia (BFASA), in partnership with the Global Farmer Network and the Nuffield Farming Scholars, is actively working toward eradicating nutritional hunger across the region. These collaborations focus on affordable technology dissemination, farmer-to-farmer knowledge exchange, and innovations in sustainable production.

From subsistence to market success: Farmers from Western Odisha drive growth through FPOs

Odisha, once known for its dependence on rain-fed agriculture and subsistence farming, is now undergoing a remarkable transformation in its agrarian landscape. This shift is visible in the evolving identity of Odisha's produce and the rising aspirations of its farming communities.

Western Odisha, a region comprising districts like Sambalpur, Balangir, Bargarh, Kalahandi, Nuapada, Jharsuguda, Sonepur, and Deogarh, is characterized by its unique cultural and economic identity within the state of Odisha. Agriculturally, the region relies heavily on crops such as paddy, pulses, oilseeds, cotton, and sugarcane, with both Kharif (monsoon) and Rabi (winter) crop cycles shaping rural livelihoods. While paddy remains the staple crop, Western Odisha has also seen the adoption of commercial and cash crops like cotton and sunflower, reflecting efforts to diversify agricultural production and address regional disparities. Despite its agricultural potential, the region faces persistent challenges such as uneven irrigation, droughts, migration of labour and limited adoption of modern technology, and disparities in infrastructure investment compared to coastal Odisha, leading to ongoing calls for more equitable development and policy intervention.



Then and Now: A story of transformation

Just a few years ago, the agricultural output from western Odisha districts was largely confined to local mandis and regional markets, with farmers relying on traditional methods and seasonal rainfall to sustain their livelihoods. Despite the inherent quality of their produce, the idea of international exports was distant, if not unimaginable. Infrastructure gaps, limited market access, and lack of awareness about global standards kept farmers tethered to low-margin sales and uncertain incomes. However, the agricultural story of Western Odisha is undergoing a gradual shift. The narrative is being rewritten with the region moving from a survival-based economy to a thriving, diversified, and globally integrated agriculture-driven economy.

Central to this shift are targeted investments in irrigation and rural infrastructure that have enabled farmers to diversify from traditional subsistence crops to high-value horticulture—fruits, vegetables, floriculture, and plantation crops. Complementary measures such as market-linked procurement, export facilitation, and cluster-based FPO strengthening have further accelerated integration into premium value chains. As a result, produce from Western Odisha—mangoes setting global benchmarks, dragon fruit carving a niche in exotic-fruit market, and cut flowers entering national and global markets—now carries an identity defined by resilience, quality, and scale. This rebranding of the region's agri-output signals Odisha's emergence as India's next horticultural powerhouse.

This shift in Western Odisha's agri-economy is the outcome of a strategic push by the Department of Agriculture & Farmers' Empowerment (DA&FE), which has systematically converted fragmented local value chains into globally aligned networks anchored by grassroots farmer organizations, empowering small holder farmers. This transformation is further supported by the market acceleration support by the Promotion and Stabilisation of Farmer Producer Or-

Dragon Fruit export from Bolangir flagged off by Hon'bl Deputy Chief Minister from Odisha

ganisations (PSFPO) project, spearheaded by DA &FE, Odisha. Implemented by Palladium and supported by the Gates Foundation, the initiative has built a robust ecosystem for smallholder farmers to thrive in global markets. Through targeted interventions—ranging from on-ground support, training, exposure visit, and handholding to post-harvest management and logistics —FPOs in the state have been equipped to meet international standards. Farmers are now earning profit margins of 40% – 62%, a dramatic improvement that is not only boosting incomes through elevated production systems, reshaping farmer aspirations—where once cultivation was about survival, it is now about quality, competitiveness, and market leadership.

Western Odisha: From rain-dependent fields to export-driven growth – stories from the ground

This transformation is evident in western

The narrative is being rewritten with the region moving from a survival-based economy to a thriving, diversified, and globally integrated agriculture-driven economy

Odisha, where remote districts like Balangir, Sambalpur, Kalahandi and Nuapada have emerged as vibrant centres of agri-horti innovation and export excellence propelling the sector forward through dynamic infrastructure development, market-oriented value chain development and sustainable domestic and export market linkages while leveraging digital platforms like eNAM and ONDC. In a striking shift from their agrarian past, Western Odisha states are now making headlines for their high-value horticultural exports.

Balangir is charting new territory and emerging as a hub for agri and horticulture cultivation driven by watershed development and the rise of Farmer Producer Organizations (FPOs) that are actively engaging with global markets. In the last one year, Balangir has carved a nice for itself as an agri-export leader by successfully exporting high-value horticulture crops like Dragon fruit and Mangoes fueled by grassroots farmer producer organizations, institutional backing, and collaborative public-private projects, which collectively enable area farmers to command premium prices for superior produce. In the last one year, over 27 metric tonnes of premium quality Amrapalli mangoes, Dragon fruit and fresh vegetables have been exported from farmers and FPOs in Balangir to destinations such as Dubai, London, Abu Dhabi, France, Sweden, Belgium, and Germany. Among its standout offerings is organically grown dragon fruit from Patnagarh, which has become a

Dragon fruit export from Bolangir

symbol of premium horticulture.

Sambalpur, on the other hand, is leveraging cold storage infrastructure and agri-tech platforms to expand its horticultural footprint and connect farmers to international buyers. Initiatives such as Sambalpur's upcoming Terminal Market Complex promise to revolutionize supply chains by directly connecting farmers to national and metropolitan markets, boosting income, and reducing losses, while leveraging transport connectivity and strategic location advantages. Farmers in the region and venturing into high-value crops like dragon fruit, strawberries, and various floriculture products—setting the region apart. A clear example of this is the Sabujasanatanpali Farmers' Producer Company Limited. The FPO, by adopting climate-resilient floriculture practices in partnership with institutions like ICAR-NBRI, has successfully cultivated high-value crops such as Eustoma flowers, which command a premium market price of Rs.1,500 per bunch. Further, Sambalpur has carved its niche in the international market with 5.7 metric tonnes of exports this year, primarily Amrapalli mangoes and assorted vegetables, reaching consumers in London and Dubai. These milestones reflect a deeper transformation in the region's agricultural identity—from staple crops to niche, globally demanded commodities driven by crop innovation and sustainable agriculture practices.

The FPO, by adopting climate-resilient floriculture practices in partnership with institutions like ICAR-NBRI

"The progress of Sabujasanatanpali Farmers Producer Company Limited (SSFPCL) in Sambalpur district reflects the impact of coordinated efforts in strengthening farmer collectives and enhancing rural livelihoods. With NABARD's support and Palladium's guidance, the FPO has successfully diversified into high-value crops and adopted modern agricultural practices. Palladium has played a key role in enabling marketing support—facilitating both domestic and international market access, including export of premium produce—which has significantly improved income opportunities for small and marginal farmers associated with the FPO. This collaborative model, backed by the Department of Agriculture & Farmers' Empowerment, Government of Odisha, continues to empower farmers through sustainable agribusiness and inclusive growth"

- ***Shri Dhiren Kumar Dash, DDM Sambalpur, NABARD***

This momentum was recently highlighted by a significant domestic marketing from Jujomora Farmer Producer Company Ltd. (JFPCL) in Sambalpur

which successfully dispatched 2.13 metric tonnes of organic red dragon fruit to Kolkata. Known for its vibrant colour, nutritional value, and premium quality, the dragon fruit cultivated in Sambalpur is gaining recognition not only in international markets but also in high-demand domestic circuits. This milestone reflects the increasing cultivation and marketing of high value crops through FPOs in the region to meet market expectations and reinforces the district's expanding role in Odisha's agri-horti success story.

Kalahandi district is rapidly emerging as a horticultural powerhouse in Western Odisha, fuelled by Farmer Producer Organizations (FPOs) that are actively engaging in the marketing of fresh vegetables. A prime example is Agrahichasi Farmers' Producer Company Limited in the Golamunda block, which has also featured in the Honourable Prime Minister's 'Mann Ki Baat' for transforming the district into a vegetable hub.

Further, this agricultural shift is also evident in the cultivation and marketing of premium quality bananas through Trilokeswar Farmer Producer Company Ltd., in Kalampur block, Kalahandi a crop that has successfully penetrated premium domestic and export markets, fetching a significant incremental price for associated farmers and transforming a staple into a profitable enterprise through FPOs. This shift reflects how FPO-led aggregation is unlocking scale, efficiency, and new opportunities for smallholders in Western Odisha's horticulture economy.

To build on to the export momentum of western Odisha consignments of premium Amrapali mangoes to Europe this year have also been sent from Nuapada district marking its entry into a high-value global market. This mirrors the region's broader export ambitions and highlights the potential for other districts to follow suit.

Way forward

Western Odisha's rise as an agri-business hub is being powered by adoption of innovative crop practices, horticulture, and FPO-led growth, with visible gains in both production and market integration. In FY 2023-2024, Odisha achieved a record horticulture output of 15305.51 thousand tonnes, with western districts contributing significantly to this milestone. Not long ago, most smallholders in the region were confined to rain-fed, subsistence farming with limited market access. Today, through the collective strength of FPOs supported by the PSFPO project under DA&FE, farmers are not only securing higher prices but also aspiring to meet export standards and tap premium international markets. Market-oriented capacity-building initiatives have further accelerated this shift, facilitating diversification into fruits, vegetables, and floriculture through FPOs. What was once a struggle for survival has become an entrepreneurial pursuit—farmers now see themselves as agri-entrepreneurs, eager to invest in quality, branding, and long-term market relationships.

To sustain this momentum, the region will need continued investment in post-harvest infrastructure, modern packaging, compliance systems, and value chain development initiatives. By embedding value addition, strengthening market linkages, and leveraging public–private partnerships, Western Odisha is poised to emerge as a national model for inclusive, export-driven horticultural growth—showcasing how farmer aspirations, once limited to subsistence, are now shaping a new vision of prosperity and global integration.

"Agrahichasi FFPO has transformed Kalahandi into a thriving vegetable hub, overcoming challenges of limited water and resources. Once marked by migration, the region now boasts over 200 farmers, including 45 women, cultivating 200 acres of tomatoes and 150 acres of bitter gourd. With an annual turnover exceeding ₹1.5 crores, their produce reaches markets across Odisha and neighbouring states. This success, driven by modern farming techniques and teamwork, highlights how determination and collective effort can bring transformative change. As they expand into potato and onion farming, these farmers continue to innovate and inspire."

Shri Narendra Modi
Honourable Prime Minister of India

Export of amrapalli mangoes from Sambalpur to Dubai, England

FARM MECHANIZATION FOR SMALLHOLDERS AND FAMILY FARMING IN INDIA

Pathways for Rural Transformation

It began with a simple question after one of my lectures on agroecology in Bengaluru. A young man, an IT professional in his late twenties, waited until the hall emptied. With eyes full of conviction, he said, "Sir, I want to quit my job and return to my village. I want to farm naturally, live simply, and serve nature. But how do I manage farming by myself? We have only four acres, and I can't find skilled labour."

His question lingered. Over the last two years, many such young professionals and smallholders have approached me with similar doubts: "Are there small machines that can help us manage our farms ourselves? Can family farming be profitable again?"

This is the new pulse of rural India, the awakening of a generation seeking purpose and self-reliance in farming, yet constrained by labour shortages, rising costs, and the absence of appropriate technology. Once viewed as a domain of large commercial farms, farm mechanization is now entering a new era that respects the scale, ecology, and spirit of family farming.

About the **AUTHOR**

Dr. Chandrashekhar M. Biradar, Founder of Global Green Growth, is an Earth System Scientist with over three decades of experience across the Indian subcontinent, Asia, Eurasia, the Middle East, Africa, and the Americas, working at the intersection of integrated farming systems, agroecology, biodiversity, tree-based landscapes, drylands, living labs-land management.

Dominance of Smallholders: The Living Backbone of Rural India

India's smallholder family farms are the heart of our agrarian and cultural heritage. Over 86 percent of all landholdings in the country are classified as small and marginal, encompassing less than two hectares or five acres. These stewardship farmers are custodians of our timeless connection with soil, water, biodiversity, feeding billions and community life sustaining both livelihoods and landscapes across generations.

Yet these farms face mounting challenges. Rural labour shortages caused by urban migration have increased dependency on external workers. Rising input costs and limited market returns have reduced profitability. Climate change has added further stress, eroding soil fertility and increasing the risks of crop failure.

Thoughtfully designed, scale-appropriate mechanization aligned with natural, tree-based, and regenerative farming can transform this scenario. It can enhance productivity, reduce drudgery, and restore the ecological harmony upon which our food systems depend.

Technological Innovations that Empower Smallholders

Farm mechanization for smallholders is evolving rapidly. The new focus is on smart, modular, and energy-efficient tools that make family farming self-reliant and sustainable.

Compact micro- and mini-tractors of 10 to 25 horsepower are tailored for small plots, orchards, and intercropped systems. With reversible drives, low fuel use, and simple maintenance, they are ideal for tree-based and diversified farms and poly-cropping systems. Multi-implement systems, powered by small engines or even pulled by traditional bullocks, now allow a single base unit to perform multiple functions such as seeding, mulching, spraying, harvesting and transport. This approach spreads investment across operations and seasons, making mechanization affordable.

Alongside modern engines, bullock power continues to hold an important and often underestimated role. In many regions, a pair of bullocks can provide clean, renewable energy for ploughing, sowing, and residue incorporation. Bullocks help manage crop residues naturally by trampling and integrating biomass into the soil, improving organic matter and supporting microbial life. When combined with mechanical tool kits, bullock-drawn implements create a balanced, carbon-neutral system that enhances soil health while reducing fossil fuel dependence.

Mechanization empowers the farmers, rural youth, migratory workers return to farming to live close to the land, and to cultivate both prosperity and peace

NetZero Nation: The future of India's smallholder farming lies in low carbon, netzero transition with 'ecologically sustainable and economically viablemechanization' where solar power, livestock power, digital tools, and ecological intelligence converge to empower farming families, restore soils, and regenerate rural economies. True progress will come not from machines replacing people, but from technology amplifying the farmingpower,restore harmonybetween people, living lands, and green economic growth.

Innovation is also redefining precision and sustainability. Solar or electric-powered seeders, transplanters, brush cutters, and irrigation pumps help farmers save energy while maintaining soil health. Low-tillage and biomass management tools such as mulching mowers and residue incorporators support natural and regenerative farming by preserving soil structure and recycling nutrients. Complementing these are digital and sensor-based tools, mobile apps, soil and moisture sensors, and decision-support systems helping even smallholders adopt data-driven practices. Together, these innovations represent a new generation of eco-aligned, system-level mechanization that enhances efficiency, lowers drudgery, and allows family farms to thrive in harmony with nature.

Meeting the Diverse Mechanization Needs of Family Farms

India's agricultural diversity demands diversity in machines. Mechanization must respect the varied agro-ecological zones and cropping systems, from paddy terraces, to grain basket to tree-based, horticultural and agroforestry systems for green economic transition.

Alongside modern engines, bullock power continues to hold an important and often underestimated role. In many regions, a pair of bullocks can provide clean, renewable energy for ploughing, sowing, and residue incorporation

Customization to crop diversification and poly-crop systems is essential. Machines designed for intercropping, narrow rotary tillers for vegetable rows, and mini-harvesters for pulses and millets can meet diverse needs. The growing network of Custom Hire Centers (CHCs), Farmer Producer Organizations (FPOs), and local entrepreneurs offers shared access to machines on a rental basis, reducing capital costs.

