



AGRICULTURE WORLD

the pulse of global agriculture

ISSN 2455-8184



VOLUME 11
ISSUE 10
October 2025
Rs. 200



REIMAGINING AGRICULTURE

For A Technology Led Transformation

A new style,
The same old trust...
Now it's the era of **Zytonic**!



With **Zytonic**,
may prosperity stay forever.

Heartfelt Diwali wishes
from the entire **Zytonic** family
to all our farmer brothers,
dealer partners, and their
families!

- Aerated soil – develops a large and dense root system
- Water conservation – saves irrigation with less water use
- Organic nourishment – ensures continuous nutrient availability
- Enhanced resistance – reduces dependency on chemical pesticides
- High-quality yield – nutrient-rich crops fetch better market prices



STIHL UPKARAN, LAYE PARIVARTAN

PROGRESS IS SWEETER
WITH STIHL
HAPPY DIWALI!





SEEDS OF SUCCESS

SOMANI SEEDZ

HYB RADISH CROSS X-35



HYB CABBAGE TEZ (IMP)



HYB CARROT WONDER RED



HYB CAULIFLOWER KHUSHI



Farmers First Choice

SOMANI KANAK SEEDZ PVT. LTD.

HEAD OFFICE: C-91/17, 2nd FLOOR, WAZIRPUR INDUSTRIAL AREA, NEW DELHI - 110052. PHONE: (+91) 47505229, 47503925, 47503925, 8587967987. EMAIL: CONTACT@SOMANISEEDZ.COM. WEBSITE: WWW.SOMANISEEDZ.COM

mahindra ^{Rise}

mahindra
TRACTORS

TOUGH HARDUM

No. 1 in Power

No. 1 in Technology

No. 1 in Fuel Efficiency

Mahindra
YUVO
TECH+

Mahindra
NOVO

mahindra
OJA



Contact Your Nearest Mahindra Dealership Today.

Mahindra Tractors

Mahindra & Mahindra Limited, Farm Equipment Sector, Farm Division, AFS Headquarters, Mahindra Towers, 1st Floor, Akurli Road, Kandivali (E), Mumbai - 400101, India. Phone: 28849588, Fax: 28465813.

Toll-Free Number 08037749101 | www.mahindractor.com | facebook.com/MahindraTractorsIndia

x.com/TractorMahindra | youtube.com/MahindraTractorsofficial | www.instagram.com/mahindractorsofficial

Terms and conditions apply.

Hingmire's Group

M/S. HINGMIRE TRADING COMPANY
M/S. SHRI REVANSIDDHA AGROTECH COLD STORAGE
M/S. HINGMIRE AGRO PROCESSING & COLD STORAGE

Plot No.32 Market Yard, Tasgaon, Sangli, Maharashtra,
(India, Pincode - 416312)



Late. Revan Hingmire,
Founder



Late. Maharudra Hingmire,
Founder



HINGMIRE'S GROUP
TRUST . QUALITY . LOYALTY

ABOUT US

Founded in 1983 by Revan (Kaka) Hingmire & Maharudra (Nana) Hingmire, Hingmire's Group has been a leader in the raisins industry for over 40 years. Now successfully run by its third generation, we are renowned for our unwavering commitment to quality, sustainability, and innovation. We meticulously cultivate and process the finest raisins, utilizing state-of-the-art facilities and stringent quality control to ensure exceptional taste and nutrition in every product.

OUR INFRASTRUCTURE

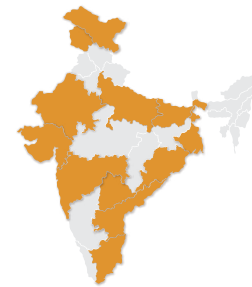
We are equipped with the latest innovative technology and efficient management. Our high-tech grading machines and modern processing plants ensure thorough cleaning and hygienic packaging of raisins.

We provide premium quality and export-grade packaging for our exclusive range of Indian raisins.

- Latest innovative technology and efficient management
- High-tech grading machines
- Cold storage facility with a capacity of 12,000 metric tonnes



MARKET PRESENCE ACROSS INDIA:



- Jammu & Kashmir
- Uttar Pradesh
- Rajasthan
- Gujarat
- Bihar
- West Bengal
- Odisha
- Andhra Pradesh
- Tamil Nadu

MR.SUBHASH HINGMIRE
(FOUNDER)

MR.KAUSTUBH HINGMIRE
(CEO)

CONTACT US:

+91 - 9209284977 , +91 - 9545991818

info@hingmiretrading.com

www.hingmiretrading.com

FOLLOW US:

@hingmire_group_4977

@hingmire's group

@hingmire trading company

@hingmire's group



HINGMIRE'S GROUP
TRUST . QUALITY . LOYALTY



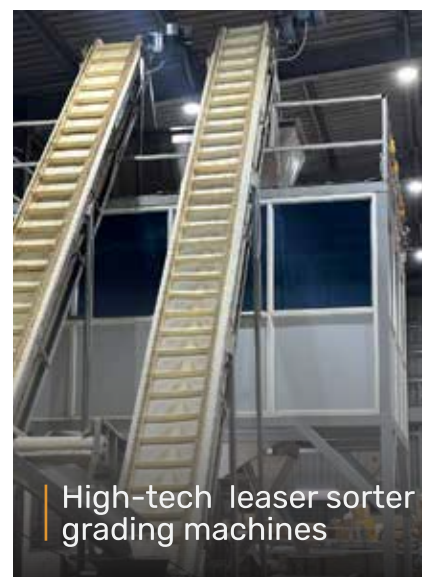
Discover the exquisite quality of DryOnWowww raisins – meticulously selected and packed for freshness and flavor. A smart choice for modern, health conscious living. Quality and convenience, delivered.

Available on Flipkart and other leading online platforms.

“Delivering Premium-Quality Raisins Worldwide”



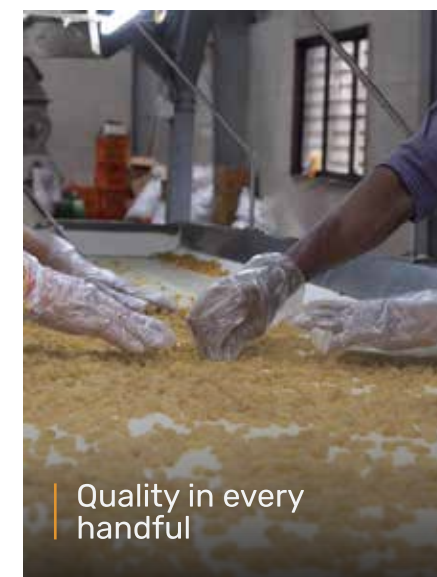
Cold storage facility with a capacity of 12,000 metric tonnes



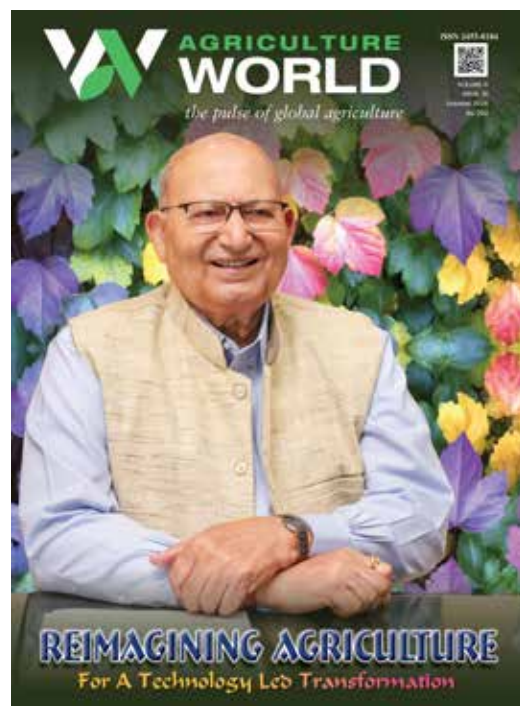
High-tech leaser sorter grading machines



Latest innovative technology and efficient management



Quality in every handful



Founder & Editor-in-Chief	MC Dominic
Managing Director	Shiny Dominic
Group Editor & CEO	Mamta Jain
Senior Sub-Editor	Shivam Dwivedi
VP - Marketing	Megha Sharma
Circulation	Abdus Samad
Graphic Designer	Sandeep Singh

Printed and Published by :
MC Dominic
60/9, 3rd Floor, Yusuf Sarai Market, Near Green Park Metro Station, New Delhi-110016

Printed at :
Pushpak Press Pvt. Ltd.
Shed No. 203, 204, DSIDC Complex Indl. Area, Okhla Phase-I, New Delhi-110020

All rights reserved.
Copyright @ Krishi Jagran Media Group. Agriculture World is published by Krishi Jagran Media Group.
Editor in Chief: MC Dominic

Content Disclaimer
Please note that the information in this magazine, does not make any claims. Agriculture World has made a constant care to make sure that the content is accurate, and the views expressed in the articles reflect the author(s) opinions.