Modular, multifunctional equipment designs enable farmers to perform minimum tillage, sowing, mulching, and harvesting using one base unit. Mechanization must also be inclusive: women- and youth-friendly machines that are light, safe, and ergonomically designed will help create employment and attract younger generations back to farming.

Educating Farmers and Building Skills

Mechanization succeeds only when farmers have the knowledge, confidence to use it effectively, and economically affordable.

Across India, cross cutting institutions and manufactures must organizing hands-on training and demonstration days to help smallholders understand the practical use of machines. FPOs, SHGs and Start-ups are emerged as important local hubs for peer-to-peer hands-on training and co-learning, while digital platforms and short vernacular videos provide practical guidance on operation, maintenance, and safety. Rural youth training programs are creating skilled operators and mechanics, ensuring the availability of local service ecosystems. Such initiatives are critical to show that mechanization and natural farming can coexist — machines can complement ecology rather than compromise it.

Barriers to Mechanization and Ways Forward

Despite progress, several barriers persist. High capital costs remain the biggest constraint for smallholders. Expanding access to low-interest credit, equipment leasing, startup grants, re-purposing subsidies, etc., can make adoption easier while generating ample of green jobs. Fragmented landholdings reduce machine efficiency; cooperative land-use planning and smaller, flexible machine designs are needed.

Rural infrastructure is still inadequate, with limited access to spare parts, service centers, and charging facilities. Local fabrication units and solar-based micro-charging hubs can help build rural supply chains. Skill and safety gaps must be addressed through operator certification and standardized training.

Cultural perceptions also need to evolve. Some farmers still associate machines with industrial, chemical-intensive agriculture. Demonstrating eco-aligned machines that support mulching, composting, and tree planting will help change this mindset and encourage adoption.

The All-in-One Nano Solar Tractor: A Game-Changer

A quiet revolution is now emerging in the fields of family farming: the All-in-One Nano Solar Electric Tractors, Nano Power Tollers, Light Weight (no soil compaction) designed for one- to ten-acre farming, including agroecology, polycropping, horticultural, and tree-based farming. This compact, zero-emission, multi-utility tractor models offers a complete solution for smallholder mechanization while remaining true to the principles of sustainable farming.

Small, solar-powered, and intelligent, the tractor operates on clean, rechargeable batteries and suits narrow lanes, orchards, and intercropped fields. Its battery-swapping and solar-charging systems ensure continuous operation without dependence on diesel or grid power.

The mini or micro tractor's multi-functional attachments include:

- Precision seed drill for low-disturbance sowing to preserve soil microbes and moisture.
- Shallow-depth rotavator for incorporating cover crops and green manures.
- Inter-cultivation for managing weeds and relay sowing tools between tree rows.
- Hydraulic pit digger for tree planting to raised bed and trench making
- Mini-combine harvester for small grains and pulses.
- Detachable electric trolley for transport of produce, compost, or materials.

Integrated with IoT-based monitoring, regenerative braking, and load optimization, this system provides energy efficiency and operational autonomy. With zero noise and emissions, it protects pollinators and soil organisms, making it ideal for organic and eco-tourism farms.

Transforming Rural Livelihoods

The All-in-One Nano Solar Tractor represents the convergence of science, sustainability, and tradition. It enables families to manage their farms independently, reduce labour dependency, and build resilience against climate variability, all while restoring harmony with nature.

This model reflects India's vision of Atmanirbhar Krishi, a self-reliant, sustainable, and nature-powered agriculture. Mechanization, when rooted in ecology, becomes not a replacement for human touch but an extension of human power and care.

It empowers the farmers, rural youth, migratory workers return to farming to live close to the land, and to cultivate both prosperity and peace from the same soil that has sustained generations and help green economic transition of the farming sectors.

MECHANISATION IN THE DAIRY SECTOR

Blending Tradition with Technology

Mechanisation has revolutionized the dairy industry by integrating advanced technologies that enhance efficiency, hygiene, and consistency in large-scale production. Automation ensures that every process—from milk collection and curdling to packaging—is streamlined, minimizing human contact and maintaining the highest quality standards.

The Ananda Group stands as a pioneer in embracing such mechanisation to deliver pure and safe dairy products.

Global Cutting Edge Machinery for Ensuring High Quality

A prime example is the Ananda Group's ALPMA automated paneer production line, sourced from Germany. This system handles every stage—from coagulation to pressing, cooling, cutting, and packaging—completely hands-free. The result is paneer that retains perfect softness, ideal moisture balance, and superior hygiene, monitored in real time through programmable logic controllers (PLC) that ensure consistent quality.

For liquid dairy products like milk, buttermilk, and flavored beverages, Ananda employs Tetra Pak aseptic technology, combining UHT treatment with multi-layered, hermetically sealed cartons that protect against air, light, and bacteria—extending shelf life without refrigeration. Additionally, the Simik automated line for Sweetened Flavored Milk (SFM) cans ensures precise filling, sealing, and packaging, maintaining hygiene with minimal manual handling. Together, these systems exemplify how Ananda fuses traditional dairy expertise with global mechanisation standards, staying true to its philosophy of "Suddhta ki Parampara"—a legacy of purity that reaches millions of homes daily.

The Paneer Revolution: Becoming the "Paneer King"

Before Ananda's innovation, paneer was typically sold loose in open markets—exposed to dust, contamination, and inconsistency.

Recognizing this gap, Dr. Radhey Shyam Dixit, the Founder and Chairman of the Ananda Group,

pioneered India's first packaged paneer, forever transforming consumer habits.

Ananda Paneer, made on the ALPMA automated line, is untouched by hand and undergoes rigorous quality checks, ensuring every block maintains the same texture, taste, and freshness. This breakthrough not only solved a hygiene problem

About the **AUTHOR**

Dr. Radhey Shyam Dixit is the Founder and Chairman of the Ananda Group

but redefined trust and traceability in the dairy segment. It was this innovation that earned Dr. Dixit the title of "Paneer King", symbolizing his pivotal role in transforming India's dairy practices.

Empowering Farmers, Uplifting Communities

At the heart of Ananda's success lies a deep commitment to farmer empowerment and community development. Through structured training programs, veterinary support, and assured milk procurement, Ananda helps thousands of farmers enhance yield and income stability. Dr. Dixit emphasizes, "We have not only expanded our milk and milk product range but also diversified into other food categories. Our mission remains to empower dairy farmers and uplift rural communities while delivering quality products to consumers." Ananda's initiatives also prioritize women empowerment, animal welfare, and rural development, ensuring that business growth translates into social progress. This philosophy reflects Dr. Dixit's belief that profitability and purpose must coexist.

Recognition and Awards: A Life of Impact

Dr. Dixit's contribution to India's dairy sector and society has earned him multiple honors, including an Honorary Degree in Dairy, Food & Nutrition from California Public University, USA, acknowledging his global influence in dairy innovation. His leadership continues to inspire the next generation of entrepreneurs—showcasing how vision, integrity, and perseverance can create both economic and social value.

Legacy of Innovation and Compassion

From a small village near Agra to becoming one of India's most respected dairy entrepreneurs, Dr. Radhey Shyam Dixit's journey embodies the perfect blend of tradition, innovation, and compassion. His relentless focus on purity, hygiene, and consumer trust turned Ananda into a beloved household name. Beyond commercial success, his initiatives in farmer welfare, women empowerment, and animal care

Ananda fuses traditional dairy expertise with global mechanisation standards

have improved thousands of lives across rural India. Today, Ananda's story stands as a powerful example of how technology and tradition can coexist, creating a brand that is not just about dairy—but about dignity, development, and dedication. As Dr. Dixit continues to guide the brand with vision and humility, his legacy remains one of innovation with heart, ensuring that the purity of Ananda's products reflects the purity of purpose behind them.

Dr. Radhey Shyam Dixit: From Village Roots to Visionary Beginnings

Born in Garhi Jahansingh near Agra, Uttar Pradesh, Dr. Radhey Shyam Dixit grew up in a humble farming family. His father was a farmer, and from an early age, young Radhey Shyam helped in their small milk business while juggling school and family farming responsibilities.

By the time he was in Class IX, he had officially entered the milk trade, gaining firsthand experience in handling milk and understanding the value of purity and trust in dairy products. After completing his Bachelor of Commerce from Delhi University, he combined practical wisdom with academic knowledge, laying the foundation for his entrepreneurial journey.

Growing up, he witnessed the struggles of families buying paneer and milk from open markets—often unhygienic, unregulated, and inconsistent in quality. These early experiences shaped his vision for a cleaner, safer, and more standardized dairy system—a dream that would later revolutionize the Indian dairy landscape.

Building a Dairy Empire: The Birth of Ananda

In 1989, Dr. Dixit founded Ananda, driven by a single guiding philosophy—purity with progress. Over the years, under his leadership, Ananda has built a diverse portfolio of 100+ SKUs, offering a wide range of fresh and frozen dairy products such as paneer, milk, butter, ghee, cream, curd, buttermilk, lassi, and sweets, while expanding strategically into FMCG categories like gram flour (besan), frozen foods, edible oils, and bottled water. Every Ananda product carries the promise of purity, freshness, and authenticity, embodying the brand's core belief in delivering wholesome nutrition to every household.

The company operates six state-of-the-art manufacturing plants, including a cattle feed plant in Siyana under the brand Ananda Farms, which supports dairy farmers and promotes sustainable productivity.

Today, Ananda has achieved a pan-India presence with growing international reach, particularly across Gulf countries, cementing its reputation as one of India's most trusted dairy brands.

THE IB GROUP

Mechanizing India's Protein Revolution

Not too long ago, the image of Indian poultry farming was one of small, backyard operations. While important, that model faced immense challenges in efficiency, quality, and scalability. Today, the Indian poultry industry is a global powerhouse. We at the Indian Broiler (IB) Group, as one of India's leading protein-centric conglomerates, are proud to have been at the forefront of this transformation. For us, mechanization wasn't just an upgrade; it was a strategic revolution that allowed us to "up our game" and set new standards in efficiently converting grains into high-quality, affordable protein for the nation.

This transformation has been driven by our focus on mastering the three most critical variables in protein production: feed, water, and environment.

Precision in Every Peck and Sip

At IB Group, we recognized early that consistency is the bedrock of quality. Manual feeding and watering were simply too variable, leading to waste and uneven growth. We pioneered the large-scale implementation of automated systems to solve this.

On our farms, automated pan and chain feeding systems are now standard. These systems deliver a precise, nutritionist-formulated diet developed in our own labs, ensuring every bird gets optimal nutrition. This has drastically improved our Feed Conversion Ratio (FCR) and ensures the uniform, healthy growth that our brand is known for.

Similarly, we replaced open drinkers with automated nipple drinking systems. This ensures a constant supply of clean water, but more importantly, it keeps the poultry litter dry. A dry environment is critical for preventing the buildup of harmful ammonia and the spread of diseases, directly enhancing the biocybersecurity of our flocks.

Engineering the Perfect Environment

One of the biggest game-changers for IB Group has been our widespread adoption of Environmentally Controlled (EC) sheds. To produce high-quality protein year-round in India's diverse climate, we had to take

About the **AUTHOR**

Mr. Bahadur Ali is the Founder and Managing Director of the IB Group, one of India's leading protein-centric conglomerates, with a diversified presence in poultry, livestock feed, edible oils, and processed protein

the weather out of the equation.

Our EC sheds are state-of-the-art facilities. They use tunnel ventilation systems with automated cooling pads and large exhaust fans to maintain the perfect temperature and humidity, even during peak summer. In winter, automated heaters protect our flocks. This precision control minimizes stress on the birds, which leads to lower mortality, better growth, and superior meat quality.

The Virtuous Cycle of Hygiene and Mechanized Health

For IB Group, mechanization is the backbone of our promise of hygiene and food safety. This begins even before the chick is hatched. We have invested heavily in In-Ovo Vaccination technology, a highly sophisticated form of mechanization within our hatcheries. This process vaccinates the embryo directly inside the egg, days before it hatches.

The benefits are profound: every chick receives a uniform, 100% accurate dose, eliminating the human error and high stress of manual, post-hatch injections. This means our flocks start life with robust, early immunity, significantly reducing the risk of disease. This technology, combined with automated feed, water, and manure collection systems in our sheds, minimizes human-animal contact and ensures the final product is safe, wholesome, and of the highest quality.

THE NEXT FRONTIER: DIGITIZATION AND THE IB ECOSYSTEM

Our journey of innovation continues. We are moving beyond simple mechanization into full-scale digitization. A prime example is our proprietary ABIS Digital Farmbook app, which connects our entire ecosystem. This platform provides real-time data and communication between our farmers, veterinarians, and management teams, ensuring rapid response and data-driven decision-making.

At IB Group, we believe technology is the key to creating a more efficient and sustainable future. Our story is one of progress where mechanization, digitization, and a deep commitment to all farmers converge to fulfill our mission: strengthening the nation by providing high-quality, affordable protein for all.

Empowering the Entire Agricultural Ecosystem

A core philosophy at IB Group is that our growth is intrinsically linked to the prosperity of all farmers. Mechanization has been the key to unlocking this shared value.

This partnership is the heart of our flagship socio-economic initiatives, Parivartan and Parivartan GenNxt. Launched in 2016, the Parivartan program is our commitment to transforming farmers' lives by helping them upgrade from traditional open-shed farming to state-of-the-art, automated Environmentally Controlled (EC) houses. We provide comprehensive support, including technical designs, financial assistance, and continuous operational guidance. This initiative elevates farmers from manual labourers to skilled farm managers, often doubling their income and dramatically reducing bird mortality. Parivartan GenNxt takes this a step further, encouraging startups and young Indians to embrace technology-driven broiler farming as a high-tech, entrepreneurial journey.

Second, and just as critically, this entire protein production engine runs on high-quality grains. As one of the largest consumers of maize and soy for our feed mills, IB Group provides a massive, stable, and reliable market for thousands of grain farmers. This commitment creates a virtuous economic cycle: our investment in farm mechanization drives demand, which in turn provides prosperity and security for the farmers who produce the grain. We are not just in the poultry business; we are in the business of empowering India's agricultural backbone.

TRANSFORMING INDIAN AGRICULTURE

THE PATH TO SMART FARM MECHANIZATION

India's agricultural sector, employing nearly half the country's workforce, stands at a critical juncture where technological innovation meets traditional farming practices. As companies like FASAL, FYLLO, CARNOT Technologies, and established manufacturers like Mahindra and John Deere introduce cutting-edge solutions, the challenge lies in making these technologies accessible and relevant across India's diverse farming landscape.

Major Technological Innovations in Farm Mechanization

The current wave of agricultural innovation goes far beyond traditional tractors and harvesters. IoT-based sensor networks from companies like FASAL and Sense it out now enable real-time monitoring of soil moisture, weather conditions, and crop health parameters. These sensors generate continuous data streams that help farmers make informed decisions about irrigation, fertilizer application, and pest management.

Drone technology, pioneered by companies like Garuda

Aerospace and Marut Drones, has introduced aerial surveillance and precision spraying capabilities. These drones equipped with multispectral cameras can identify crop stress, pest infestations, and nutrient deficiencies across large areas in minutes rather than the hours or days required for manual scouting. Advanced models can carry out targeted spraying operations, reducing chemical usage while improving application effectiveness.

Precision agriculture platforms like FYLLO and CULTYVATE integrate multiple data sources to provide comprehensive farm management solutions. These platforms combine satellite imagery, weather data, soil information, and crop models to generate customized recommendations for each field. Variable rate technology (VRT) in modern tractors from Mahindra, John Deere, and CNH Industrial allows automatic adjustment of seed, fertilizer, and pesticide application rates based on GPS-guided prescription maps.

Robotics and automation represent the frontier of farm mechanization. Companies like Agribot (IOTECH) are developing autonomous solutions for weeding, harvesting, and crop monitoring. AUTOFARM's automation systems control greenhouse environments, managing temperature, humidity, and irrigation without manual intervention. Meanwhile, CARNOT Technologies' telematics solutions enable fleet management and equipment optimization, tracking usage patterns and maintenance needs across farm machinery.

Soil testing has evolved with Krishi Tantra's portable testing solutions that provide rapid on-site analysis, eliminating the delays associated with laboratory testing. This immediate feedback allows farmers to make timely decisions about soil amend-

About the **AUTHOR**

Mr Sunil Khairnar has played a pivotal role in establishing and advising several successful social ventures like Agriwatch, ISAP India Foundation, and Indigram Labs Foundation, which have carved a niche in India's agri-social and business landscape. The institutions founded by him have won 22 recognitions/awards in the past 25 years.

ments and fertilizer applications.

Addressing Diverse Mechanization Needs

Small farmers (under 2 hectares), who constitute about 86% of Indian farmers, cannot justify individual ownership of expensive machinery. For them, the Custom Hiring Center (CHC) model provides access to modern equipment on rental basis. Mobile app-based platforms now connect farmers with nearby CHCs, making booking as simple as calling a taxi. Shared IoT sensor networks and drone services operating on pay-per-use models make precision agriculture tools accessible without large capital investments.

Medium farmers (2-10 hectares) benefit from cooperative ownership models where farmer producer organizations (FPOs) collectively purchase and maintain equipment. These farmers can adopt selective mechanization, investing in multipurpose equipment while accessing specialized machinery through rental services. Digital platforms provide these farmers with basic farm management capabilities, weather advisories, and market linkages at affordable subscription rates.

Large farmers (above 10 hectares) can implement comprehensive mechanization strategies, including owned machinery fleets with GPS guidance systems, dedicated drone operations, and full-scale IoT sensor deployments. These operations justify investments in advanced telematics systems for fleet management and integrated farm management software that coordinates all aspects of production.

The technology providers are increasingly offering tiered service models. Basic versions provide essential features at low costs, while premium versions include advanced analytics and automation capabilities. This approach ensures that farmers at different scales can access appropriate technology levels matching their operational needs and financial capacity.

Education and Awareness Initiatives

Government programs like the Sub-Mission on Agricultural Mechanization (SMAM) conduct regular demonstration programs showcasing new technologies in farmers' fields. These live demonstrations prove more effective than classroom training, allowing farmers to see real-world benefits and operational procedures.

Krishi Vigyan Kendras (KVKs) across the country serve as crucial knowledge dissemination centers, organizing training programs on modern farming equipment operation, maintenance, and safety. They collaborate with technology companies to conduct hands-on workshops where farmers can operate equipment under expert guidance.

Digital literacy initiatives specifically designed for farmers use vernacular language content delivered through mobile apps, YouTube channels, and WhatsApp groups. Companies like FYLLO and FASAL provide extensive video tutorials and vernacular language support, making their platforms accessible to farmers with limited formal education.

Progressive farmer networks, where successful early adopters mentor neighboring farmers, have proven particularly effective. These peer-learning models build trust and demonstrate practical benefits through relatable examples. Agricultural universities and technical institutions run certificate programs for rural youth, creating a pool of trained operators and technicians who can support mechanization in their communities.

The shortage of skilled operators and technicians creates operational challenges. Modern precision agriculture equipment requires technical knowledge that traditional farmers often lack, while training infrastructure hasn't kept pace with technology advancement

Barriers to Large-Scale Adoption

The primary barrier remains the high initial investment required for modern farm machinery. Despite government subsidies, many small and marginal farmers cannot afford even the down payment for equipment loans. Limited rural credit availability and complex loan procedures further restrict access to financing.

Fragmented land holdings make mechanization economically unviable for individual farmers. The average farm size of 1.08 hectares in India constrains the use of large machinery, requiring innovative solutions like small-scale equipment or shared ownership models.

Inadequate rural infrastructure, including poor road connectivity and unreliable electricity supply, limits the deployment of advanced technologies. Many IoT devices and automation systems require consistent power and internet connectivity, which remains unavailable in remote areas.

There is cultural resistance and risk aversion among farmers accustomed to traditional methods slow adoption rates. Without clear demonstration of economic benefits and adequate support systems, farmers remain hesitant to invest in unfamiliar technologies.

Successfully addressing these challenges requires coordinated efforts from government, technology providers, financial institutions, and farming communities to create an enabling ecosystem for agricultural mechanization.

SMALL FARMERS AND THE MECHANIZATION SHIFT

About the **AUTHOR**

Dr Ravindra Kumar Sohane is the Director of Extension Education at Bihar Agricultural University (BAU), Sabour

In recent years, the Government of India and various state agencies have promoted mechanization through Custom Hiring Centres (CHCs), subsidies, and rural entrepreneurship programs to improve access to machinery. These initiatives aim to bridge the technological gap by making advanced tools and machinery available to framers through cooperative models and rental services. Furthermore, integrating mechanization with digital and precision technologies—such as IoT-based monitoring, artificial intelligence (AI), and data-driven decision-making—can accelerate the transition towards smart, sustainable, and inclusive agriculture.

Mechanization in Large Farms

Large farms, generally classified as those with operational holdings of four hectares or more, have historically been the early adopters of agricultural mechanization. Their financial capacity enables investment in high-cost machinery, such as tractors, combine harvesters, power sprayers, precision planters, and balers, which substantially reduce dependence on manual labour (Singh et al., 2022). Mechanization in large farms enhances the timeliness of agricultural operations, leading to optimal use of inputs and improved crop yields. It also supports the adoption of advanced precision agriculture technologies, including GPS-guided equipment, drones for crop monitoring, and automated irrigation systems, thereby increasing both productivity and resource efficiency (FAO, 2021).

Large farms benefit from economies of scale, as the cost of machinery ownership per hectare decreases with an increase in farm size. Mechanization also enables diversification into commercial and export-oriented cropping systems, such as horticulture, oilseeds, and cash crops, contributing to enhanced profitability and competitiveness . However, continuous use of heavy machinery can cause soil compaction, reduce soil aeration, and impair root growth. Excessive dependence on fossil-fuel-based equipment contributes to greenhouse gas emissions and increased carbon footprints. Moreover, large-scale mechanization can lead to rural labour displacement, affecting employment opportunities for landless agricultural workers.

Mechanization in Small Farms

In contrast, small and marginal farmers—who

constitute approximately 85% of India's total agricultural holdings—face distinct challenges in adopting mechanization (Government of India, 2024). The average operational holding of less than two hectares limits the use of large, heavy machinery due to irregular, fragmented, and scattered land parcels. Smallholders often lack the financial resources to invest in expensive machinery and are constrained by limited access to institutional finance, subsidies, and maintenance services.

Despite these challenges, mechanization holds substantial potential for small farms when adapted appropriately. Small-scale mechanization involves the use of compact, multi-functional, and low-cost equipment—such as power tillers, mini tractors, portable threshers, and reapers—that suit the operational needs of small and fragmented holdings. These machines not only reduce labour drudgery but also ensure timely completion of critical agricultural operations, resulting in higher cropping intensity and improved productivity. Unlike large-scale mechanization systems, which are often unsuitable for India's diverse and small plots, small-scale mechanization focuses on improving operational efficiency without displacing labour or imposing heavy financial burdens on farmers. It facilitates timely field operations, enhances precision in input application, reduces drudgery, and contributes to overall productivity gains.

Automation and powered machinery reduce the need for extensive manual labour, addressing labour shortages and making farming more attractive. Precision technologies, including GPS and data analytics, enable more efficient use of water, fertilizers, and pesticides. Advanced tools like drones for crop monitoring and spraying, AI robots for automated tasks, and driverless tractors are transforming the scope of mechanization. Mechanization modernized agriculture by increasing productivity through the timely and precise application of inputs, but adoption levels vary, particularly in India, where Custom Hiring Centers provide access to machinery for small farmers. Modern mechanization integrates technologies like GPS, AI, and drones for precision agriculture and employs autonomous machinery for tasks like sowing and harvesting.

Biggest barriers to large-scale farm mechanization adoption in India.

With an average farm size of 1.16 hectares in India (compared to 14 ha in the EU and 170 ha in the US), mechanization remains economically non-viable for small farmers. Farm machineries are expensive, and small farmers struggle to afford it due to limited financial access. Although 90% of tractors are financed, strict loan criteria and high costs make mechanization difficult. Indian farmers have limited access to advanced machinery, and much of the equipment available is of substandard quality, leading to high operational costs and inefficiency. Hill agriculture (20% of cultivated land) and remote areas have low mechanization due to terrain challenges, lack of suitable equipment, and weak policy support.

Promoting and expanding CHCs allows small and marginal farmers to rent expensive machinery on an as-needed basis, offsetting the high cost of individual ownership. Government and industry efforts should focus on developing and promoting affordable, small-scale, multi-functional machinery suitable for diverse farm sizes and operations. Improving credit access for small farmers and making loan procedures simpler can make mechanization more accessible. Options like reducing interest rates or routing subsidies directly to manufacturers can also help. Increasing farmer education and providing hands-on training for new equipment can boost technical skills and confidence. Campaigns and demonstrations can also raise awareness of mechanization's benefits.

Diverse mechanization for small, medium and large farmers

To address the diverse mechanization needs of small, medium, and large Indian farmers, India's strategy focuses on a tiered, collaborative approach that provides solutions tailored to different farm sizes and economic realities. The primary mechanisms involve promoting CHCs for smallholders, scaling up advanced technologies for larger farms, and investing in research and development for all farmers. This data-driven approach uses GPS, drones, sensors, and the Internet of Things (IoT) to provide real-time information on soil health, moisture levels, and crop health. This helps optimize the use of water and fertilizers, increasing efficiency and reducing costs. Large farms can invest in more powerful equipment like combine harvesters and high-capacity tractors, which dramatically improve speed and efficiency during peak farming seasons. Larger landholdings are better suited for testing and adopting autonomous or driverless machinery, such as tractors and robotic harvesters, to perform tasks with minimal human intervention. Over 86% of India's farms are small and marginal, with landholdings under two hectares. For these farmers, individual ownership of large, costly machinery is not economically viable. The following approaches provide them access to mechanization:

- **Custom Hiring Centres (CHCs):** CHCs allow small farmers to rent expensive, modern machinery and implements, such as tractors, laser land levellers, and harvesters, for a reasonable fee. The Sub-Mission on Agricultural Mechanization (SMAM) provides financial assistance and subsidies to set up these centres, which can be run by entrepreneurs, Farmer Producer Organizations (FPOs), or cooperatives.
- **Gender-friendly tools and Cooperative ownership:** The Indian Council of Agricultural Research (ICAR) and other institutions have developed smaller, affordable, and multi-functional equipment suited for fragmented landholdings. This includes power tillers, manual planters, and solar sprayers. Encouraging farmers to pool their land or cooperatively purchase and share machinery through FPOs or Self-Help Groups (SHGs) helps overcome the «adverse economies of scale» posed by small farm sizes.

POWERING PROGRESS

India's Technological Triumph

The systems-level accomplishment defining India's progress in farm mechanisation and precision agriculture

When we first started backing agri-startups in 2011, "farm mechanisation" was a word you mostly heard around tractors and threshers. Maybe an irrigation pump, if you stretched it. A decade later, digital infrastructure and agritech startups transformed that idea entirely. Mechanisation also became about accessing intelligence, precision, and resilience through technology.

Of course, tractors and drones and irrigation pumps are just as important as they were a decade ago, but with the rise of digital tools, the extent & scope of their impact has increased multifold.

Farm machinery and data-powered systems are now distilled into tools and services that India's smallholder farmers can afford to invest in, to level-up income, efficiency and cut input-related costs considerably.

Some Success Stories

Data-driven decision-making on farms has unlocked higher farm productivity, better-managed climate risks, and reduced input costs – all this, in ways that farmers can sustain, and profit from with relative ease. This acceleration is driven by both public and private efforts; resulting in an

About the **AUTHOR**

Mr Mark Kahn co-founded Omnivore with Mr Jinesh Shah in 2010. Omnivore is a venture capital firm and a pioneer in agritech investing in India

ecosystem where government, investors, policy makers, incubators, universities, corporations, and startups are complementing each other's efforts rather than competing.

We're also seeing a new generation of entrepreneurs - globally exposed, technically fluent, yet deeply grounded in India's rural realities. And without widening the urban-rural divide, their startups are choosing to take on rural inclusion and smallholder farm economics, without having to compromise on making a profit in the process.

Take Niqo's Jaisimha Rao, who walked away from a Wall Street career to shape AI-powered weeding robots in India. Today, Niqo Robotics' GPS-guided weeding tractors help farmers semi-automate field paths with millimetre precision.

Or Fasal's founders, Ananda Verma and Shailendra Tiwari, who turned a failed weekend hydroponics experiment into India's largest IoT-driven farm network. Their SaaS platform now helps smallholders monitor and manage farms with the precision modern agriculture demands.

AgNext's founder, Taranjeet Singh Bhamra, believed that "agriculture should be data-driven" — and built India's first standardised quality-assessment framework to tackle billions in food waste.

The shift from hardware-heavy mechanisation to digitally enabled, service-led models has opened new pathways for efficiency and inclusion. What began as isolated innovations in farm machinery has evolved into a coordinated national effort to reimagine every link of the agri-value chain.

And Celcius, born in the pandemic, when Swarup Bose invested all his savings to build India's first serious attempt at an "Unbroken Cold Chain," unifying more than 4,000 reefer vehicles across 600+ cities.

These are just a few examples from a much larger movement. Across India, a new generation of founders is bringing a piece of emerging technology (like engineering or life sciences) and intersecting it with the needs of agriculture, And each story, whether it's about a robot, a sensor, or a cold-chain network, carries the same intent: to make farming more sustainable and less backbreaking.

It's all playing out in the real world - with support from investors, corporations, universities, and government missions.

New Pathways for Efficiency and Inclusion

The shift from hardware-heavy mechanisation to digitally enabled, service-led models has opened new pathways for efficiency and inclusion. What began as isolated innovations in farm machinery has evolved into a coordinated national effort to reimagine every link of the agri-value chain.

Backbreaking farm labour must soon be history. The transformations shaping India's agricultural future come from entrepreneurs who dared to bet on farmers when others wouldn't — and from teams building systems that combine climate action, productivity, and economic justice.

The finish line will keep moving, but the opportunity to make lasting fixes has never been more available. If these founders and their allies keep at it, their collective work won't just transform Indian agriculture - it can potentially reshape how billion+ lives are fed and sustained.

SATELLITES FOR A CLIMATE-SMART AGRI FUTURE

Agriculture has consistently been a cornerstone of the economy of India, representing the sustenance for families across the country. More than 50 percent of the population earns their living from agriculture, and they have long been part of the neighborhood determining not just the land, but the communities where that land is located. Today, farmers must deal with pressures that would have been unimaginable decades ago, including weather patterns and climate change, limited water sources, small and fragmented landholdings, dealing with new pests and diseases, and the need to feed a growing population. Solutions to these challenges will require ingenuity, data, and attention to practice and place - the experiences of those who farm.