CONTENT

12	Dr Paroda
16	Dr SN Jha
18	Sh Suresh Prabhu
20	Dr Nachiket
22	Mr M Balakrishna
24	Dr Balvinder Shukla
28	Dr Divya Gulati
30	Dr VN Kale
34	Dr Gajendra Singh
36	Mr Kunal Gupta
40	Dr BN Tripathi
44	Dr CR Mehta
48	Mr Hadi Sugeng
50	Dr Mamta Tewari
52	Mr Narinder Mittal
56	Mr Tushar Trivedi
58	Dr RS Sengar
62	Yamuna Kumari
64	PRADAN
66	Mr Sanjay Sethi
68	Dr. Shiva
70	Ms Samyukta
72	Mr Abhishek Wadekar

THE VISION

Agriculture for Developed India@2047: Building the Pillars of Prosperity and Purpose



FMR. M C DOMINIC

Founder & Editor-in-Chief Krishi Jagran and Agriculture World
Founder & President -Agriculture Journalist Association of India (AJAI)
Founder & Managing Trustee - MAC Krishi Jagran Foundation

As India marches toward the vision of a Viksit Bharat by 2047, agriculture stands not just as the foundation of our economy but as the force shaping our collective future. Across the nation, we are witnessing an extraordinary convergence of science, innovation, and human spirit, transforming our farms into engines of resilience and renewal.

This transformation is not accidental; it is intentional. From mechanization to biofortification, from entrepreneurial skilling to circular farming systems, Indian agriculture is redefining what “development” means. It is not merely about GDP growth; it is about dignity in rural livelihoods, sustainability in production, and nutrition in every meal.

Mechanization and automation are no longer the privileges of large farmers; they are becoming the right of every cultivator. Smart machines, drones, and AI-driven precision tools are now reaching smallholders, empowering them with efficiency and autonomy. Meanwhile, climate-smart agriculture and circular economy principles are reintroducing balance, turning waste into wealth, energy into opportunity, and sustainability into everyday practice.

Equally vital is the rise of rural entrepreneurship. India’s youth are reimagining farming as a profession of pride, not compulsion. With the right skilling, mentorship, and technology access, they are building a self-reliant rural economy where innovation thrives from the grassroots upward.

The pages of this issue are a reflection of that spirit, a tribute to thinkers and doers who are engineering the future of Indian agriculture. To achieve the dream of Viksit Bharat, we must continue to invest in our farmers, in science, and in systems that place the planet and people at the core of progress.

Agriculture will not just feed the nation; it will define its destiny.

Empowering Rural India: Heartbeat of a Developed Nation



Today's agriculture is more than an economic activity, it is the heartbeat of national development. As India envisions Viksit Bharat@2047, the transformation of our villages into hubs of innovation, technology, and opportunity is essential. This

journey begins with empowering the very hands that till the soil and nurture the nation.

Our farmers are adapting rapidly to climate and market realities. Through the integration of digital tools, renewable energy, and sustainable practices, they are turning traditional farming into modern enterprise. Mechanization and automation, once distant goals, are now within reach for small and marginal farmers through custom hiring centres, women-led cooperatives, and agri-startups. These are not just productivity tools; they are instruments of social equity and inclusion.

Equally transformative is the entrepreneurial skilling revolution. The expansion of RSETIs, industrial

partnerships, and AI-enabled learning platforms is preparing a generation of rural youth to be job creators, innovators, and solution seekers. Their ideas are revitalizing agri-value chains, building resilient local economies, and ensuring that prosperity is not confined to cities alone.

The circular economy, too, is redefining sustainability. Waste is being converted into energy, residues into new materials, and carbon footprints into community assets. It is this fusion of innovation, responsibility, and inclusiveness that will shape India's agricultural destiny.

At Krishi Jagran, we remain steadfast in our mission to spotlight these stories of transformation. The vision of a Developed India will be realized when every farmer, entrepreneur, and village becomes part of this movement, where agriculture is respected, profitable, and proudly future-ready.

The future is not waiting to arrive; it is being cultivated today, in every field, by every farmer who believes in tomorrow.

SHINY DOMINIC
Managing Director

www.krishijagran.com

Maximizing Mechanization



Agriculture mechanization is one of the key drivers of rural transformation and agricultural growth. By integrating modern machines, tools, and technologies into farming systems, farmers can significantly enhance productivity, reduce drudgery, lower costs, and ensure timely operations.

However, to fully realize these benefits, a clear roadmap is essential to maximize agricultural mechanization in India and other developing economies.

Promoting Technology Innovation

- **Small and Smart Machines:** Innovations in low-cost, fuel-efficient, and multi-functional machines tailored for small landholdings must be prioritized.
- **Digital Integration:** Use of IoT, sensors, drones, and AI-based solutions for precision farming can reduce input costs and optimize farm operations.
- **Eco-Friendly Equipment:** Mechanization should be aligned with sustainability goals, focusing on electric, solar, and biofuel-based machinery.

Building Human Capacity

- **Skill Development:** Regular training for farmers, rural

youth, and machinery operators is essential to ensure safe and efficient use of equipment.

- **Awareness Programs:** Demonstrations, field days, and farmer producer organizations (FPOs) can showcase the benefits of mechanization and encourage adoption.

Encouraging Local Manufacturing and Innovation

- **MSME and Start-ups:** Supporting rural entrepreneurs and start-ups in farm machinery manufacturing will create jobs and make machines more accessible.
- **Localization:** Developing machines suited to specific crops, soil conditions, and regional requirements will improve adoption rates.

Maximizing agricultural mechanization requires a multi-dimensional approach that combines technology, policy, finance, and farmer empowerment. While large-scale farms already benefit from machinery, the future lies in making mechanization inclusive, affordable, and sustainable for smallholders. By following this roadmap—strengthening access, financing, innovation, capacity building, local manufacturing, and policy support—India can significantly boost productivity, improve rural livelihoods, and contribute to the vision of a self-reliant and prosperous agricultural sector.

MAMTA JAIN
Group Editor & CEO

October, 2025

Reimagining Indian Agriculture:

A National Imperative for Developed India@2047



Dr. R.S. Paroda

Chairman, Trust for Advancement of
Agricultural Sciences (TAAS)

Reimagining for a Developed India

The Government of India's vision of Developed India@2047 is both bold and inspiring. With an impressive GDP growth rate of 6.8%, India is on course to become the world's third-largest economy by 2030. According to Morgan Stanley, India could surpass Germany as early as 2028 with a GDP of US \$4.7 trillion.

However, this economic trajectory cannot be sustained without strengthening every pillar of our economy — particularly agriculture, which remains the backbone of India's growth. Reimagining agriculture is, therefore, not an option but an imperative.

Why Reimagination is Essential

History offers a stark reminder of what happens when agriculture is neglected. The Royal Commission on Agriculture (1928) observed:

"An Indian farmer is born in debt, lives in debt, and dies in debt."

During British rule, agriculture suffered from chronic neglect. The establishment of the Imperial Council

of Agricultural Research (1929) — later renamed the Indian Council of Agricultural Research (ICAR) — marked a turning point. Since independence, ICAR has been the driving force behind India's Green Revolution and subsequent food security.

Today, as the challenges evolve, so must our approach. Agriculture needs to be reimagined to meet the demands of a changing economy, climate, and global market.

Agriculture: The Engine of a Developed India

Agriculture contributes 16–18% to India's GDP and provides livelihoods to 45% of the workforce. In 2023–24, India's agricultural exports reached US \$52 billion, with a target of US \$100 billion by 2035.

For India to achieve a US \$5 trillion economy by 2030, agriculture must contribute at least US \$1 trillion. To realize this, policies must place farmers — especially small and marginal farmers (86%) — at the center, empowering them to become market-oriented, technology-driven, and entrepreneurial.

Science, Innovation, and Policy: The Three Pillars of Transformation

India's agricultural transformation must rest on science, innovation, and strategic reform.

Key national committees — including those chaired by Dr. R.A. Mashelkar (2005), Dr. M.S. Swaminathan (2006), and Dr. R.S. Paroda (2019) — have consistently emphasized:

"Building farmers' technical literacy and fostering collective intelligence are the foundation for transformative change."