Harnessing Satellites for Smarter Farming

Farmers in India are increasingly being revolutionized by satellite-assisted precision agriculture technology. The India precision agriculture market size reached USD 304.60 Million in 2024. Looking forward, the IMARC Group expects the market to reach USD 700.87 Million by 2033, exhibiting a growth rate (CAGR) of 9.70% during 2025-2033. The rising demand for high crop yields, government support through subsidies, increasing adoption of AI-driven analytics, expanding IoT-based farm management systems, declining sensor costs, and the need for sustainable water and nutrient management are some of the major factors augmenting India precision agriculture market share."

The value proposition is real:

- Optimizing irrigation and fertilizer use
- Detecting crop stress or disease before it spreads
- Reducing losses and improving yields sustainably

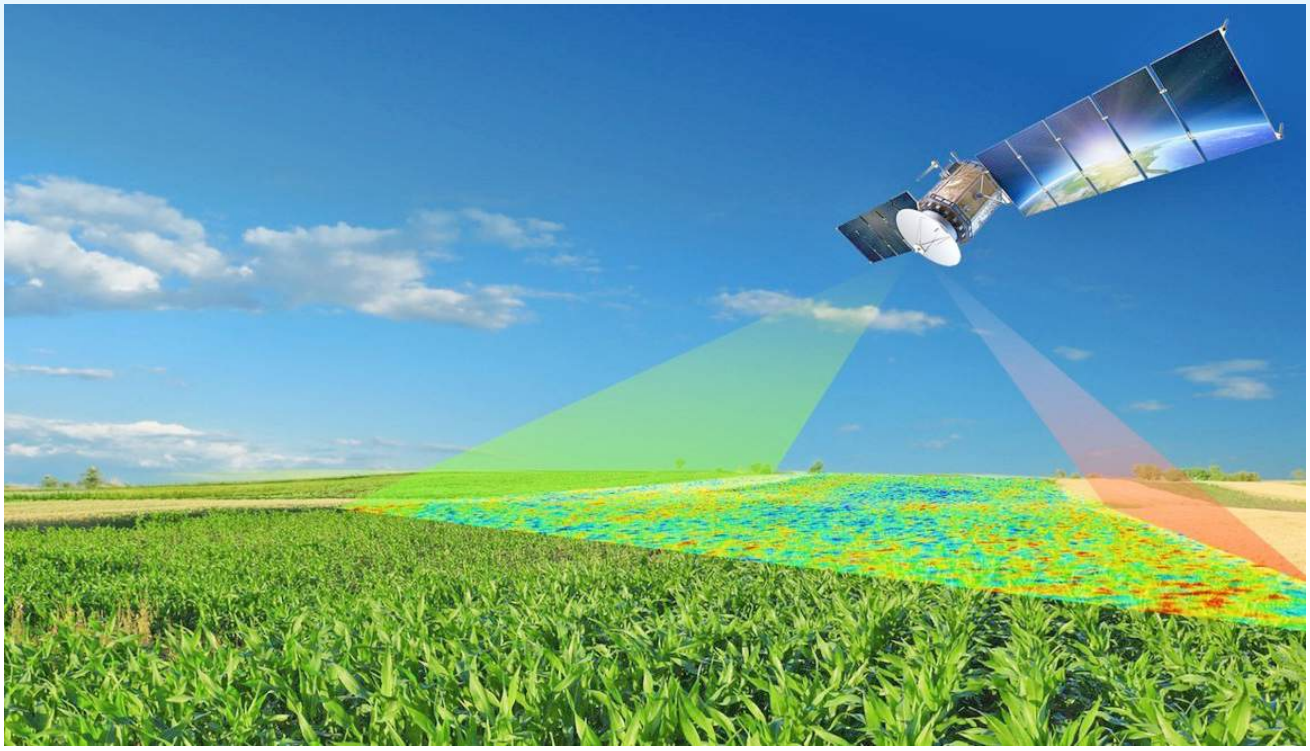
In addition, it is easy to connect these tools to advisory platforms and apps to provide farmers with timely insights based on their type of crop and region. This approach works because technology supports human judgement rather than replaces it. Although satellite data can provide a different perspective for well-timed and accurate reactive action, farmers have experience, intuition and traditional knowledge that continue to be invaluable in decision-making.

Knowledge and Capacity Building

Agriculture's systemic issues cannot be resolved by technology alone. Farmers are supported in blending their traditional knowledge with data-driven insights from satellite analytics. By providing clear, actionable recommendations on soil health, irrigation, and crop management, farmers can adopt smarter practices suited to their land and context.

About the **AUTHOR**

Dr. Sat Kumar Tomer is Co-Founder & CEO, Satyukt Analytics. The company's core innovation lies in scalable algorithms that tap into earth-observation satellite data, offering crucial insights tailored to specific needs



This combination fosters:

- Resilient farming practices adapted to climate variability
- Greater adoption of digital tools among smallholders
- Long-term preparedness for future agricultural challenges

Crop advisory platforms powered by artificial intelligence, remote sensing, and satellite-enabled monitoring of soil health provide farmers with the information they need to make informed decisions and take action. Education helps farmers understand when these innovations are accessible, valuable, and adaptable to their contexts, helping build a farmer's confidence and local systems.

Strengthening the Agricultural Ecosystem

The advantages derived from these technologies reach far beyond the farm level. Data-driven monitoring helps to increase transparency in the supply chain, improves access to credit and insurance, and strengthens community partnerships to provide a consistent supply of healthy food. New approaches like blockchain-enabled traceability are getting India's agriculture products up to domestic and international quality standards.

If technology and traditional methods of farming are successfully integrated, we have an opportunity to develop a climate-resilient, future-ready agri-economy that will support farmers, citizens, and the nation's food security for generations.

In a world where the climate can be a source of uncertainty, these tools allow farmers and institutional stakeholders to anticipate challenges, to strategize, and to appropriately respond, enhancing the resilience of India's agricultural economy. Farmers can access high-end domestic and international markets by guaranteeing transparent and verifiable data.

In addition to increasing buyer confidence, digital traceability creates opportunities for India's agricultural exports and guarantees farmers receive more equitable prices. The intersections of technology, knowledge, and community will allow us to design systems that not only increase productivity but also safeguard livelihoods.

Building a Future-Ready Agri-Economy

The next phase of India's agricultural transformation lies in aligning human expertise, satellite-enabled insights, and education. Together, they enable productivity, sustainability, and resilience at scale.

The decisions taken today are a choice to innovate, invest in farmer capacity, and uplift smallholder farmers will influence crop yields but also the overall well-being of communities, food systems, and even India's farming competitiveness on a global scale.

If technology and traditional methods of farming are successfully integrated, we have an opportunity to develop a climate-resilient, future-ready agri-economy that will support farmers, citizens, and the nation's food security for generations.

DRIVING RURAL GROWTH
MODI GOVT'S GST REFORM FOR FARM EQUIPMENT

The GST 2.0 reforms introduced by the Modi government, slashing the Goods and Services Tax (GST) on tractors and agricultural machinery from 12–18% to just 5%, mark a transformative milestone for India's agricultural sector. This landmark decision echoes the government's steadfast commitment to reinforcing the economic foundation of rural India.

By significantly cutting the cost of vital farm equipment, this reform brings direct relief to over 14 crore farmers—many of them smallholders and marginal cultivators—who depend heavily on mechanization for productivity. Prime Minister Mr Narendra Modi's leadership once again stands out for championing rural progress and advancing the spirit of 'Atmanirbhar Bharat' through affordable access to technology and promotion of domestic manufacturing. The sharp reduction in GST is expected to bring tractor prices down by several thousand rupees, while also encouraging sustainable agricultural practices in the face of growing challenges such as erratic rainfall and soil degradation.

India's 5% GST Rate: A Forward-Thinking Reform for Farmers

On the global stage, India's 5% GST rate on tractors and agricultural machinery reflects a distinctly progressive outlook. In the United States, most states grant full sales tax exemptions—effectively 0%—for agricultural tractors used in authenticated farm

About the **AUTHOR**

Mr Vikram Aditya Ahuja is an agri entrepreneur and an environmental activist based at Fazilka, a border district of Punjab

operations, ensuring unhindered access to advanced equipment. Similarly, Canada extends a zero-rated status under its GST/HST framework, completely exempting farm machinery such as tractors to enhance farm productivity and technological adoption.

In Australia, agricultural machinery attracts a 10% GST; however, farmers can reclaim this amount through input tax credits, effectively reducing their financial burden. Across the European Union, standard VAT rates vary between 17% and 27%, yet several member states, including Germany and France, apply reduced rates of 5–10% on agricultural equipment to encourage sustainable and environmentally friendly farming practices.

China applies a 13% VAT on tractors but offers rebates ranging from 10% to 15% on agricultural machinery to promote rural growth and mechanization. In Brazil, recent tax reforms have established a zero rate for tractors and related implements under the new VAT regime, replacing the earlier ICMS taxes that ranged from 12% to 18%. With its reduced GST rates, India's policy now matches or exceeds these international measures, potentially driving a 20% to 30% increase in tractor sales and supporting national food security objectives.

Farmers need straightforward, farmer-focused transparency measures to ensure that the benefits of the GST reductions actually reach the agricultural fields

Indian agriculture faces significant sustainability challenges, with more than 85% of landholdings less than two hectares in size. This fragmentation contributes to inefficient use of resources, accelerated depletion of groundwater, and increased vulnerability to climate change. In this context, the GST reduction on farm machinery is a highly welcome measure, as it can help improve mechanization and promote more sustainable farming practices.

Reducing the GST rate is expected to encourage the adoption of more fuel-efficient tractors, which will help lower emissions and improve operational efficiency on farms. However, the real effectiveness of this policy depends on guaranteeing that these benefits reach the farmers directly, rather than being lost through non-transparent market

Selling Right, Not Just Selling More

The tractor industry must show real kindness to India's struggling farmers by being fully transparent. Farmers are already fighting to stay afloat with high debts, post harvest losses and rising input costs—they can't afford to waste their money on the wrong tractor variants or unused farm implements because of unclear details and hidden prices. Manufacturers and dealers need to act as true helpers, not just sellers, and make sure every buy fits the farmer's exact needs. If not, their greed could destroy the heart of our farming world.

channels.

Government Action Needed to Correct Flaws in Tractor Sales Processes

Inconsistencies within the tractor sales ecosystem have frequently weakened the impact of such reforms, exposing small farmers to the risk of exploitation. Dealers and manufacturers often fail to display the Maximum Retail Price (MRP), permitting arbitrary pricing that inflates costs beyond the manufacturer's intended rates. Even when prices are listed, they seldom distinguish between pre-GST rates (under the previous system) and the new 5% GST, which conceals the actual savings and allows for concealed price increases.

It is unfortunate that tractors often lack clear and precise information regarding engine power and other key specifications. This level of ambiguity is uncommon in the product lines of two-wheelers and four-wheelers offered by automobile manufacturers. Yet, in the case of tractors, this lack of transparency has become an accepted norm.

Examining the product portfolios of many tractor brands reveals that engine power is often described imprecisely, without reference to standard measures such as SAE horsepower (HP), brake horsepower (BHP), or cubic capacity (cc). The information communicated to the primary buyers—the farmers—is typically limited to a general classification, such as the "50 HP category," lacking the detailed specifications common in other vehicle sectors.

A closer examination of tractor product specifications reveals ongoing vagueness in crucial details. Essential information such as transmission type (manual or automated), steering mechanisms (mechanical or hydraulic), hydraulic lift capacities, and gear ratios is frequently omitted or glossed over. This lack of clarity makes it extremely difficult for buyers to make informed comparisons between models.

Is it conceivable to purchase a two-wheeler or four-wheeler without clear and precise information on such technical specifications?

Tractor Makers Must Support Farmers with Compatible Implements and Attachments

Post-purchase utility is another important consideration. In the case of two-wheelers or four-wheelers, their usefulness begins immediately upon leaving the showroom. However, this is not true for tractors. Tractors are intended to reduce the physical burden of farming and enhance comfort for farmers, but they cannot accomplish this goal on their own.

Tractors primarily serve as the driving force for specific and essential agricultural implements. With this in mind, tractor manufacturers should offer detailed information on compatible attachments and implements, including performance variations for different tractor models. Such information is vital for effective farm operations and often represents the primary motivation behind purchasing a tractor.

Due to the absence of such information, farmers often remain unaware of which implements and attachments are compatible with their tractors, as well

as the appropriate power requirements. This lack of clarity results in mismatched purchases, causing significant losses for farmers. Consequently, many end up with implements and attachments that are either underpowered or unnecessarily excessive for their needs.

The outcome of such mismatched purchases is idle capital, increased fuel expenses, and over-capitalization. This financial strain extends beyond the farmers themselves to affect their families as well. Households already vulnerable to debt face increased stress due to these inefficient investments and underutilization of equipment.

Non-Banking Financial Companies (NBFCs), which play a crucial role in rural financing, frequently fail to address these gaps in information and compatibility. Dealer networks prioritize maximizing loan disbursements, a focus that does not align with the best interests of the primary stakeholders—the farmers. Profit maximization appears to take precedence over ensuring the financial and operational wellbeing of the farming community.

Media advertisements from leading tractor manufacturers often unintentionally worsen this problem. These promotions highlight attractive features but rarely provide detailed specifications, feature breakdowns, or transparent pricing information. As a result, uninformed farmers are frequently drawn into unfavourable purchases. Unless the inconsistencies within the tractor sales ecosystem are addressed, the lack of transparency will persist, preventing farmers from fully realizing the benefits of the recent GST reductions announced by the government.

This lack of transparency from sellers also contributes to poor farm economics, which in turn affects the broader national interest. Smallholder farmers often purchase tractors that are too large for their modest plots, leading to inefficient resource use and undermining efforts toward sustainable agriculture.

Government Should Implement Strong Regulations to Protect

Stronger government mandates for clear price displays, detailed product information, and regulatory audits can empower farmers to make informed decisions, avoid over-investment, and promote sustainable farming

Reform Gains

The Modi government has introduced significant initiatives in the agricultural sector, such as e-NAM and the Kisan Credit Card scheme. Building on this proactive momentum, it is now essential for the government to implement robust measures to protect the advantages gained from the GST reforms. This can be achieved by mandating that dealers clearly display the Maximum Retail Prices (MRPs) for all tractor models and variants, along with detailed specifications including precise engine data (HP, BHP, cc), transmission, steering, hydraulics information, and gear ratios. Additionally, presenting a side-by-side comparison of prices under the previous GST regime (12–18%) and the current 5% rate, broken down by model and variant, will increase farmer awareness of the benefits and instil greater confidence in the reforms.

The government should enforce that tractor manufacturers include mandatory disclosures on features, power-category attachments, and implement compatibility on their advertisements and company websites. Regulatory oversight, potentially managed by the Department of Agriculture, could monitor compliance and impose penalties for violations, thereby protecting farmers from exploitation by dealers. These measures will empower farmers to choose appropriately sized machinery, help prevent excessive indebtedness, and encourage environmentally sustainable farming practices.

The Modi government's decision to reduce GST on tractors to 5% represents a forward-thinking and impactful reform that acknowledges the hard work of farmers and strengthens the foundation of India's agricultural sector. With greater transparency and accountability, this policy shift has the potential to convert good intentions into measurable benefits, protecting small and marginal farmers from unfair market practices. This initiative deserves strong commendation for its proactive stance. Moving forward, continued efforts should focus on enhancing transparency and regulatory oversight to ensure that the benefits reach the intended recipients, thereby fostering a more equitable and sustainable agricultural economy for the future.

This GST reduction aligns India with progressive global practices, where countries like the US and Canada offer low or zero tax rates on agricultural machinery to boost mechanization. However, to fully realize these gains, issues such as inconsistent pricing, lack of clear product specifications, and opaque dealer practices must be addressed. Stronger government mandates for clear price displays, detailed product information, and regulatory audits can empower farmers to make informed decisions, avoid over-investment, and promote sustainable farming. Collectively, these steps will enhance tractor sales, improve farm productivity, and support national food security, while protecting vulnerable smallholders from exploitation.

Therefore, the government's GST cut is not just a tax adjustment but a critical catalyst for overall agricultural development that requires complementary reforms and vigilance to transform India's farm economy into a model of fairness and sustainability.

This article does not support heavy-handed government intervention that could hinder India's free-market economy. Instead, it calls for straightforward, farmer-focused transparency measures to ensure that the benefits of the GST reductions actually reach the agricultural fields. It is noteworthy that Indian farmers purchase twice as many tractors annually as the combined total bought by China, Pakistan, and the USA. It is essential not to undermine this thriving sector, vital to India's farm economy.

MECHANICAL HARVESTING FOR MULTIPLE PICK CROPS NEEDS URGENT ATTENTION

For a long time, we have relied on the availability and affordability of labour in India, with current costs at INR 500-600 per day in most states. However, finding labour within the required time frame has become increasingly difficult, especially during peak harvest periods. This is a critical challenge for labour-intensive, economically important multi-pick crops like cotton, tomato, and chilli.

Shift To Mechanical Harvesting Shall Immensely Help Farmers

This situation is reminiscent of the challenges faced by California's tomato growers and processing industry in the 1950s. During a visit to UC Davis in 1982, I learned from Prof. Charles M. Rick, the father of tomato genetics, about the evolution of the first mechanical harvester. In the 1950s, Dr. Jack Hanna, a tomato breeder at UC Davis, recognized the labour challenges faced by the processing industry. Despite facing initial skepticism, he persisted by collaborating with agricultural engineer Coby Lorenzen, a colleague at UCD, and Blackwelder, a tractor manufacturer, to co-develop a. the square, firm, determinate tomato and b. the first mechanical tomato harvester. In 1959, the first tomato suit-

About the **AUTHOR**

Dr Surinder K Tikoo is currently a director ATPBR Foundation. He has over 56 years' experience as a breeder, teacher, research & development leader in both public and private sector

able for mechanical harvesting and the first harvester was deployed. A colossal moment in the history of the crop.

The breeder, through nearly a decade of work, combined traits of a determinate plant using the sp (self-pruning) gene and j2 (jointless) gene for ease of fruit harvest at the ripe stage, uniform flowering and fruit ripening, and firm fruit that can handle the rough handling of the harvester, resulting in cultivar V 145, the first mechanically harvestable tomato variety. Physiologists standardized an ethrel spray at 25 ppm, to be sprayed when 20% of fruits were mature, and 15 days later, all fruits were ripe and ready to harvest. Coby Lorenzen, working with the tractor team, engineered the harvester to cut the ripe tomato crop at the bottom, uproot the plant, and shake the tomatoes free. The jointless gene helped fruits to easily fall off, and the firmness helped fruits remain intact while falling into the bin. I had the pleasure of actually seeing this operation in the fields in 1982, by which time further progress had been made in both the variety used (UC 82B) and the harvester, which had a laser eye to tip off any green fruits that had not ripened.

Today, varieties have been replaced with hybrids with even more firmness, better viscosity for paste, better color, and several disease resistances. I now feel it is time for us in India to move to mechanical harvesting in these crops immediately and in due course move on to similar harvesters in several other crops, like cabbages, caluflowers, radish, carrot etc like elsewhere in the globe.

Cotton Harvesting Mechanisation

Challenges: Requires multiple manual pickings, making it highly labour-demanding. Labour shortage leads to delayed picking, weathering losses, and fibre discoloration. Rising wage rates (Rs. 500–Rs.700/day) are making manual picking unsustainable.

Advantages: It enables quick, once-over collection of open bolls, reduces field losses and lint contamination, saves up to 30–40% in total cost of harvesting and reduces drudgery and dependence on migrant labour.

Mechanisation encourages an employment shift—labour can move from repetitive manual tasks to more skilled work in grading, processing, and allied industries. It also helps attract younger entrepreneurs to farming

Breeding requirement: Compact plant types and synchronized boll opening. Such genotypes are availble. There is urgent need to register the defolation chemicals that are common in USA and many countries but awaits clearance in India since a decade.

Chilli Harvesting Mechanization

Challenges: Harvesting accounts for nearly 50–60% of the total labour costs. A long harvest window and competition for labour causes delays. Most products today don't have uniform maturity.

Advantages: Enables once-over harvesting at full red maturity, ideal for drying and export. Reduces harvest cost by up to 50% vs manual methods. Minimizes losses due to rain, sunburn, or fungal infection. Ensures uniform quality and better colour retention (ASTA value), easy integration with solar or mechanical dryers for post-harvest processing.

Breeding requirement: Requires an ideotype breeding approach targeting: uniform flowering and ripening, easy fruit detachment using the ds (de-stalk) gene, and determinate plant types amenable to mechanical picking.

Tomato Harvesting Mechanization

Challenges: Harvesting accounts for nearly 50–60% of the total labour costs. Hybrids/varieties suitable for mechanisation and with ideal processing qualities are not available

Advantages: Efficient one time harvests reduce labour costs and eases bulk transport from farm to processor. Processors want tomatoes at Rs. 5 per kg to make it viable for them to invest. This has limited processing less than 2% of our production. During the glut period in March/April, tomato prices crash and hence best time to go for processing.

Breeding requirement: Determinate plants, uniform ripening, high viscoscity, low pH, jointless gene, reistance to viruses and fungal diseases.

In all three crops the right genotypes are availble within the country.

Pathways for Adoption across Crops

Custom Hiring Centres (CHCs) – State support to enable machine rentals for clusters of smallholders.

FPO and Cooperative Models – Shared ownership reduces capital burden.

Demonstrations and Training -Field demos through KVKs, ICAR, SAU's, Pvt Sector

Local Manufacture and Adaptation – Crop and region suited harvesters through Make-in-India incentives. Must also look at mini harvesters for small tractors

Credit and Subsidy Support – This is available under various Govt schemes.

Multiple Benefits

Mechanized harvesting can transform smallholder profitability in India. With policy incentives, shared-use models, and adaptive R&D, India can lead in labour-saving, quality-driven, and climate-smart agriculture.

AGRICULTURE'S NEW ERA

THE SHAKTIMAN LEGACY AND THE NATIONAL IMPERATIVE

The time has come for a new revolution — one that blends mechanization, smart farming, policy reforms, and sustainability. As highlighted by recent insights from government initiatives, a unified, technology-driven, farmer-centric model is essential for future-ready agriculture. Within this transformation, Shaktiman — India's leading agri-machinery, implement manufacturer — emerges not just as a manufacturer but as a strategic enabler of this national shift.

At the core of India's agricultural challenge is the need to modernize farming practices, reduce labor dependency, and improve productivity per hectare. Mechanization and smart farming are no longer optional but essential. However, with India's overall mechanization rate still hovering around 40–45%, regional disparities continue to hold back progress.

With government programs like the Sub-Mission on Agricultural Mechanisation (SMAM) and Pradhan Mantri Kisan Samman Nidhi (PM-KISAN) have laid important foundations, execution at the last mile remains key.

Specialized Mechanization

This is where Shaktiman's Hi-Tech Farm Solutions division becomes a transformative force. Shaktiman's Hi-Tech Farm Solutions, a forward-looking platform within Shaktiman, focuses on driving specialized mechanization in critical crop segments that are typically underserved. It promotes cutting-edge technologies tailored for crops like Sugarcane, Paddy, Fodder (Silage), and Tree Pruning Solutions, Cotton as well as Self-Propelled Boom Sprayers designed for high-efficiency plant protection.

Mr. Hasmukh Gohil, Managing Director and Mr. Ashwin Gohil, Chairman, Tirth Agro Technology Private Limited. "SHAKTIMAN"

By making advanced machines available through FPOs, CHCs, and rental platforms, Shaktiman's Hi-Tech Farm Solutions supports the vision of democratized access to mechanization

Among the standout innovations under this platform is the launch of the Sugarcane Harvester 3737 TejasUltra. This machine has revolutionized sugarcane harvesting not only in India but also in international markets. It represents a historic milestone. Initially, India used to import sugarcane harvesters from Brazil; later, Shaktiman designed and developed the first-ever machine in India, tailored to Indian farming requirements. More notably, Shaktiman spearheaded the export of this harvester to Fiji, laying the foundation for expansion into countries such as Mexico, Brazil, Philippines, Vietnam, Sierra Leone, Guadeloupe, Colombia, Tanzania, Sri Lanka, Nigeria, Mauritius, Réunion Island, and Guatemala. This remarkable journey demonstrates how indigenous engineering excellence, backed by a deep understanding of farmer needs, can create global footprints.

Visionary Leadership

This success is attributed to the visionary leadership of Mr. Ashwin Bhai Gohil (Chairman) and Mr. Hasmukh Bhai Gohil (Managing Director), whose unwavering focus on innovation and farmer-centric thinking has made Shaktiman a household name in rural India.

We have played a pioneering role in introducing mechanized sugarcane harvesting to India and beyond. Shaktiman stands for Indian agricultural progress, offering top-quality equipment, implements, and services. This philosophy resonates with Shaktiman's guiding purpose of "Making Agriculture More Economical®".

End-To-End Mechanization Solutions

This is more than a tagline—it is a long-term mission that's redefining how farming is done. Shaktiman offers end-to-end mechanization solutions: from Seedbed Preparation, Planting & Sowing, Crop Management, Harvesting to Post-Harvest Management. This integrated approach has impacted the lives of over a million farmers in India and globally, empowering them to farm more profitably, efficiently, and sustainably.

In paddy cultivation, the Paddy Master 3785, a high-capacity harvester suited for Indian terrains, offering speed, precision, and reduced grain loss. Combined with mechanized rice transplanters, these technologies help farmers cope with labour shortages and climate uncertainties, ensuring timely sowing and harvesting.

The use of Self-Propelled Boom Sprayer Protektor 600 is another critical innovation in modern farming. These machines ensure uniform chemical application over large areas, helping conserve water and pesticides while significantly reducing operator fatigue. With their high ground clearance and advanced spray control systems, they are perfectly suited for row crops like cotton, maize, Paddy, soybean and many other Multi Crops. Today, when farmers think of efficient spraying, the name that comes to mind is Protektor—a trusted solution from Shaktiman.

About the
AUTHOR

Mr. Vishwa S. Somannavar, Vice President Hi Tech Farm Solutions at Tirth Agro Technology Pvt Ltd "SHAKTIMAN"

In the silage and fodder management space, offers mobile Silage balers that convert green fodder into compact, storable, and transportable feed for dairy animals. With livestock playing a vital role in farm income for over 70 million households, this mechanization creates food security not only for people but also for the animals they depend on.

Mechanized Fruit Harvester cum Tree Pruning

One of the most specialized interventions of Shaktiman's Hi-Tech Farm Solutions is in Tree Pruning Solutions. Recognizing the challenge of managing orchards, vineyards, and plantation crops, Shaktiman offers mechanized pruning tools that improve cutting precision and plant health, reducing the risk of disease while enhancing fruit quality and yield. These machines are built to global standards but adapted for Indian crop systems.

Mechanization in Cotton

India is one of the world's largest producers of cotton, yet a significant portion of its cotton cultivation continues to rely on manual labour, making the process time-consuming, inefficient, and costly. Shaktiman's Hi-Tech Farm Solutions is transforming this scenario through a robust portfolio of cotton-focused mechanization machinery—culminating in the development of India's first indigenous Cotton Picker 1437. This pioneering innovation is designed to enhance productivity, reduce drudgery, and support farmer prosperity by offering a reliable, cost-effective, and locally adapted alternative to manual cotton harvesting.

KrishiUdan, Shaktiman's Flagship Brand Experience

Further amplifying this outreach is KrishiUdan, Shaktiman's flagship brand experience centre, which showcases cutting-edge agricultural technologies to the farming community.More than just a showroom, KrishiUdan serves as a live interface—where farmers, dealers, students, researchers, and policymakers can interact with the full spectrum of mechanization solutions, witness live demos, and engage in hands-on learning. This initiative plays a pivotal role in building awareness, trust, and aspiration among rural audiences, reinforcing Shaktiman's farmer-first approach to technology dissemination.

This emphasis on capacity building is complemented by Shaktiman's broader initiatives, including the L.S. Gohil Learning & Development Academy in Rajkot and regional farmer training camps. Shaktiman's Hi-Tech Farm Solutions exemplifies how industry can lead this change: by understanding crop-specific pain points, offering fit-for-purpose technology, and nurturing the knowledge ecosystem that sustains it.

POWERING INDIA'S AGRI-MECHANIZATION REVOLUTION

Over the past four decades, Beri Udyog Pvt. Ltd. (Fieldking) has emerged as a pioneer in the field of agricultural mechanization, consistently introducing cutting-edge technologies that enhance productivity, reduce drudgery, and improve operational efficiency across diverse agro-climatic regions of India and international markets. The company's continuous commitment to innovation, research, and farmer-centric design has positioned it among the global leaders in agricultural implement manufacturing.

Among Fieldking's most notable technological innovations

Rotary Tillers, Slashers, Cutters, Cultivators, and Harrows engineered with advanced blade geometry and optimized transmission systems. These innovations have significantly improved soil pulverization quality, reduced fuel consumption, and ensured superior field finish while minimizing soil compaction.

About the **AUTHOR**

Mr Ravi Beri is the Managing Director of Beri Udyog Pvt. Ltd. (Fieldking)

High-Speed Disc Harrows designed specifically for residue management in paddy, maize, and wheat-growing regions. These implements enable rapid and effective land preparation by incorporating crop residues into the soil, thereby reducing burning practices and supporting sustainable agriculture.

Super Seeder and Precision Seed Drills featuring adjustable tine designs and integrated residue management mechanisms. These allow simultaneous tillage, seeding, and mulching operations, ensuring optimal seed placement and germination across varying soil conditions.

Track-Type Combine Harvesters, specially designed for wetland and soft soil areas, ensure efficient harvesting without causing soil rutting or compaction. Their advanced traction systems allow operation in challenging terrains, improving harvest timeliness and reducing grain losses.

Tandem Axle Hydraulic Tipping Trailers engineered with precise load distribution, durable chassis construction, and safety mechanisms. These trailers have

revolutionized farm logistics by improving load-carrying efficiency and reducing turnaround time in transport operations.

Straw Management and Mulching Implements that align with India's sustainability objectives. These machines minimize stubble burning, improve soil organic matter, and support integrated crop residue management, contributing to carbon sequestration and long-term soil fertility.

Smart Seeder Machines (Ongoing Development) incorporating precision depth control, adjustable blade configurations, and data-based sensor compatibility. These next-generation implements are designed to interface with digital farming platforms, supporting variable rate application and precision agriculture.

Through these innovations, Fieldking continues to bridge the technological gap between traditional and modern farming, enhancing both the profitability and environmental sustainability of agriculture.