The ongoing dialogue on the Reimagining of Agricultural Research System marks a visionary step toward revitalizing agricultural education, research, and extension — aligning them with emerging challenges of climate change, sustainability, and global competitiveness.

Modernizing Agricultural Education

Agricultural education must evolve from traditional teaching to technology-driven learning that prepares youth for 21st-century challenges.

Universities and institutions should integrate:

- Artificial Intelligence, Machine Learning, and Robotics
- Blockchain and Digital Market Intelligence
- Sustainable and Climate-Resilient Farming Systems
- Entrepreneurship, Agri-Business Management, and Start-up Development

The focus must shift from "degree to delivery" — producing graduates who are innovators, entrepreneurs, and change makers, not merely job seekers.

Transforming KVKs into Knowledge-Innovation Hubs

The 2019 Paroda Committee Report recommended transforming Krishi Vigyan Kendras (KVKs) and Agricultural Technology Management Agencies (ATMAs) into "Knowledge-Skill-Innovation Centres."

These hubs should become epicenters for continuous learning, capacity building, and technology transfer, enabling farmers to address emerging challenges — from climate variability and soil health management to mechanization, value addition, and market integration.

When rural youth are trained and empowered with

modern tools and knowledge, they can truly embody the principle:

"Think globally, but act locally."

Research Must Be Innovation-Driven: ICAR's 2006 policy on Intellectual Property Management and Commercialization was a step forward, yet innovation adoption remains slow. To accelerate progress, we must:

- Strengthen public-private partnerships in R&D,
- Promote innovation-based entrepreneurship, and
- Ensure farmer-oriented research outcomes.

India's Total Factor Productivity remains low. Water-use efficiency is just 36–40%, while soil nutrient efficiency and carbon levels are declining. New technologies such as genomics, gene editing, and precision farming must be harnessed to enhance sustainability and resilience.

Policy Reforms for Empowered Agriculture

Since independence, several reforms — from land and irrigation reforms to APMC Acts and Contract Farming — have sought to modernize agriculture. Yet progress has often been uneven.

To re-energize rural transformation, we need policy boldness that ensures:

- Greater trust and partnership with the private sector,
- Enhanced investment in R&D and innovation,
- Rationalized subsidies with direct benefit to small farmers, and
- Continuous skill and knowledge development at the grassroots.

Conclusion

Reimagining Indian agriculture for the future demands a multi-dimensional approach combining policy innovation, science, technology, and human capacity development. Only when agriculture becomes knowledge-based, technology-led, and globally competitive, will it sustain food and nutritional security and contribute meaningfully to the vision of Developed India@2047.

Agriculture must, once again, be recognized not just as a means of livelihood — but as the driving engine of India's economic transformation.

A Visionary Extraordinaire:

Dr Rajendra Singh Paroda

Voice Over (V.O.)

A sustainable revolution never starts with a bang. Sometimes, but begins with a seed... a vision... and determination of a single person.

This is the story of one such individual.

A revolutionary who empowered India to produce millions of additional tons of food grains—precisely when the nation needed it the most.

Quote – Dr. M. S. Swaminathan: “Wherever he has gone—India, FAO, CGIAR—he has left footprints on the sands of time.”

A pioneer who built one of the world’s largest Plant Gene Banks, ensuring conservation of our rich genetic heritage.

Quote – Dr. A.P.J. Abdul Kalam: “If there were a second life, I would like to be an agricultural scientist—just like him.”

A go-getter who ensured release of Bt cotton and promoted crop hybrids - elevating India’s status to global level.

Dr. Raju Barwale: “His support for Bt cotton was a turning point. It revolutionized Indian cotton production.”

A leader who forged **global alliances**, aiding nations across Asia and Central Asia to become food secure.

Quote – Dr. Ismail Serageldin: “We fought side by side to provide food security for the poor. His dedication is truly remarkable.”

A transformer who revolutionized **Indian agricultural research** - leading ICAR (Indian Council of Agricultural Research) to an unprecedented height.

Quote – Dr. Gurdev Khush: “When you think of ICAR, you think of him.”

A visionary who **reshaped the destiny** of millions of farmers—and championed the cause of food security worldwide?

This is the remarkable story of Dr. Paroda— the architect of modern National Agricultural Research System whose influence extends far beyond India’s borders.

SEEDS OF PROMISE: A HUMBLE BEGINNING

(Text on screen) **August 1942, Saradhna - Rajasthan**

In the arid fields surrounding the village sat a young boy, unaware that he was destined to become the driving force behind modernisation of India’s agricultural landscape.

After excelling in village school, he moved to Dayanand College, Ajmer, and then to the Rajasthan College of Agriculture, Udaipur - earning a gold medal for his Master’s in Plant Breeding and Genetics.”

Serving as General Secretary and President of student unions, he displayed a remarkable leadership and the ability to connect with people.

Encouraged by his mother to pursue higher education, he secured a Commonwealth Scholarship for post-doctoral research in the United Kingdom.

‘Will you stay in these green pastures or return back to help your own people to grow food?’

A simple question from a British gardener, changed everything...

Dr. R.S. Paroda: “That question hit me like a thunderbolt. My decision became clear—I had to go back.”

UPSCALING INNOVATION & ESTABLISHING A LEGACY

Returning home, Dr. Paroda joined the Haryana Agricultural University, Hisar, where in a short span (1971 and 1977) he revitalized the forage research program, earning the prestigious ‘Rafi Ahmed Kidwai Prize’ and the ICAR ‘Best Team Research Award’.

In 1985, he became Director of the National Bureau of Plant Genetic Resources (New Delhi).

With meagre funds and no land, a situation in which generally one would have stepped back, Dr. Paroda took up the challenge.

Determined to build India’s National Gene Bank (NGB), he managed to get a 24-million-dollar grant from USAID, and successfully commissioned the second largest and most modern Genebank in 1996 that safeguards more than 480,000 plant germplasm collections.

Impressed by the centre of Iowa State University where the 1st Crop Science congress was held in 1992, Dr. Paroda established the State-of-the-art National Agriculture Science Centre at New Delhi in 2001. He became the second agricultural scientist after Dr. Swaminathan to preside over the prestigious Indian Science Congress in 2001.

As Director General, ICAR, (1994-2001) he created 30 new ICAR institutes and the first Central Agricultural University. He successfully secured the US 240 Million dollar World Bank project (1988) for Organization & Management Reforms, including innovative eco-regional research programs (CG: Rural Agricultural Work Experience (RAWEE)), and initiation of several key institutions. (CG: Agriculture Technology Management Agency (ATMA), Institute Village Linkage Program (IVLP), Agriculture Technology Information Centre (ATIC) along with computerization and renovations of labs and buildings.

In response to a call by Late Prime Minister Shri Atal Bihari Vajpayee, Dr. Paroda established the Trust for Advancement of Agricultural sciences (TAAS) to link science to society. Today the Trust has become an influential and vibrant Think Tank for agricultural policy advocacy and public awareness.

His vision and work transcended borders. He strengthened APAARI (CG: Asia-Pacific Association of Agricultural Research Institutions) serving as its Executive Secretary for 22 years, uniting Asian countries NARS (National Agricultural Research system) for shared research goals and collaborations.

Later, heading a World Bank-funded CGIAR program for Central Asia and the Caucasus, he created a regional forum ‘CACAARI’ (pronounced as Kakaari) and established gene banks across eight countries—earning him the title ‘Gene Guru’. The ICRISAT (Pronounced as one word and not to be read as acronym) Genebank, largest among CGIAR Centers and the Gene bank in Kazakhstan, are named in his honor. He also established the Global Forum on Agricultural Research (GFAR) at FAO, Rome in 1997 and served as its founder Chairman till 2001.