Barriers to Large-Scale Mechanization in India

Small and Fragmented Landholdings: About 85% of Indian farmers operate on small plots that are often non-contiguous, making the use of large implements economically unviable.

High Initial Investment Costs: Even with government subsidies, the capital required for tractors and modern equipment remains a major constraint. Limited credit access and rigid financing options further exacerbate this challenge.

Low Awareness and Technical Skills: This leads to underutilization or misuse of machines, reducing productivity gains.

Regional and Crop Diversity: India's vast agro-climatic variation demands region-specific design customization, which increases manufacturing complexity and cost.

After-Sales and Service Limitations: In many rural areas, access to spare parts, trained mechanics, and service centers is inadequate—leading to operational downtime and maintenance issues.

Socio-cultural Resistance: Traditional mindsets and risk aversion among older farmers often delay the acceptance of new technologies.

Policy and Infrastructure Gaps: Inconsistent mechanization policies, coupled with poor rural infrastructure—such as inadequate roads, irrigation, and power supply—hinder mechanization efforts.

Collaborative efforts are required between manufacturers, government bodies, financial institutions, and research organizations to create sustainable models for inclusive mechanization.

Addressing the Mechanization Needs of Small, Medium, and Large Farmers

India's agricultural structure is characterized by wide disparities in landholding size and economic capability. Recognizing this, Fieldking develops tailored mechanization solutions that cater to the specific requirements of small, medium, and large farmers.

For Small Farmers (below 2 hectares): Compact, low-cost, and easy-to-operate implements such as mini rotary tillers, cultivators, rotary cutters, and lightweight trailers are provided. These implements are compatible with low HP tractors (20–35 HP) and designed for easy handling, minimal maintenance, and reduced operational costs—making mechanization accessible to marginal and smallholders.

For Medium Farmers (2–5 hectares): Implements like rotary slashers, high-speed harrows, straw choppers, and multi-utility trailers cater to farmers seeking an optimal balance between performance and affordability. Designed for 35–50 HP tractors, these machines support effective land preparation, residue management, and transport operations, enhancing productivity without increasing cost burdens.

For Large Farmers (above 5 hectares): Fieldking provides heavy-duty implements such as tandem axle trailers, large rotary tillers, super seeders, and track-type combine harvesters, compatible with tractors above 50 HP. These machines are engineered for high performance and durability, enabling efficient large-scale operations, reduced field time, and enhanced residue and logistics management.

This tiered product strategy ensures that every segment of the farming community—regardless of size—can access appropriate mechanization solutions suited to their land, crop type, and financial capacity.

Efforts to Educate and Empower Farmers

Technological progress in agriculture can only be successful when farmers are well-informed and confident in adopting new technologies. Fieldking strongly emphasizes education, awareness, and skill development among India's farming communities.

Key initiatives include:

Field Demonstrations and Krishi Melas: Regular live demonstrations are organized across key agricultural states such as Punjab, Haryana, Uttar Pradesh, Madhya Pradesh, and Gujarat, where farmers can witness implement performance in real conditions. This hands-on exposure builds trust and understanding of machinery benefits.

Mobile Service and Demo Vans: Dedicated service vans equipped with demo units reach remote rural areas, allowing farmers to experience first-hand the operational simplicity, fuel efficiency, and productivity improvements of mechanized equipment.

Educational Content and Digital Outreach: Fieldking provides easy-to-understand user manuals, instructional videos in regional languages, and interactive WhatsApp advisory groups, empowering farmers with knowledge on implement operation, maintenance, and best practices.

Support for Agri-Next Generation: The company actively engages with agricultural universities and young farmers through internship programs, technical projects, and exposure visits. This helps nurture a new generation of tech-savvy farmers ready to lead India's mechanization revolution.

DRIVING SMALL FARM REVOLUTION

Over the past few years, Captain Tractors Limited has emerged as one of the pioneers in compact and mini-tractor technology in India. Recognizing that Indian farming is highly diverse, with many small and fragmented landholdings, the company has consistently focused on designing tractors and implements that maximize productivity while minimizing costs.

One of the company's most notable innovations has been the development of its compact tractor series ranging from 12 HP to 28 HP, both in 2WD and 4WD variants. These machines are engineered to deliver high fuel efficiency with low RPM drop, ensuring smooth performance even under challenging field conditions. In fact, Captain Tractors has created multiple generations of mini-tractors, each iteration improving on durability, mileage, and operator comfort.

Equally significant is Captain's emphasis on building an integrated ecosystem of farm implements compatible with its tractors. From zero-tillage seed drills, rotavators, and reapers to specialized potato planters, loaders, sprayers, and trailers, the company has developed attachments that allow one machine to perform multiple roles on the farm. This modular approach helps farmers reduce dependency on manual labor, optimize time during peak agricultural seasons, and derive greater return on investment.

By combining compact design with multi-functionality, Captain Tractors has provided small and medium farmers with a technologically advanced yet affordable alternative to conventional, high-powered tractors that are often unsuitable for small plots

Addressing Diverse Mechanization Needs

India's agricultural landscape is extremely heterogeneous. Farmers differ not only in landholding size but also in the crops they grow, the soil conditions they operate in, and their access to capital. Captain Tractors has addressed this diversity through a segmented product and service strategy.

Small farmers: For farmers with fragmented and smaller holdings, Captain's 12–20 HP mini-tractors are compact, cost-efficient, and easy to maneuver. These machines are specifically designed for narrow fields and orchards where larger tractors cannot operate effectively. Lightweight implements such as small rotavators, mini seed drills, and compact trailers allow these farmers to

About the **AUTHOR**

Mr Rajiv Wahi is CEO - International Business, Captain Agri Machinery Exim LLP - India (Export Arm Of Captain Tractors Pvt. Ltd)

mechanize operations like ploughing, sowing, spraying, and harvesting without heavy financial burden.

Medium farmers: For those with slightly larger landholdings, Captain offers mid-range tractors and a wider range of implements including disc harrows, cultivators, fertilizer broadcasters, and reaper attachments. These enable farmers to mechanize multiple stages of the crop cycle across different seasons. The ability to switch between implements ensures that farmers can maximize utilization of their machines and achieve better productivity across diverse crops.

Large farmers and contractors: For larger farms and commercial operators, Captain's higher-end 22–28 HP 4WD compact tractors provide greater power, durability, and the capacity to handle heavier implements. These tractors, when coupled with loaders, sprayers, or large trailers, allow continuous operations over extended periods. Large farmers and custom hiring contractors particularly benefit from the higher work rate and robustness of these models.

Through this tiered approach, Captain ensures that farmers of every scale find an option suited to their needs, thus democratizing access to mechanization.

Efforts To Educate Farmers About Technological Innovations

Innovation alone does not guarantee adoption; education and awareness are equally important. Captain Tractors has recognized that small and medium farmers often hesitate to adopt mechanization due to lack of exposure, limited technical knowledge, and fear of high costs. To bridge this gap, the company has invested heavily in farmer outreach and training.

The company leverages multimedia tools so that farmers can visualize how a compact tractor can perform multiple tasks in their own cropping conditions.

Captain has built an extensive dealer network across the country, which serves not only as sales points but also as education centers for farmers.

Captain participates in agricultural fairs, exhibitions, and training events where farmers can see live demonstrations of various implements in action.

The company emphasizes after-sales support, ensuring that operators are trained in basic maintenance and operation. Captain has created an ecosystem that educates and empowers farmers to embrace technological innovation.

Barriers to Farm Mechanisation

Despite advancements in technology and the availability of farmer-friendly equipment, large-scale adoption of mechanization in India continues to face systemic barriers.

The foremost challenge is land fragmentation. A significant proportion of Indian farmers own less than two hectares of land, often divided into multiple plots. Such holdings make it difficult for farmers to justify investing in large machinery, as the return on investment remains limited.

Access to affordable finance is another major barrier. Many small and marginal farmers lack formal credit history or collateral, which prevents them from availing loans to purchase even compact tractors. Subsidy schemes exist, but they are not always evenly implemented across states and can be slow or bureaucratic.

Another hurdle is the short seasonal window of machinery use. For example, a tractor may be used heavily during sowing and harvesting but remains idle during the rest of the year. Without access to custom hiring centers or rental models, farmers find it difficult to bear the high upfront cost for equipment that is not utilized year-round.

Skill and awareness gaps also persist. Many farmers are not trained to operate or maintain machinery, leading to underutilization or breakdowns. This lack of technical knowledge creates reluctance to adopt mechanization, especially among older generations.

Finally, infrastructure and policy bottlenecks slow down adoption. Spare parts availability, service centers, and reliable maintenance support are still patchy in rural areas. Policy inconsistencies and delayed subsidies further erode farmer trust.

Together, these barriers highlight that while mechanization has the potential to revolutionize Indian agriculture, achieving widespread adoption will require coordinated efforts in credit facilitation, training, custom hiring models, and stronger infrastructure support.

Illicit Crop Protection Chemicals

A MENACE FOR INDIAN AGRICULTURE

Crop protection chemicals have played an important role during the green revolution in making India sustainable in feeding its burgeoning population with the aim of becoming the food bowl of the world. Indian crop protection chemical industry is a highly regulated industry with the governing law being Insecticides Act, 1968 and Insecticides Rules, 1971 along with various other associated laws and statutes regulating the industry.

Crop protection chemicals being inherently toxic in nature are mandatorily registered under Section 9 of the Act with Central Insecticides Board & Registration Committee after assuring itself of the safety and efficacy of the product proposed to be registered either for manufacture or import.

A product is deemed to be "Misbranded" as per the Act in either of the following conditions.

if its label contains any statement, design or graphic representation relating thereto which is false or misleading in any material particular, or if its package is otherwise deceptive in respect of its contents; or

if it is an imitation of, or is sold under the name of, another insecticide; or

if its label does not contain a warning or caution which may be necessary and sufficient, if complied with, to prevent risk to human beings or animals; or

if any word, statement or other information required by or under this Act to appear on the label is not displayed thereon in such conspicuous manner as the other words, statements, designs or graphic matter have been displayed on the label and in such terms as to render it likely to be read and understood by any ordinary individual under customary conditions of purchase and use; or

if it is not packed or labelled as required by or under this Act; or

if it is not registered in the manner required by or under this Act; or

if the label contains any reference to registration other than the registration number; or

if the insecticide has a toxicity which is higher than the level prescribed or is mixed or packed with any substance so as to alter its nature or quality or contains any substance which is not included in the registration.

Various penalties and punishments have been prescribed in the Act to deal with the problem of misbranded products.

However, despite of the legal provisions as mandated

About the **AUTHOR**

Mr Rajat Srivastava is General Manager – Regulatory Affairs & IPR, General Crop Science Pvt Ltd

within the Act, Indian agriculture is frequently facing the problems of illicit crop protection chemicals, which can be either spurious, counterfeit, fake or misbranded though spurious, counterfeit and fake have not been explicitly defined in the Act.

Efforts To Minimise Sale Of Illicit Crop Protection Products

It is estimated that Indian agriculture is suffering losses to the tune of approximately 40% due to use of illicit crop protection products which not only results in crop losses endangering the food security of the country but also endanger the safety of humans, animals, flora and fauna and the various abiotic factors. This not only leads to loss of image and trust for the genuine manufacturers but also economic losses for them, farmers and the country.

Government of India has been trying to deal with this problem and have made it mandatory to print Quick Response (QR) codes on the label of the products to identify the genuineness of the product. The QR Code is designed to mandatory contain the following information:

Unique identifier or global trade item number (GTIN);

Batch number;

Date of manufacturing;

Date of expiry; and

Web link or uniform resource locator of the company

The industry has gone beyond the provisions of laws and have implemented the concept of track and traceability up to the level of end users to ensure that product remains genuine and even the packaging remains untampered till its usage.

Consolidated efforts of the industry and the government are required to tackle this problem more effectively

The crop protection industry is also using various other provisions like registering the design of their packaging material, using tamper-proof packaging and using various other technologies available to deal with the problem of illicit crop protection chemicals.

Even though considerable efforts have been made to deal with this problem, still the fly-by-night operators or illegal manufacturers are playing with the mindset of the farmers and targeting them by offering them products at low prices as compared to standard products and thus enticing them with low agri-input costs with the promise of improved results, which on the contrary is playing havoc with them. Therefore, there is an urgent need to deal with these practices by dealing with the current provisions of the Insecticides Act & Rules together with the provisions of the various other legal provisions under the laws of the country till more stringent laws as promised by the current Hon'ble Union Agriculture & Farmers Welfare Minister are enacted by the Parliament of India.

Farmer Education

The industry on their part is playing their part to educate the farmers to deal with the problem of illicit products through various activities and training programmes under their stewardship activities. Department of Agriculture, Krishi Vigyan Kendras and Agriculture Universities in various states are also providing the required awareness to the farmers in this regard. However, more consolidated efforts are required wherein the industry and the government join hands with together with the support of the local law enforcement agencies in Public-Private Partnership mode to tackle this problem more effectively.

ONE NATION, ONE SUGAR CODE A WIN FOR UNIFORMITY, A WORRY FOR TRADITION

Towards an all-encompassing regulation in the sugar sector, the new Sugar (Control) Order 2025, marks a landmark shift in the governance of the sector

The new Sugar (Control) Order 2025 that came into force in May streamlines the regulatory framework with the supersession of the Sugar (Control) Order, 1966 and the Sugar Price (Control) Order, 2018 into a single unified regulation for the sugar sector. This revision not only reduces regulatory overlap but also paves the way for greater efficiency and coherence in sugar industry operations, in line with current industry dynamics and technological advancements.

This revision stands to be transformative due to its focus on uniformity, standardization, and digitization. Drawing on definitions from the Food Safety and Standards Authority of India (FSSAI), the Order harmonizes terminology for various sugar products, including Plantation White Sugar, Refined Sugar, Khandsari Sugar, and Gur (Jaggery), ensuring uniformity in definition of various products thus enhancing clarity for stakeholders. A particularly notable addition is the inclusion of *raw sugar* under the ambit of regulatory control for the first time. This strategic move aligns India's framework with global standards while putting an end to the practice of marketing raw sugar under labels such as "Khandsari" or "Organic". By curbing such misrepresentation, the new Order safeguards both consumers and legitimate producers, reinforcing transparency and trust in the Indian sugar sector.

Khandsari production has long been a bastion of artisanal, open pan processing, a traditional approach that is labour intensive, providing a vital source of employment for both skilled and unskilled workers. The broad difference between Khandsari sugar and mill sugar is the refinement process, as these Khandsaris use traditional methods with minimal chemical intervention, offering a more natural alternative as against the highly refined, vacuum-processed sugar manufactured by the large-scale sugar mills. Unlike mill sugar, which undergoes multiple stages of complex processing for higher purity and shelf life, Khandsari sugar retains the essential vitamins and fibre which is otherwise lost in the excessive processing. Thus, these Khandsari units continue to provide consumers with a less processed and low glycemic index option in the market.

Vital Provisions

Another critical point of this new 2025 Order is the provision that brings large-scale Khandsari producers, having a crushing capacity above 500 TCD *(Tonnes of Cane per Day)*, under the same regulatory ambit as large sugar mills, which were earlier outside the regulatory purview of the subsumed Orders. As per the latest data, India hosts 373 khandsari units with an aggregate capacity of roughly 95,000 TCD; of these, 66 units (together accounting for about 55,200 TCD) will now fall within the Order's reach. To smoothen the transition before the next crushing season, these eligible units are being fast tracked for registration on the National Single Window portal.