A VISION IN FULL BLOOM: AWARDS, LEGACY & LASTING IMPACT

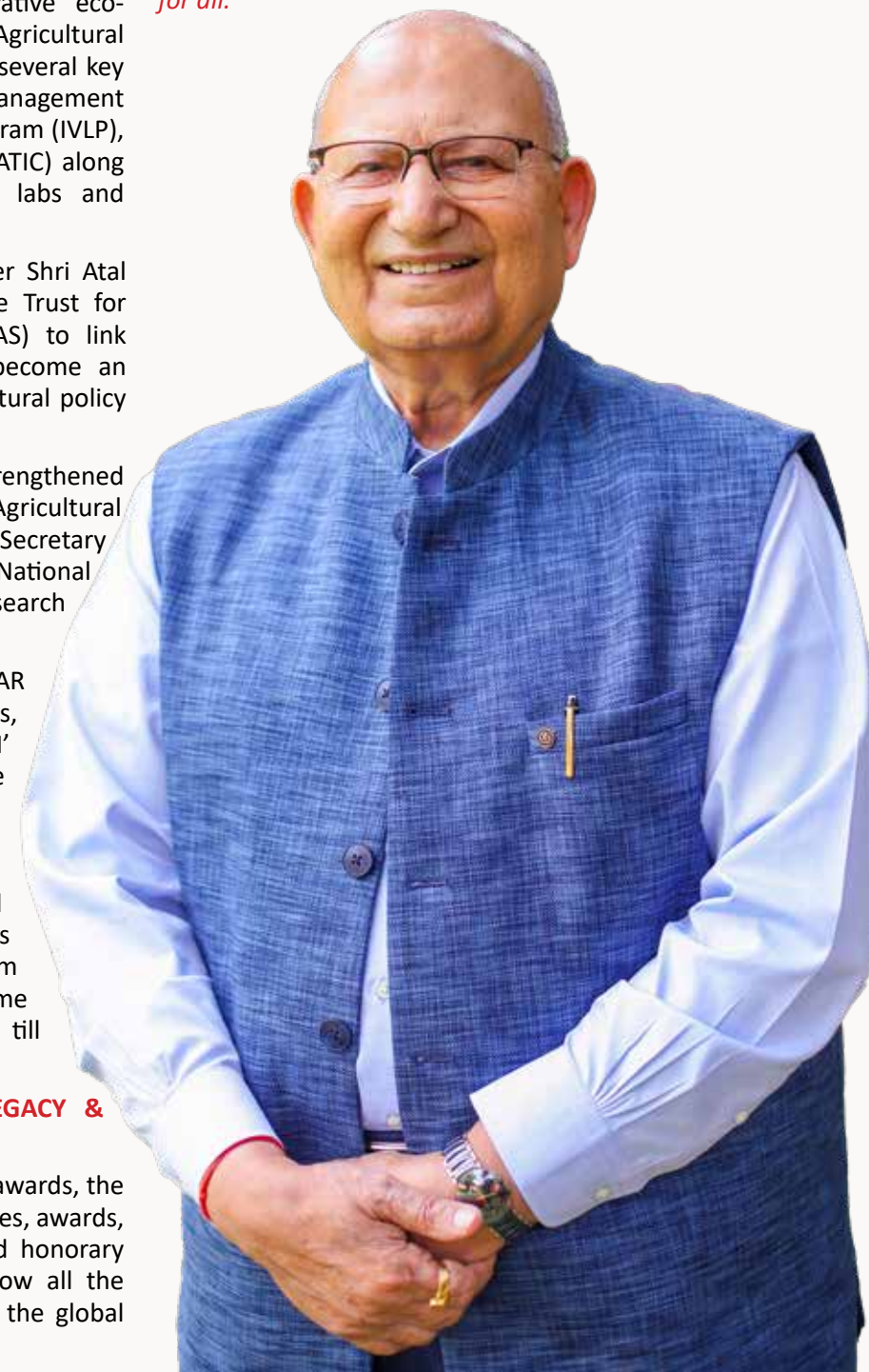
From receiving one of India’s highest civilian awards, the Padma Bhushan in 1998 to numerous accolades, awards, fellowships of many academies globally and honorary doctorate of 21 universities (graphically show all the awards here), Dr. Paroda stands tall among the global agricultural leaders.

Quote – Dr. Rattan Lal: “He is the modern Swaminathan of India and the Global South.”

From a modest village in Rajasthan, towards shaping agricultural futures around the globe, Dr. Paroda’s life exemplifies vision, resilience, and an unyielding spirit of service. He not only transformed India’s agricultural destiny but even today continues to plant seeds of hope for millions, for a flourishing tomorrow.

A Visionary Par Excellence: Dr. R. S. Paroda

Inspiring young generations to ensure a brighter future for all.



Roadmap to Maximize Agricultural Mechanization by 2047

India's agricultural sector, the backbone of rural livelihoods and food security of the country, is though progressing well, it however needs certain directional to look Indian Agriculture really developed by filling the gaps of labour shortage, time constraints and input/resources scarce by 2047. With shrinking landholdings, labour shortages, climate stress, and rising demand for food, mechanization is no longer optional or essential – it is now compulsion. Currently, India's mechanization level hovers around 47%, far behind countries like China (59.5%) and Brazil (75%). To achieve the goal of "Viksit Bharat" by 2047, India must aim for at least 75% mechanization; and to achieve the same, an indicative roadmap having four phases, but not limited to, is proposed herewith.

The **first phase** may be called as **Foundational (2025–2030)** phase with three components such as policy reform and institutional support, infrastructural and skill developments. Policy reform and institutional support may include: launch of a National Mission on Agricultural Mechanization (NMAM) with dedicated funding and targets, creation of state-level mechanization departments/directorate to tailor interventions to local village level in each district of each state, promotion of public-private partnerships for R&D with special funding and deployment of farm machinery, and integration of farm machinery' soil conservation; irrigation & drainage; post-harvest/food processing and energy in agriculture under one umbrella of directorate/department of Agricultural Engineering in each state.

Infrastructural Development is must for a strong foundation and should be prioritised. It should be comprising of establishment of farm machinery banks at village and block levels to enable shared access for

smallholders, expanding rural and farm road networks to facilitate machinery movement and logistics, digitization of land records and crop data to support precision mechanization, and establishing village level economic zone and National Institute of Agricultural Robotics and AI (Artificial Intelligence) to cater the introduction of contemporary technologies in agriculture.

The Skill Development after laying a strong foundation is another pillar for efficient operation. Introduction of Agricultural Engineering degree courses in each State Agricultural Universities (SAU); IITs, introduction of mechanization modules diploma courses in ITIs, training rural youth as "Agri-Tech Operators" to manage and maintain machinery including on farm postharvest machinery, storage structures, and launching awareness campaigns to shift perceptions of farming and post-harvest activities as a tech-driven profession to retain youth in agriculture.

The **Second Phase** may be said as **Acceleration (2030–2037)** phase. This phase may constitute technology adoption, providing financial incentive and taking steps for sustainable integration. For Faster technologies adoption and promotion of precision agriculture tools like GPS-guided tractors, drones, artificial intelligence, and IoT sensors; encouragement for mechanized nursery raising, automated harvesting, and smart packaging; and support for indigenous manufacturing of affordable region-specific equipment are some steps need to be taken. **Financial Incentives** may comprise of offer of subsidies for machinery purchase and leasing, especially for marginal farmers, providing low-interest loans through Kisan Credit Cards for mechanization, introduction of tax benefits for agri-tech startups and machinery innovators, starting performance link incentive scheme to promote manufacturing farm machinery in areas, where manufacturing is negligible or minimal. There is a need of Sustainable Integration for efficient and maximized output. Some steps for such integration suggested are: promotion of solar-powered and electric machinery to reduce carbon footprint, encouragement of biomass utilization and residue management through mechanized solutions, integration of mechanization with water-saving irrigation systems like drip and sprinkler, and bringing soil conservation, irrigation and drainage, farm machinery, post-harvest/food processing and energy in agriculture under one umbrella of Directorate of Agricultural Engineering in each state.

The **Third Phase** may be called as **Consolidation (2037–2042)** phase. This is the phase of building digital ecosystem comprising a national agri-mechanization portal for equipment booking, training, and troubleshooting; use of AI and big data to optimize machinery deployment based on crop cycles, soil health, climate conditions and integration of eNAM with mechanization services to streamline post-harvest logistics for **quality and ethical based marketing. Cluster-Based Mechanization** by

developing agri-tech clusters with shared infrastructure, storage and processing units; encouragement to Farmer Producer Organizations to pool resources for machinery access and promotion of contract or specific purpose based farming models with mechanization embedded in service delivery are need of the hour. Monitoring and Evaluation is an integral part of any schemes or target oriented projects. We should develop **mechanization level index** to track progress across states, conduct annual audits and publish mechanization scorecards, and use satellite imagery and remote sensing for real-time impact assessment of the scheme.