This move that places traditional Khandsari units at par with large-scale sugar mills, mandates these relatively

About the **AUTHORS**

Mr. Siddharth Nema and Ms. Alfiya Ansari are economists with India Exim Bank

smaller units to procure sugarcane at the Fair and Remunerative Price (FRP), set on the recommendations of the Commission for Agricultural Costs and Prices (CACP), an important provision that rightly protects farmers' interests and guarantees them a just return for their produce. However, this policy shift poses significant challenge for Khandsari producers. Unlike modern sugar mills, Khandsari units rely on open-pan processing, which yields lower sugar recovery from the same quantity of cane juice. Additionally, their by-product stream is less versatile, with a large portion converted into jaggery—a product with lower sucrose content and limited market absorption, lacking the price support necessary to cover rising production costs. As a result, while the cost of their primary input—sugarcane—has increased, the revenue from the main output, sugar which commands higher prices in the market, remains comparatively low due to its limited volume. This imbalance squeezes profit margins and threatens the long-term viability of Khandsari operations.

Further, the already existing regulations reserve the more efficient vacuum pan technology for large sugar factories, and only one such factory is permitted within a restricted radius *(15/25 km, depending on respective state regulation)*. This limits the scope of the establishment of new sugar factories in the area and upscaling of these Khandsaris to sugar mills with modern technology. If Khandsari units which utilises 45-50% of the total sugar cane and plays a vital role in India's MSME sector, continue to face viability challenges, this could not only disrupt sugar supply chains but also jeopardize livelihoods across the hinterlands, raising concerns about the long-term sustainability of sugar industry.

A more balanced approach is essential—one that safeguards farmers' rights while also ensuring the viability of these smaller, labour-intensive units that contribute to the agility and inclusivity of sugar sector ecosystem

Greater Transparency And Quality Assurance

Since, the underlying cost structures and economies of scale between large sugar mills and Khandsari units differ significantly, applying the same pricing framework across both, without accounting for their operational disparities, places Khandsari units at a disadvantage. Despite their operational constraints, Khandsari units often function as vital intermediaries—ensuring prompt payments and offering farmers in their vicinity a faster and more accessible option for sugarcane unloading, which is a perishable produce, particularly in areas where distance regulations limit the presence of large sugar mills.

By extending formal oversight to the larger Khandsari units, the new Order promises greater transparency and quality assurance. The challenge, however, is to ensure that compliance does not worsen the economics of a segment already squeezed by technological limits and narrow product markets. If policymakers can pair regulation with targeted support, be it in technology access, byproduct valorisation, branding, packaging or market development, Khandsari's rich heritage can thrive alongside the broader push for modernization.

TRANSFORMING INDIAN AGRICULTURE THROUGH DRONE MECHANIZATION

Marut Drones, India's leading AgriTech innovator, has been at the forefront of introducing disruptive mechanization technologies designed for Indian agriculture. Our flagship product AG 365 is India's first multi-utility DGCA-certified agriculture drone, scientifically tested by leading agricultural universities. This drone is not just a spraying tool—it is built for multi-utility operations including fertilizer spreading, granular broadcasting, seeding, and even aquaculture feeding.

Key Technological Innovations

Precision Agriculture via AI & Radars: AG 365 is equipped with integrated terrain and obstacle radars, ensuring accurate and safe spraying even in undulating fields.

Multi-utility Hexacopter Design: A powerful multicopter with 6 rotors that supports both manual, semi-autonomous, and autonomous spraying modes.

High Endurance & Coverage: Sprays 25–30 acres per day, completing one acre in just 7 minutes, saving both time and water.

Night Operations Support: Farmers can extend operations beyond daylight hours, a crucial advantage during peak agricultural seasons.

Transport-friendly: The drone can be easily carried on two or three-wheelers, making it accessible for village-level entrepreneurs.

Marut Drones is also pioneering India's Drone-as-a-Service (DAAS) model, empowering rural entrepreneurs to purchase drones and offer services to other farmers, democratizing access to advanced mechanization.

Addressing the diverse mechanization needs of small, medium, and large farmers

India's farmers are not a homogeneous group—they range from smallholders with less than 2 hectares to large farming cooperatives managing hundreds of acres. Marut Drones has designed its solutions to cater to all these categories:

Small Farmers: For those with limited landholding, direct ownership of a drone may not be viable. Through the DAAS model and subsidy support (up to 50%–70%), small farmers can avail drone spraying services at affordable rates. This reduces their dependency on manual labor and avoids crop damage caused by stepping into fields.

Medium Farmers: With landholdings

About the **AUTHOR**

Mr Prem Kumar Vislawath is the Founder & CEO of Marut Drones, one of India's pioneering and leading drone technology companies. His efforts have been recognized nationally, with Marut becoming a trusted partner for government projects, FPOs, and farmers across India

of 40–50 acres or more, drone ownership becomes essential. Manual spraying not only increases labor costs but also delays operations, leading to reduced productivity. Marut Drones' AG 365 ensures timely spraying, higher efficiency, and improved yields, making it a cost-effective investment.

Large Farmers, FPOs, and Cooperatives: For groups managing 100+ acres, drones are a game-changer. They allow quick coverage, reduce pesticide wastage, and enable precise input application, significantly lowering operational costs. Additionally, Marut provides specialized training for FPO members, helping them adopt technology faster.

By offering different tank capacities, DGCA-certified quality, and multi-utility functions, Marut ensures that one solution can address the spectrum of Indian farmers' mechanization needs.

Educating farmers about benefits and usage of technological innovations

At Marut, we understand that technology alone is not enough—farmers need awareness, training, and confidence to adopt it. That's why farmer education and capacity building are at the heart of our operations.

Some Key Initiatives

Marut Drone Academy (MDA): India's leading DGCA-authorized training academy, where over 1,500 certified drone pilots have already been trained, contributing to India's skilled AgriTech workforce. The academy also offers Repair & Maintenance courses, ensuring long-term serviceability in rural regions.

Farmer Awareness Campaigns: We organize large-scale awareness drives, demonstrations, and Drone Yatras across states like Telangana, Andhra Pradesh, Karnataka, Tamil Nadu, Odisha, and Maharashtra. These demonstrations not only showcase the efficiency of drones but also address farmers' doubts on cost, loan processes, and after-sales service.

Influencer & Local Language Content: Recognizing India's linguistic diversity, Marut develops content in Telugu, Kannada, Tamil, Marathi, Odia, and Hindi, delivered through regional influencers and farmer networks to build trust.

Partnerships with Governments and FPOs: We actively collaborate with state governments, Krishi Vigyan Kendras (KVKs), and FPOs to conduct workshops and highlight subsidies, financing, and earning potential through drones.

Through these initiatives, Marut is not only educating farmers but also creating a new ecosystem of entrepreneurship and employment in rural India.

ADDRESSING THE BARRIERS TO TECH ADOPTION

* Easy loan and subsidy facilitation with tie-ups from SBI and other banks under AIF.
* Strong after-sales service network PAN India, ensuring farmers feel secure in their investment.
* Focus on quality: DGCA certification, field-testing by universities, and robust R&D ensures long-term trust.
* Building entrepreneurs: By enabling rural youth to become drone service providers, Marut bridges the gap between technology and accessibility.

Time is ripe for policymakers, industry players, farmers, and civil society to unite in driving meaningful reforms and building a robust, transparent, and trustworthy agri-input ecosystem

Biggest barriers to large-scale farm mechanization adoption in India

Despite clear benefits, the adoption of mechanization, especially advanced technologies like drones, faces several challenges in India:

Financing Gaps: Many farmers, especially smallholders, lack the upfront capital to buy drones. Although subsidies and AIF (Agriculture Infrastructure Fund) loans are available, awareness remains low, and the financing process is often slow.

Proliferation of Non-TC Drones: Cheap, uncertified drones flood the market, luring farmers with low prices but offering poor durability, no warranty, and no subsidy eligibility. This creates distrust and hampers adoption of quality-certified drones.

Awareness & Training Deficit: A large section of farmers still lacks awareness about how drones can save input costs, reduce crop damage, and increase profitability. Without training and handholding, adoption remains limited.

Fragmented Landholdings: With a majority of Indian farmers holding less than 2 hectares, individual drone ownership is not always feasible. This requires scalable service-based models (DAAS) to make drones accessible.

Cultural Resistance to Change: Traditional farming practices are deeply ingrained. Convincing farmers to move from manual spraying to advanced drone spraying requires consistent demonstration, trust-building, and policy push.

THE FUTURE OF FARMING

AUTOMATION IS REVOLUTIONIZING AGRICULTURE

Automation is reshaping agriculture by enabling farmers to optimize yields, lower labor costs, and adopt sustainable practices. With the global population expected to reach 9.7 billion by 2050, the pressure to produce more food with minimal environmental impact is immense. Technologies such as artificial intelligence (AI), robotics, and precision agriculture are equipping farmers to meet these critical challenges.

Benefits of Automation in Farming

Increased Efficiency: Automa-

About the **AUTHOR**

Mr Rashmi Kumar Abroal, the founder and owner of Rashmigreenland Organic Food Products, has supplied a range of exotic vegetables to many European countries and to major Indian stores for over 50 years, and has won many prestigious awards.

tion allows farmers to manage larger tracts of land, reducing labor costs and improving crop yields.

Precision Agriculture: Tools like drones, GPS, and sensors gather detailed data about soil, crops, and weather, enabling targeted and reduced resource use.

Improved Sustainability: Automation supports eco-friendly practices by minimizing water and chemical inputs and preventing soil erosion.

Better Decision-Making: Data analytics and AI supply farmers with insights for smarter planting, harvesting, and management strategies

Types of Automation in Agriculture

Autonomous Tractors: Self-driving tractors handle plowing, planting, and harvesting with little human intervention.

Drones: Unmanned aerial vehicles monitor crop health, soil moisture, and weather conditions.

Precision Irrigation: Systems that tailor water use precisely to soil and crop needs.

Robotic Harvesting: Machines that pick and sort crops efficiently and accurately.

The Evolving Future: What's Next for Automation?

As automation technologies advance, several innovative solutions are emerging:

Artificial Intelligence: Systems that analyze real-time data, optimize yields, and cut waste at every stage.

Advanced Robotics: Robots performing complex tasks, like pruning and grafting, with unprecedented precision.

Technology Integration: Merging automation with the Internet of Things (IoT) and blockchain to create transparent, efficient supply chains.

Challenges and Opportunities

Despite its transformative potential, automation faces notable challenges:

Cost Barriers: High initial investment can be a hurdle, especially for small-scale farmers.

Regulatory Needs: New frameworks are necessary to ensure safe, effective adoption of advanced technologies.

AI-powered precision agriculture is boosting crop yields, optimizing resource use, and building resilience for the farms of tomorrow

Skills and Training: Both farmers and workers require ongoing training to adapt to evolving systems.

Mechanization and Smallholder Farmers

Farm mechanization dramatically improves productivity, efficiency, and income for all farmers, including smallholders. By reducing manual drudgery and enhancing the timeliness of farming operations, mechanization raises yields, lowers costs, and supports better livelihoods.

Key Benefits

Increased Efficiency: Mechanization streamlines tasks, boosting productivity and lowering labor demands.

Higher Productivity: Modern equipment improves both yield and produce quality.

Economic Gains: Reduced costs and improved productivity translate into higher farmer incomes.

Less Physical Strain: Mechanization shifts the focus from manual labor to strategic farm management.

Precision Farming: Machines allow targeted interventions and minimize resource waste.

Impact on Smallholders' Access to Technology: Small farmers can use modern machinery to bolster productivity and competitiveness.

Income Growth: Lower costs and greater productivity drive higher earnings.

Food Security: Enhanced yields mean more stable, secure food supplies.

Challenges and Limitations of Mechanization

Upfront Costs: Equipment investments can be out of reach for many smallholders.

Credit Access: Limited credit restricts the adoption of new technologies.

Technical Know-How: Training is essential to use and maintain new machinery effectively.

Environmental Risks: Without proper management, mechanization can be one of the causes of environmental degradation.

Automation and mechanization are ushering in a new era for agriculture, enabling greater productivity, sustainability, and prosperity for farmers. However, it is crucial to address cost, knowledge, and environmental barriers to ensure these technological advancements benefit all, particularly smallholder farmers.

FARM MECHANIZATION

The Path for Agricultural Progress

Mechanization today stands as one of the most powerful drivers of progress in global agriculture, addressing food security, enhancing productivity, and reshaping rural livelihoods.

Tractors, combine harvesters, seed planters, drones, and irrigation systems have become essential assets, enabling efficient, large-scale, and sustainable farming operations.In India, where nearly half the population depends on agriculture, mechanization has especially widened its footprint. While the overall level of mechanization is about 47%, it varies widely—exceeding 70% in states like Punjab and Haryana but remaining low in northeastern regions due to terrain and farm size constraints.

The increasing presence of farm machinery has raised yields, strengthened food systems, and generated employment in manufacturing and repair sectors.

From Animal Power to Automation

The traditional image of oxen plowing fields has gradually faded, replaced by engines and power weeders. While this shift has freed farmers from arduous labour and increased efficiency,

About the **AUTHOR**

Mr Narender Mehra is a highly accomplished farmer of Uttarakhand. He has developed a wheat variety named Narendra 09 which is adaptive to climate change. He is the first farmer to cultivate black rice in Uttarakhand. Mr Mehra has worked on the conservation and promotion of traditional indigenous seeds. He has successfully grown sugarcane, usually grown in hot plains, in the mountainous district of Pithoragarh. Mr Mehra set the world record by growing 25 kilograms of turmeric from a single plant. He has been fully dedicated to organic/natural farming for the last 10 years, currently leading the mission of inspiring thousands of farmers to adopt natural farming

it has also altered rural biodiversity and farming ecology. Soil organisms such as earthworms—vital to soil fertility—have been disturbed due to intensive tractor use. As a result, balancing mechanization with ecological sustainability has become a policy priority. The government's National Mission on Natural Farming seeks to integrate agroecological principles, encouraging reduced chemical and energy use.

Mechanization and natural farming often remain at odds—one emphasizing industrial precision, the other ecological harmony. The challenge for policymakers is to align technology with sustainability goals.

Technological Transformation of Agriculture Mechanization

Drones, AI-driven tractors, and sensor-based irrigation systems now collect and interpret large volumes of data to improve farm performance. A modern farmer can monitor soil conditions, apply precise fertilizer doses, and even guide autonomous harvesters from a smartphone. AI and Internet of Things (IoT) integration has expanded possibilities further. Automated systems linked to weather data help farmers reduce risks from droughts or floods. Smart machinery can identify nutrient deficiencies or pest infestations in real time, optimizing interventions with minimal waste. According to the Food and Agriculture Organization (FAO), this digital transformation can increase land productivity by 20–30% while reducing labor drudgery and energy use.

Benefits of Farm Mechanization

Higher Productivity – Mechanization boosts output by ensuring operations like seeding, weeding, and harvesting are timely and precise. It enables multiple cropping cycles per year and reduces post-harvest losses.

Labour and Time Efficiency – Machines fill gaps caused by labor shortages, especially during peak seasons. Rapid mechanized operations save time and minimize delays that affect yields.

Improved Income and Quality – Mechanization enhances product quality, making produce more market-ready and profitable. Mechanized threshing and grading, for instance, ensure uniformity and reduce waste.

Governments, technology startups, and farmer organizations must work together to ensure that innovation is both inclusive and sustainable

Socio-economic Upliftment – Mechanization generates employment in machine assembly, service, and repair industries, promoting local entrepreneurship and skill development.

Varieties of Mechanization

Man-Operated Equipment: Tractors, tillers, and planters used for plowing, sowing, and harvesting form the backbone of mechanization.

Automated Machinery: GPS-guided equipment, drones, and AI-powered systems represent the new frontier of smart agriculture, optimizing every stage of production—from irrigation to pest control.

Sustainability and Inclusivity

Modern mechanization must go hand in hand with sustainability. Heavy machinery, if misused, can cause soil compaction, reduce fertility, and increase carbon emissions. Sustainable alternatives—such as solar-powered irrigation pumps, electric tractors, and conservation tillage—are gaining traction. Inclusivity is equally vital. For small and marginal farmers owning less than two hectares of land, costs remain prohibitive.

The government's Sub-Mission on Agricultural Mechanization and custom hiring centers (CHCs) are addressing this gap by providing machines on a rental basis, ensuring that technology serves all strata of agriculture. Encouraging local manufacturing under the "Make in India" initiative has also helped reduce equipment prices and build rural employment opportunities.

Key Challenges in Mechanization

Despite remarkable progress, several barriers persist, including the following.

High Initial Costs: The purchase and maintenance of advanced machines remain expensive.

Access to Finance: Limited credit availability restricts ownership and adoption among resource-poor farmers.

Technical Skills: Lack of training in the operation, calibration, and maintenance of machines leads to underutilization or breakdowns.

Fragmented Land Holdings: India's small farm sizes make large machinery impractical, necessitating customized small-farm solutions.

The Future Path

The future of Indian agriculture lies in bridging technology with tradition. Mechanization is poised to evolve from power-driven tools to AI-equipped smart systems. Collaborative models such as farmer cooperatives, public–private partnerships, and start-up-led service networks are expected to democratize access to technology. Furthermore, digitally connected machinery and blockchain-backed supply chains will make farm operations more transparent and traceable.

Governments, technology startups, and farmer organizations must work together to ensure that innovation is both inclusive and sustainable. Investment in rural skill training centers, innovation hubs, and low-cost design adaptations will be essential to scale mechanization equitably. If guided by thoughtful policies and ecological awareness, farm mechanization will not merely modernize agriculture—it will redefine it as knowledge-driven, sustainable, and globally competitive.

From Field to Factory

A GLOBAL SOUTH VISION FOR INCLUSIVE MECHANIZATION

"A man with a hoe cannot compete with a man with a harvester."

That truth echoes across the farms of the Global South. From the dusty plains of Africa to the fertile deltas of India, millions of smallholder farmers still wrestle with the land using tools their grandfathers used - and reap little more than survival. While satellites beam data across continents, too many of our farmers still till, sow, and harvest with bare hands. This is not a technology gap. It is a justice gap. A vision gap. A boldness gap.

Mechanization, when done right - is not just the insertion of machines. It is the liberation of potential.

The Promise and the Paradox

For decades, "mechanization" has been paraded as the magic bullet for productivity in the Global South. And indeed, machines can multiply output, reduce post-harvest losses, lower drudgery, and unlock new value chains. Yet, in many contexts, mechanization has failed to take root. Why?

Because it was often imported, not embedded. Imposed, not integrated. Exclusive, not inclusive.

In most parts of Africa, as in parts of rural India, we've seen large machines rust under mango trees because they were too expensive, too complex, or too divorced from real farmer needs. We've seen government-run tractor services collapse under poor maintenance and elite capture. We've seen foreign aid

Mechanization is not just about machines. It is about dignity. About freeing farmers from backbreaking labor. About connecting the cassava in the soil to the chips on the shelf. About turning effort into enterprise.

About the AUTHOR

Mr Curtis Akunfu is Managing Director, Duapa Agri, Ghana. Duapa Agri is the leading African-owned agribusiness specializing in the origination, processing and distribution of ethically sourced agricultural products

projects deliver equipment with no local spare parts or repair training.

If mechanization is to transform agriculture, it must do so from the ground up - not as a miracle delivery, but as a system. A factory cannot run on a single cog.

Inclusive Mechanization: Three Core Shifts

What the Global South needs is a new mechanization compact; one that is inclusive, scalable, and rooted in our reality. That compact must shift along three key dimensions:

1. From Ownership to Access

Most smallholder farmers cannot afford to buy a tractor. But they can pay per acre. Service models, from Uber-style tractor-sharing platforms to cooperative-run shelling machines in West Africa, are proving that access trumps ownership. What matters is usage, not title deeds.

2. From Single Machines to Value Chain Systems

Mechanization cannot stop at land preparation. We need machines across the chain; threshers, dryers, graders, packers - designed for local crops and local contexts. In my company, Duapa Agri in Ghana, we are deploying decentralized cashew shelling units, run by farmer groups and women's cooperatives, feeding into a central finishing factory. That's mechanization as a chain, not a chain reaction.

3. From Imported Equipment to Local Innovation

If we want sustainability, we must invest in local fabrication ecosystems.

As we mechanize, let us not mechanize inequality. Let us mechanize inclusion. Let us build a Global South where our fields feed our factories — and our people flourish

Let India's robust agri-engineering industry partner with African metalworks hubs. Let young innovators build machines that match the terrain, the crops, and the budgets. Let us teach repair as much as we teach coding. Mechanization must be maintainable — or it is meaningless.

Policy and Capital: The Missing Gears

Mechanization will not happen without bold public policy and smart finance. Governments must:

- Zero-rate import duties for essential equipment.
- De-risk local fabrication with R&D support.
- Create leasing schemes and service-provider registries.
- Build rural infrastructure to move machines and goods efficiently.

Meanwhile, capital must shift from charity to investment. From donor grants to blended finance. From subsidies that distort to incentives that scale.

Let us create Mechanization Impact Bonds. Let pension funds co-finance agri-equipment leasing companies. Let smallholder-focused agri SMEs, like Duapa Agri, access affordable asset-backed financing that unlocks mechanization at scale.

The Global South's Advantage

Why should we settle for catching up? The Global South can leapfrog if we align our policies, innovations, and willpower.

India already exports agri machinery to over 100 countries. Africa holds 60% of the world's uncultivated arable land. Together, we can design, build, and deploy an inclusive mechanization movement that is made by the South, for the South.

Imagine a world where a woman in rural Benin books a mobile peanut sheller via SMS, operated by a youth cooperative using solar-powered machinery designed in Bangalore, fabricated in Kumasi, and financed by a blended Indian-African agritech fund.

That is not fantasy. That is the future we must forge.

From Field to Factory: A Shared Frontier

Mechanization is not just about machines. It is about dignity. About freeing farmers from backbreaking labor. About connecting the cassava in the soil to the chips on the shelf. About turning effort into enterprise.

As we mechanize, let us not mechanize inequality. Let us mechanize inclusion. Let us build a Global South where our fields feed our factories — and our people flourish.

From field to factory, the journey must begin with us.

USING MECHANIZATION TO CURB CROP RESIDUE BURNING

INSPIRED BY SCIENCE, MOTIVATED BY RESULTS

"Slash-and-burn" in slang suggests ruthless destruction. We think of CEOs who significantly downsize departments, political candidates who blast their foes, and homeowners who clean out their trash-packed garages.

In these cases, slash-and-burn is a metaphor. In agriculture, it's real.

Burning fields is a traditional way to clear land for farming. It performs its immediate job well. It eliminates vegetation, and the leftover ash even fertilizes the soil in the short term. It's popular among smallholders in rural Africa and Asia as well as in remote areas of my native South America.

The Dangers of Slash and Burn

In the long term, however, slash-and-burn destroys organic matter, releases carbon, and exposes soil to erosion. It's a quick fix that causes enormous long-term damage.

I became a regenerative farmer in Argentina because I wanted to be a sustainable farmer. It was a conscious decision. I realized that conventional systems of agriculture weren't working—everything from burning fields to conventional tillage to outdated practices were degrading soils and resources. We had to do something different and recover productivity, resilience, and profitability.

Inspired by science and motivated by practical results, I started with small trials of cover crops, no-till, more diverse rotations, and livestock integration. These methods worked so well that they

About the **AUTHOR**

Mr Jorge Lopez Menendez currently farms in Argentina and works as a consultant and partner at Numen Bio, leading regenerative agriculture projects in Malawi, Sierra Leone, and Liberia. Jorge is a member of the Global Farmer Network www.globalfarmernetwork.org

are now at the foundation of how I produce food.

I've adopted regenerative techniques on farms in the provinces of La Pampa and Buenos Aires, where I help raise livestock and grow soybeans, sunflower, barley, sorghum, corn, wheat, and forages.

Farmers Seek Solutions That Work

I've also introduced regenerative farming to Africa, where I work with farmers as a consultant in Liberia, Malawi, and Sierre Leone. They were veteran burners. Slash-and-burn was fundamental to their farming. I'm passionate about showing them an alternative.

What struck me most was their eagerness to learn. At first, they were sceptical but curious: Would regenerative practices work in the soils and climates? It was one thing for me to talk about its success in South America, and another for them to witness it work in Africa.

The turning point came when they saw a seeder that allowed them to sow more efficiently without burning. Their yields improved immediately. When they saw the concrete results, they were quick to adopt new practices. A simple machine showed an entire community that regenerative agriculture is both practical and transformative.

Why Regenerative Agriculture Appeals

Regenerative agriculture holds a special appeal to young people. Many of them resist farming because they view traditional agriculture as antiquated and obsolete. They seek purpose and innovation. For them, regenerative agriculture is a revelation. It connects production with food security, new technologies, and climate action. It reveals that farming is not just about hard work but also science, knowledge, and entrepreneurship.

When young people believe that agriculture can deliver a meaningful career, they bring energy, new ideas, and continuity.

That's why I signed the Global Farmer Network's declaration on regenerative agriculture.

Farmers must speak up and demonstrate our credibility and commitment so that governments, investors, and consumers see that we are partners in solutions rather than problems to be solved

Too often, agricultural policies and narratives fail to account for those of us who work the land. Farmers must speak up and demonstrate our credibility and commitment so that governments, investors, and consumers see that we are partners in solutions rather than problems to be solved.

We must seize the initiative and show that regenerative agriculture is a real, scalable, farmer-led pathway. We've seen other terms twisted and misused by non-farmers, to the detriment of what we do. We must join the conversations that will shape our future.

My experience in Africa convinced me of this. I had gone there to teach agricultural methods and that's what I did. Yet I learned something important: Knowledge travels. When one farmer embraces a new idea, an entire community can change.

This can work in the wider world, too.

I invite you to read the Global Farmer Network (GFN) statement on regenerative agriculture. If the document speaks to you, it may speak to others. Adding your voice will help them hear. Please consider signing it.

That's how we'll spread our ideas—and in a slash-and-burn world, we can begin to build something better.

This writeup was first published by Global Farmer Network, and was headlined 'Inspired by Science and Motivated by Results, Regen Ag Delivers Sustainability'

FROM STRUGGLE TO STRENGTH

How a Woman Farmer in Uttarakhand is Growing Her Own Future

On Mahila Kisan Diwas, meet Basanti Bisht from Sunderkhal village in Uttarakhand, a farmer who turned her struggle into success through apple farming supported by Unnati Apple by Anandana, The Coca-Cola India Foundation.

In the picturesque village of Sunderkhal, Uttarakhand, Basanti Bisht's orchard glows red with promise. What began as a few saplings planted with determination has grown into a thriving apple farm – a symbol of resilience, learning, and self-belief.

Just a few years ago, Basanti was cultivating cabbage and wheat on her small plot of land, often losing crops to wild animals and earning little in return. "It just wasn't working," she recalls. "So, I decided to try something new."

That "something new" was high-density apple farming introduced through Project Unnati Apple, supported by Anandana – The Coca-Cola India Foundation. Through the initiative, Basanti learned modern orchard techniques – from planting to irrigation and pest management – that would help her grow more in less time.

"These trees are smaller, but their yield is much higher," she smiles. "When we planted them, people from the village came to see. Some thought it wouldn't work here, but I believed in it."

With a small investment and her own hard work, Basanti transformed her land. Within a year, her orchard produced seven boxes of apples – and by the second year, that number rose to fifty. Her apples now attract not just buyers, but visitors. "I run a small homestay where guests can pluck apples themselves. If they pick them, it's Rs.210 a kilo. If I pick them, it's Rs.200!" she says and laughs.

Basanti's success has become a model for her village – several women have since started planting their own

high-density apple orchards. She often helps them with guidance and motivation. "People come and ask where to get the plants, how to grow them. It feels good to share what I've learned."

Feels Good to Create Something of Your Own

For Basanti, farming is more than livelihood – it's pride and peace. "Even when I'm away, I want to come back and walk through my orchard," she says. "It feels good to be among the trees."

Her message this Mahila Kisan Diwas is simple but powerful, "I tell all women who live away from their villages to come back and start farming. It feels good to create something of your own."

Basanti's journey mirrors the purpose of Project Unnati Apple, which has helped hundreds of farmers in Uttarakhand adopt climate-resilient, high-yield apple cultivation. Through this initiative, Anandana – The Coca-Cola India Foundation continues to empower farming communities with new skills, improved productivity, and lasting confidence – showing that when women grow, communities flourish.

Project Unnati Apple

In Uttarakhand, Project Unnati Apple supports farmers in adopting high-density apple farming, a technique that increases yield per acre while reducing water usage and crop vulnerability. The project has trained and supported hundreds of apple growers across the region, helping them transition to a more profitable and climate-resilient form of agriculture. Project Unnati Apple is part of the broader Project Unnati initiative, which helps farmers across India enhance fruit productivity, income, and sustainability through advanced horticulture techniques. The project focuses on improving agricultural practices, optimizing resource use, and promoting sustainable livelihoods.

About Anandana, The Coca-Cola India Foundation

The Coca-Cola India Foundation, a Company registered under Section 25 of the Companies' Act is committed to sustainable development and inclusive growth by focusing on areas that aim to create a better and healthy society, and a strong and resolute India by enabling the common man to better his or her life. In order to promote the Foundation's objectives, monetary grants and other assistance is provided to NGOs, beneficiary organizations, cooperatives, philanthropies and such others who can be suitable partners in implementing projects for social welfare across the country.

AGRICULTURE TODAY GROUP

4th All India Progressive Farmers Convention 2025

...cultivating pride in farming

Thursday, 13th November 2025

Constitution Club, Rafi Marg, New Delhi

Empowering the Hands that Nourish the World

India Progressive Farmer Awards 2025

Register Now -

www.agriculturetoday.in/farmers-convention

Scan the QR to Register

For more details, Please Contact :

Ms. Zaman Almas | +91 – 7290088228

zaman.almas@agriculturetoday.in

Regular Posting Date 27-28
Date of Printing 23
Post Office: Lodhi Road

DL(ND)-11/6128/2024-25-26
RNI No. 68745/98

SBI
The banker to every Indian

AGRI FINANCE MADE SIMPLE

Introducing

Agri & Food Enterprise Loan

- All Agro Processing /Mfg units in Agri/Food/Fruit/Fish/Dairy/ Allied Agri/ etc. are eligible
- Working Capital, Term Loans, LC, BG, Exports, etc.
- Loans up to ₹100 Cr. offered
- Attractive Interest Rates
- Long Moratorium period up to 2 years with repayment term up to 10 years
- Convergence with Govt. schemes for capital subsidy/interest subvention in eligible schemes
- Processing fee concessions up to 75%

For assistance, call 1800 1234 | 2100 or visit bank.sbi

Follow us on