The fourth and final phase is Transformation (2042–2047) which comprises of

- **Universal Access:** ensure every farmer has access to at least one mechanized service per crop cycle, expand Farm Machinery Banks to cover 100% of rural blocks, and make mechanization gender-inclusive by designing equipment suitable for women farmers.
- **Resilience and Adaptability:** Development of machinery adaptable to climate extremes—floods, droughts, and heatwaves, integration of mechanization with crop insurance schemes like PMFBY, capacity building for rapid deployment of machinery during natural disasters etc. should be inbuilt in the system
- Positioning India as a global hub for low-cost, climate-resilient, gender neutral farm machinery, promotion of export of indigenous equipment to Africa, Southeast Asia, and Latin America, and host international agri-tech expos to showcase innovations and attract investment under umbrella of **Export and Innovation Hub** in each block.

Expected Outcomes by 2047 may be summarized in Tobler form as below:

Metric	2025 Baseline	2047 Target
Mechanization Level	47%	≥75%
Farm Power Availability	2.54 kW/ha	≥7.5 kW/ha
Smallholder Machinery Access	<30%	≥90%
Post-Harvest Loss Reduction	15–20%	<5%
Women Participation in Mechanization	<10%	≥60%

Maximizing agricultural mechanization by 2047 is not just a technological challenge—it's a socio-economic transformation. It demands changes in course of the way agricultural research and implementation plan is framed in the country. It demands coordinated efforts across policy, finance, education, and innovation. With strategic planning and inclusive execution, India can empower its farmers, boost productivity, and secure its place as a global agricultural powerhouse, if this thought is brought in centre stage of the Indian Agriculture.



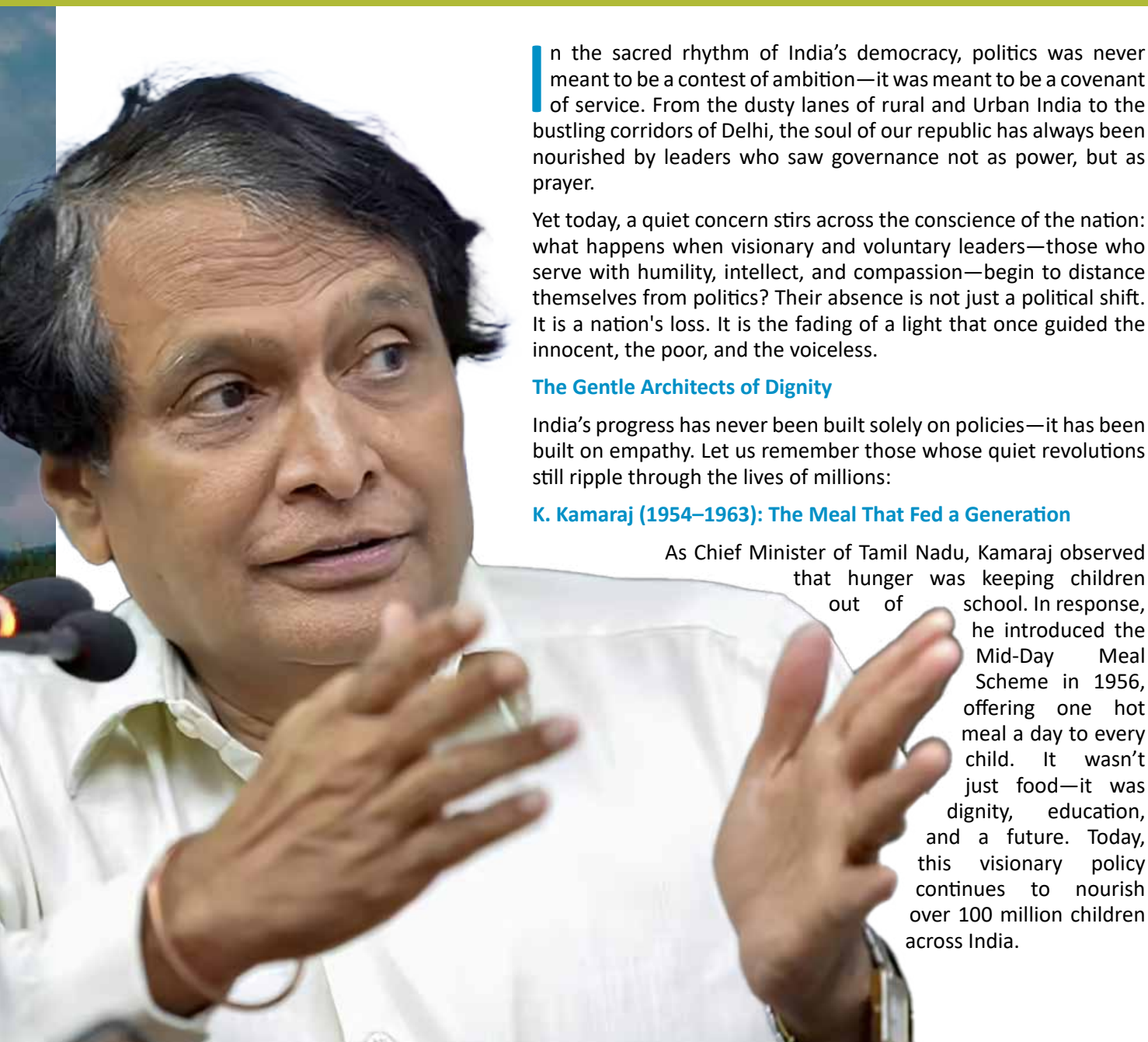
DR SN JHA

President ISAE & DDG (Agricultural Engineering),
ICAR



When the Torch Is Set Down

India's Quiet Loss of Visionary Leadership



SH SURESH PRABHU
Former Union Minister - Commerce & Industry, Railways

In the sacred rhythm of India's democracy, politics was never meant to be a contest of ambition—it was meant to be a covenant of service. From the dusty lanes of rural and Urban India to the bustling corridors of Delhi, the soul of our republic has always been nourished by leaders who saw governance not as power, but as prayer.

Yet today, a quiet concern stirs across the conscience of the nation: what happens when visionary and voluntary leaders—those who serve with humility, intellect, and compassion—begin to distance themselves from politics? Their absence is not just a political shift. It is a nation's loss. It is the fading of a light that once guided the innocent, the poor, and the voiceless.

The Gentle Architects of Dignity

India's progress has never been built solely on policies—it has been built on empathy. Let us remember those whose quiet revolutions still ripple through the lives of millions:

K. Kamaraj (1954–1963): The Meal That Fed a Generation

As Chief Minister of Tamil Nadu, Kamaraj observed that hunger was keeping children out of school. In response, he introduced the Mid-Day Meal Scheme in 1956, offering one hot meal a day to every child. It wasn't just food—it was dignity, education, and a future. Today, this visionary policy continues to nourish over 100 million children across India.

Ramakrishna Hegde (1983–1988): The Uniform of Equality

During his tenure as Chief Minister of Karnataka, Hegde noticed poor children attending school in torn or mismatched clothes. In 1983, he introduced free school uniforms for all government school students, ensuring that no child felt lesser because of poverty. His gesture stitched together self-worth and inclusion, one thread at a time.

Vergheese Kurien (1965–1998): The Milk of Collective Strength

As the architect of India's White Revolution, Kurien transformed the country from a milk-deficient nation to the world's largest producer. Through the Amul cooperative model, he empowered rural women and farmers, proving that visionary service can nourish both stomachs and spirits. His leadership of NDDB (National Dairy Development Board) from 1965 onward remains a benchmark in ethical rural development.

Dr. M.S. Swaminathan (1960s–2020s): Seeds of Scientific Compassion

The father of India's Green Revolution, Swaminathan introduced high-yielding crop varieties and sustainable farming practices that saved India from famine in the 1960s. His later work focused on climate-resilient agriculture, farmer rights, and rural nutrition, always centering the dignity of the farmer. His passing in 2023 marked the end of an era in ethical agricultural leadership.

Present-Day Visionaries Choosing Quiet Service

In recent years, some of India's most capable and compassionate leaders have chosen to step back from electoral politics—not out of apathy, but out of a thoughtful desire to serve through quieter, more constructive avenues. Their decision reflects a deep discomfort with the increasingly transactional nature of public life, and a yearning to protect their integrity.

Suresh Prabhu: The Reformer Without a Megaphone

A Chartered Accountant by training, Prabhu held ten Union Cabinet portfolios between 1998 and 2019, including Power, Environment, Railways, and Commerce. His tenure was marked by:

- The Electricity Act of 2003, which transformed India's power sector with transparency and competition.
- Railway modernization, emphasizing safety, passenger amenities, and digital innovation.
- Environmental reforms, including the Biological Diversity Act and bamboo resource development.

Though widely respected for his clean image and policy acumen, Prabhu gradually withdrew from electoral politics, choosing to contribute through academia, diplomacy, and advisory roles.

Dr. Jayaprakash Narayan: The Idealist Who Chose Integrity

A former IAS officer and founder of the Lok Satta Party, Narayan envisioned a politics rooted in ethics and citizen empowerment. His contributions include:

- Advocacy for the Right to Information Act, empowering citizens to demand transparency.
- Campaigns for electoral reform, pushing for inner-party democracy and clean candidates.
- Development of grassroots governance models, especially in Andhra Pradesh.

Disillusioned by the transactional nature of mainstream politics, he stepped away from contests—but continues to mentor youth and civil society movements with unwavering idealism.

Why Do Visionaries Retreat?

- **Polarization and toxicity:** Politics has become a battleground of egos, not ideas.
- **Moral compromise:** Systems often reward loyalty over integrity.
- **Media distortion:** Quiet service is drowned in sensationalism.
- **Fatigue of conscience:** Idealists are cornered, branded, or silenced.

But when they leave, the poorest lose their voice. The youth lose their mentors. The nation loses its soul.

A Call to Conscience

India must not become a place where visionaries feel unwelcome. We must:

- Celebrate quiet service, not just loud slogans.
- Open doors to thinkers, healers, and reformers—from poets to scientists, from spiritual leaders to social workers.
- Protect dignity in discourse, allowing politics to be a space for ideas, not insults.

Let us create a culture where the wise do not walk away—but walk in.

Conclusion: The Prayer of a Nation

To every visionary who once served and now watches from the margins: your work still feeds, educates, and uplifts us. But your absence is felt—in every hungry child, every silenced reform, every dream deferred.

To every citizen: let us make politics worthy of vision again.

Let us walk together—not behind banners, but beneath the light of vision restored.

Written by Lucas

Roadmap to maximise agri-mechanization & automation by 2047

ICAR-CENTRAL INSTITUTE OF POST-HARVEST ENGINEERING AND
TECHNOLOGY, LUDHIANA

India's aspiration to become a developed nation by 2047 depends largely on the transformation of its agriculture sector. Today, farming remains largely labour-intensive and vulnerable to high losses and low input use efficiency, but with mechanisation and automation, it can evolve into a technology-driven, efficient, and globally competitive system. This transformation will extend well beyond tractors and harvesters to include precision agriculture, robotics, post-harvest processing, IoT-based monitoring, and AI-powered decision-making. Over the next two decades, Indian agriculture will progress from basic machine access to intelligent, data-driven automation, optimising the entire farm-to-fork chain. The vision for 2047 is clear: every farmer, regardless of land size, should have timely access to suitable machines supported by intelligent systems that minimise drudgery, boost productivity, reduce losses, and enhance value capture. Alongside the agriculture, agricultural machinery manufacturing sector will also evolve to gain global leadership.

Phase 1: 2025–2030 – Building access and inclusivity: In the immediate future, the emphasis will be on accessibility and inclusiveness. Since more than 85% of Indian farmers operate on less than two hectares, ownership of expensive machinery is unrealistic. Therefore, mechanisms like custom hiring centres (CHCs), FPO-managed machinery banks, mobile agro-processing services and micro-franchise service models must expand quickly. These hubs should provide diverse equipment such as mini power weeders, small-scale planters, drones for spraying, harvesters, dryers, graders, and packaging machines. Post-harvest mechanisation is equally vital, as significant losses (quantitative as well as qualitative) occur after harvesting. Establishing modular village-level agro-processing centres (APC) with cleaners, graders, dryers, and packaging facilities will help farmers capture more value locally. IoT-enabled cold storage and transport systems will play a critical role, enabling real-time monitoring of conditions like temperature and

humidity to extend shelf life and reduce wastage. Skills development will also be prioritised through district-level “Mechanisation Skill Centres,” which will train operators, drone pilots, and technicians. A special focus will be on empowering women farmers with ergonomically designed tools and support for micro-entrepreneurship. Financial inclusion tools like pay-per-use models, lease-to-own schemes, and usage-based insurance will make mechanisation affordable. Predictive maintenance systems, powered by QR-coded service logs and IoT sensors, will ensure reliability. Standardization of products and processes is one of the major areas for production of quality machines and value added food products. The country will be able to align all the major standards with the relevant international standards. Further more, we will be able to influence the international standard so as to protect the rights and interest of Indian manufacturers and industry.

Phase 2: 2030–2040 – Integrating Intelligence: The second phase will shift the focus from access to intelligence. Mechanisation will be deeply integrated with AI, machine learning, robotics, and IoT, enabling smart, precision-driven operations. Farm machinery will evolve into intelligent systems capable of sensing variability in soil and crop conditions, adjusting inputs in real time, and minimising resource wastage. AI-driven drones and robotic arms will carry out complex



DR NACHIKET KOTWALIWALE
AND
DR DHRITIMAN SAHA



tasks like weed identification, crop stress detection, and selective harvesting of unevenly maturing crops. Post-harvest processes will also undergo significant automation. Machine vision and hyperspectral imaging will allow automated grading and quality assessment of grains, fruits, and vegetables, ensuring transparent, quality-based pricing. Robotics will not only enhance capacity and efficiency but also take care of processing jobs performed under precarious conditions. 3D printing will streamline food processing and packaging through food prototyping and customisation, especially if the functional foods. 3D food printing will also support personalised nutrition programs, while smart packaging with embedded biosensors will extend product shelf life and guarantee traceability via blockchain. IoT-based sensors and digital twin technology will make storage predictive—cold rooms, for example, will use physics-based and AI models to forecast shelf life and detect risks - like moisture migration or spoilage. Agro-industrial by-products can be processed into nutraceuticals, functional foods, and bioactive compounds using eco-friendly methods like fermentation or supercritical fluid extraction. In the livestock sector, automation in feeding, milking, environment control and waste handling will enhance hygiene and efficiency, particularly in peri-urban dairy clusters. Collectively, these advancements will transform agriculture into a precision-oriented, data-rich ecosystem with real-time decision-making and reduced dependence on manual labour.

Having developed a formidable capacity of producing sensors and related electronic devices in the country, the Indian agriculture machinery manufacturers will be able to provide advanced machinery at a very competitive price and with a precision comparable to its global competitors.

Phase 3: 2040–2047 – Achieving Autonomy and Sustainability: The final phase will prioritise autonomy, resilience, and sustainability, aligning with the goal of

“Viksit Bharat.” By then, mechanisation levels should exceed 75%, with farm power availability comparable to global standards. Autonomous robots, cobots, and robotic swarms will dominate horticulture; performing tasks like weeding, spraying, and harvesting with minimal human input. Multipurpose autonomous vehicles, equipped with AI and computer vision, will carry out seeding, intercultural practices, and harvesting under remote supervision. The post-harvest chain will be fully digitised and AI-managed, with digital twins enabling predictive shelf-life estimation, resource allocation, and dynamic price discovery. Advanced biosensors and spectroscopy will be widely used to detect adulterants, pathogens, and contaminants, reinforcing food safety and boosting India's global agri-export dominance. Sustainability will become mainstream, and technologies for crop residue management will eliminate stubble burning, turning biomass into bio-CNG, biofuels, and eco-friendly composites. Machinery will increasingly run on solar, hydrogen, or hybrid systems, supported by carbon-neutral protocols to reduce emissions across the supply chain. Decentralised, clean-energy-powered value-addition hubs will allow farmers to process high-value foods, nutraceuticals, and bio-materials closer to their fields, reducing rural-urban disparities. By India's centenary year of independence, mechanisation and automation will be visible in every farming village. Farmers will access fleets of shared machines through digital platforms, drones and robots will perform tedious fieldwork, IoT sensors will ensure quality from field to storage, and AI will predict yields, prices, and shelf life. Waste will be transformed into value-added products, nutraceuticals, and bio-materials, creating new income streams. Farming will no longer be viewed as a low-income, labour-heavy occupation but as a modern, technology-powered enterprise. The roadmap envisions mechanisation and automation not as luxuries, but as rights for all farmers and agri-supported industry — ensuring prosperity, food security, and global competitiveness by 2047.

MECHANIZATION

The Mantra for Viksit Krishi



MR M BALAKRISHNA

Fundamental Aspects:

Short-term focus (by 2030): Access and affordability of basic mechanization, precision agriculture pilots, innovative financing models, and rural skilling initiatives.

Long-term focus (by 2047): Widespread automation and autonomy, electrification, digital twin farming, climate-smart integration, and establishing global leadership in Agri-robotics.

Technology & Infrastructure

- **Short-term:** Expand adoption of basic mechanization (tractors, harvesters, power tillers, planters). Promote custom hiring centers and leasing models to improve access for small and marginal farmers. Deploy drones for spraying, mapping, and seeding. Strengthen rural connectivity to enable digital advisory services and precision tools.
- **Long-term:** Implement fully integrated precision agriculture (sensors, AI-based decision-making, per-plant care). Deploy autonomous fleets (driverless tractors, robotic harvesters, weeding robots). Transition towards electrification and low-carbon mechanization. Introduce universal digital twin farm models for planning, optimization, and risk management.

Farmer Access & Inclusivity

- **Short-term:** Promote pay-per-use models via FPOs/SHGs. Launch special schemes for women and youth entrepreneurs in Agri-tech. Provide affordable financing, credit guarantees, and outcome-based subsidies.
- **Long-term:** Ensure every farmer cluster/village has access to on-demand mechanization services within 24–48 hours. Upgrade skills for operators, technicians, and Agri-tech entrepreneurs. Create strong rural employment opportunities in robotics servicing, digital advisory, and automation hubs.

Sustainability & Climate Readiness

- **Short-term:** Promote water-efficient mechanization (laser levelling, direct rice seeding, precision planters). Encourage conservation tillage and residue management (straw choppers, balers). Incentivize fuel-efficient equipment.
- **Long-term:** Transition to electric/clean-fuel tractors and harvesters. Deploy carbon-smart farming machines integrated with MRV (Measurement, Reporting, Verification) systems for carbon credits. Develop circular mechanization models—converting crop waste into bio-CNG/energy to achieve zero-waste farm clusters.

Post-Harvest & Value Chains

- **Short-term:** Promote mechanized threshing, drying, grading, and cold storage facilities at village/block levels. Integrate drone/IoT-linked logistics systems.
- **Long-term:** Establish fully automated packhouses and cold chains connected to e-markets. Use robotics for sorting, packaging, and grading. Deploy AI-driven logistics and predictive supply chains to minimize losses.

Policy & Regulation

- **Short-term:** Launch a National Mechanization Mission 2.0 with state-level implementation. Establish safety, data, and interoperability standards. Promote right-to-repair policies and local spare parts manufacturing.
- **Long-term:** Continuously adapt policies for autonomous systems (liability, insurance, safety). Mandate green energy transition for fleets. Implement farmer-centric data governance and benefit-sharing frameworks.

Research, Innovation & Manufacturing

- **Short-term:** Incentivize low-cost innovations (retrofit auto-steer kits, low-hp tractors, multipurpose implements). Support startups in drones, robotics, and AI advisories. Introduce PLI schemes for domestic manufacturing.
- **Long-term:** Position India as a global hub for Agri-automation exports. Drive advanced R&D in robotics, AI vision, and bio-inspired machinery. Integrate space technology, IoT, and quantum computing into farming ecosystems.

Capacity Building & Skills

- **Short-term:** Expand KVKs, agricultural institutes, and extension services with mechanization training. Introduce certification programs for drone operators and machine technicians.
- **Long-term:** Develop specialized agricultural automation engineers. Launch continuous skill upgradation programs for rural youth. Implement a National Agri-Tech Workforce Policy to balance automation with rural employment.

Transforming Indian Agriculture Through Strategic Automation



India's vision to become a developed nation by 2047 places the agricultural sector at a critical juncture, with the aim to be the Food Basket of the world, to have more than 10% share in global Agri & allied exports and to make Indian agriculture sector globally competitive, diversified and sustainable.

With India's population projected to reach 1.61 billion by 2047, boosting farm mechanization to 75-80% requires a technological revolution and a comprehensive transformation of the agricultural ecosystem, including governance.

Learning from Global Agri-leaders

The path forward becomes clearer when we examine global leaders in agricultural mechanization.

The US excels in precision agriculture, drone technology, and advanced irrigation systems. The Netherlands' controlled environment agriculture and vertical farming innovations have earned it the title "Silicon Valley of Agriculture." Israel's expertise in drip irrigation, sensor-based monitoring, and satellite technology is notable. China's precision farming and robotic automation, Japan's agricultural robotics, and Germany's precision

PROF. (DR.) BALVINDER SHUKLA
Vice Chancellor, AMITY University

agriculture technologies demonstrate the transformative power of innovation.

These global examples of successful agricultural mechanization call for a holistic approach combining technology adoption, policy support, and complete stakeholder engagement.

India's Agricultural Landscape

India's agricultural research and education infrastructure provides a solid foundation for this transformation. With premier institutions such as The Indian Agricultural Research Institute (IARI), National Dairy Research Institute and Punjab Agricultural University, 74 agricultural institutions and approximately 101 agricultural research institutes across the country, India possesses the research ecosystem required for developing locally relevant mechanization solutions. The Indian Council of Agricultural Research (ICAR) plays a pivotal role in coordinating this vast network.

Current Mechanization Landscape and Challenges

India's present overall farm mechanization rate stands at 47% with substantial disparities in mechanization levels across different crops and regions. While crops like wheat and rice have higher mechanization rates due to government support and market demand, others like sorghum and millets which are high on nutrition remain largely dependent on traditional methods. This highlights the need for customized solutions considering factors like crop characteristics, regional climate, and market demand etc.

The predominance of small landholdings in Indian agriculture presents unique challenges such as difficulty in adopting modern agricultural technologies; lower economies of scale resulting in higher purchasing price and low profitability; limited scope for crop diversification and rotation; higher vulnerability to sudden climate change. Traditional mechanization models designed for large-scale farming operations often prove inadequate for the uneven land ownership patterns.

Another significant challenge to mechanization is the poor after-sales service of equipment, which can lead to prolonged downtime, increased repair costs, and decreased overall productivity, ultimately discouraging farmers from investing in modern machinery.

Strategic Roadmap for 2047

The roadmap to maximize agricultural mechanization and automation by 2047 requires a systematic, phase wise, multi-stakeholder approach that addresses current inefficiencies while building future capabilities.

Phase 1: Comprehensive Assessment and Planning

The foundation of successful mechanization lies in thorough ground-level assessment. Government bodies, in partnership with local NGOs, industry, universities and research institutes, must conduct extensive surveys across the country to understand region-specific agricultural challenges, identify opportunities for improvement, and explore viable automation interventions. These surveys should adopt a project-based approach, involving experts from agriculture, horticulture, food technology, input supply, post-harvest technologies, and research domains to ensure comprehensive coverage.

This assessment phase is critical for developing context-appropriate solutions considering local agricultural practices, soil conditions, crop patterns, and farmer capabilities, rather than adopting one-size-fits-all approaches.

Phase 2: Policy Framework and Implementation Strategy

Based on comprehensive assessments, policymakers must develop detailed implementation roadmaps with clear timelines and measurable targets. This involves creating supportive policy environments that encourage mechanization adoption while addressing potential barriers such as financing, training, and maintenance infrastructure.

The policy framework must balance immediate needs with long-term sustainability goals, ensuring that mechanization efforts align with environmental conservation and climate resilience objectives.

Phase 3: Scheme Deployment and Technology Integration

The rollout phase focuses on implementing mechanization schemes through multiple channels. Key strategies will include promoting precision agriculture through GPS-guided tractors, drones, and sensor-based systems to optimize resource utilization. Developing cost-effective machinery suitable for small landholdings and establishing cooperative models for machinery sharing to address the unique challenges of Indian agriculture.



Creating comprehensive digital platforms for farm mechanization will ensure that farmers have access to machinery, technology, and expertise while enhancing overall efficiency and productivity. These platforms can facilitate equipment sharing, maintenance scheduling, and technical support.

Custom Hiring Centres (CHCs) will play a critical role in democratizing access to high-cost agricultural machinery. By pooling resources, small and marginal farmers can benefit from advanced mechanization without bearing the full financial burden of ownership. These centres can also be supported by Farmer Producer Organizations (FPOs), ensuring better governance, transparency, and wider outreach.

Farmer Producer Organizations (FPOs) act as a strong collective voice for farmers, enabling them to negotiate better prices, access finance, and adopt mechanization at scale. Integrating FPO-led models into the mechanization roadmap will not only address the challenge of fragmented landholdings but also improve coordination and efficiency in machinery usage.

A hybrid model where FPOs manage Custom Hiring

Centres could emerge as a scalable and sustainable solution. Such models would combine the advantages of collective bargaining, access to subsidies, and localized management, ensuring that mechanization benefits reach the grassroots level. Training and capacity building programs under this framework can further enhance the skillsets of rural youth, create employment while support mechanization adoption.

Phase 4: Monitoring, Quality Assurance, Evaluation and Continuous improvement

A robust monitoring system involving stakeholders at all levels, including farmer organization, gram panchayats, district collectors, NGOs, students and researchers, ensures effective implementation, identifies areas for improvement and suggest measures for mid-term correction. Regular reporting mechanisms and real-time feedback loops help maintain scheme effectiveness and address emerging challenges promptly.

The involvement of academic institutions and student communities can significantly scale monitoring efforts while providing practical learning opportunities. This approach creates a self-reinforcing system where

education, research, and implementation continuously inform each other.

Beneficiary-driven rating systems to evaluate the effectiveness ensures that mechanization efforts deliver tangible benefits to farmers while identifying successful models for replication.

Addressing Implementation Challenges

A critical challenge in the current agricultural development chain is the approximately 50% optimization loss occurring due to coordination gaps between stakeholders. While agriculturists, researchers, and policymakers excel in their respective domains, inadequate stitching reduces overall effectiveness.

The proposed roadmap addresses this challenge through systematic stakeholder involvement and continuous monitoring. By engaging students and researchers in monitoring processes, the system can achieve scale while maintaining quality oversight.

Incentivization of Technology Integration, Innovation and Skill Development

Success requires emphasis on research and innovation,

and skill development programs for technicians in farm machinery repair and maintenance. Public-private partnerships with farm equipment manufacturers can accelerate innovation and technology adoption.

While a high volume of research work and patents is often prioritized, it's essential to shift the focus towards innovations that are locally relevant and impactful. Instead of solely emphasizing quantity, government should incentivize successful innovations that address pressing local challenges. Prioritizing locally driven innovation, would ensure that research and development efforts yield tangible benefits for the community, and create more meaningful and sustainable solutions that positively impact people's lives.

The roadmap to maximize agricultural mechanization and automation by 2047 will require coordinated and committed efforts across all stakeholder levels, from policy formulation to ground-level implementation. By learning from global best practices while addressing local challenges, India can achieve its mechanization goals and ensure food security for its growing population and position itself as a global leader in agricultural mechanization and automation.

The Affordability Myth:

Protein Doesn't Have to Be Expensive

“The idea that protein is expensive has lingered for decades, shaping meal choices in kitchens across the country. Families skip protein-rich foods because they fear high grocery bills, students trade protein for more filling but less nutritious carbohydrates, and working professionals assume “healthy food” means spending on costly powders. These are all too familiar situations. But the notion that protein must break the bank is, quite simply, a myth, and breaking it can open the door to healthier, more satisfying diets for millions.



DIVYA KUMAR GULAI
Chairman, CLFMA of India

Affordability: Fact vs. Perception

Protein deficiency remains a public health concern, affecting about 73% of people, with only 10% meeting the daily recommended intake through their diets. A 2023 survey by Kantar IMRB revealed that 90 per cent of people in Lucknow are protein-deficient, while Ahmedabad and Chennai report rates of 84 per cent. Even among non-vegetarians, 65 per cent do not get enough protein, showing that the issue goes beyond dietary preference.

Despite these alarming numbers, the idea that protein is unaffordable persists. In reality, protein is widely available and surprisingly economical. The problem lies less in cost and more in habits and perceptions. Many people assume that only expensive meats or protein powders can provide sufficient nutrition, overlooking simple, everyday foods that are both rich in protein and budget-friendly.

Affordable options are already on supermarket shelves and in local markets. Eggs cost around ₹5–7 each and provide 6 grams of protein. Soya chunks, priced under ₹15 per 100 grams, pack 52 grams of protein. Chicken breast, at about ₹28 per 100 grams, supplies 24 grams of protein, while a bowl of dal gives 9 grams for a fraction of the cost of meat or supplements. Lentils, chickpeas, paneer, peanuts, and other staples can easily form the backbone of a protein-rich diet without straining the household budget.

Protein Source Comparison: Crunching the Numbers

Here's what the real cost of protein looks like with food readily accessible in most markets:

Notice that soya chunks and eggs deliver some of the highest value-per-rupee among all protein sources,

Food	Protein/100g	Average Price*	Cost per 10g Protein*
Soya Chunks	52g	₹15 (per 100g)	~₹3
Eggs	6g	₹6 (per egg)	~₹5
Chickpeas	19g	₹15 (per 100g)	~₹8
Dal (Lentils)	24g	₹12 (per 100g)	~₹5
Paneer	19g	₹35 (per 100g)	~₹18
Peanuts	24g	₹10 (per 100g)	~₹4
Chicken Breast	24g	₹28 (per 100g)	~₹12
Milk	3g	₹6 (per 100ml)	~₹20

*Prices are averaged across various retail sources; actual costs may vary by region and season.

debunking the assumption that plant-based protein is either incomplete or prohibitively expensive. Even animal proteins such as chicken, often considered a luxury, are accessible to most middle-income families.

Supplements and protein powders, meanwhile, remain more expensive, generally costing ₹900–₹2,500 per kg, and providing about 60–80g of protein per 100g. For most people, these costs are unnecessary, as common food sources easily meet daily needs.

The Hidden Costs of Misconception

Why does the affordability myth persist? Advertising from protein bars and powders to influencers promoting high-ticket products is one factor. Long-standing

meal traditions that prioritise rice, wheat, and other carbohydrates also play a role, relegating pulses, eggs, dairy, and meat to side dishes.

Cultural preferences and taboos further complicate matters. Many households avoid eggs or certain meats, assuming plant sources are poor alternatives. Yet lentils, peanuts, soya, and affordable cuts of chicken or fish are nutritionally robust and accessible. Many families, particularly in rural areas, rely heavily on a few staple foods like rice and potatoes because these are inexpensive and readily available, even when other protein-rich options are within reach. In reality, minor swaps such as adding a cup of milk, a handful of roasted chana, or a small portion of chicken can significantly increase protein intake without raising the food bill.

How Real People Beat the Myth

The good news is that many families are quietly proving that protein does not have to be expensive. Simple changes to everyday meals can make a huge difference without increasing the grocery bill.

For example, households that add eggs to breakfast, a portion of soya chunks or dal to lunch, and peanuts or milk as snacks often see marked improvements in energy, growth, and overall health. Incorporating lean cuts of chicken or small portions of mutton a few times a week provides additional protein without turning meals into a luxury.

Children who receive a balanced mix of pulses, dairy, and occasional meat tend to grow taller, recover faster from minor illnesses, and have more consistent energy throughout the day. These small, practical swaps show that a protein-rich diet is within reach for almost every household, challenging the long-standing belief that protein is only for the affluent.

Making Protein Accessible to All

So, what can be done? Institutions and policymakers have already taken steps, like including eggs and pulses in mid-day meals at schools, and fortifying common foods to address nutritional gaps. Public nutritional campaigns now highlight that traditional dishes such as khichdi with dal, poha with peanuts, rajma-chawal, and besan chillas to fulfil protein needs without any costly additions.

Smarter grocery choices also help. Bulk buying, local sourcing of eggs, and seasonal planning of meals keep food budgets in check. Soya, once dismissed as “inferior,” is earning pride of place in meal plans thanks to its texture, ease of cooking, and unmatched value.

Towards a Protein-Confident Future

Ultimately, the affordability of protein is not just about picking the cheapest ingredient, but it's also about breaking habits and building knowledge. Awareness is growing that complete nutrition doesn't demand supplements or restaurant-style meal plans. Instead, protein is present in abundant, affordable ingredients available in every market and kitchen shelf.

It's time to retire the myth that protein is only for the affluent. By honouring traditional recipes, getting inspired by others' success stories, and trusting the unparalleled value of local protein foods, every person can enjoy the benefits of good health without paying a premium for the privilege.

Viksit Krishi for Viksit Bharat

Indian agriculture has transformed into a globally significant narrative of growth—extending beyond mere sustenance to encompass nutritional and health security. Nevertheless, it confronts pandemics and evolving dietary and lifestyle patterns, particularly the increasing apathy of millennials towards conventional agriculture. In this scenario, mechanization has become an imperative rather than an option.

Post-1947, India's road towards mechanization commenced. The tractor industry experienced rapid growth. Farm power escalated from 0.48 kW/ha in 1975–76 to 2.50 kW/ha in 2018–19. Machines such as powered tillers, seed drills, and harvesters became prevalent. Several farmers have profited from government initiatives.

India's current level of mechanization stands at approximately 47%, and to achieve the status of a developed nation, or Viksit Bharat, by 2047, it must target a minimum of 75% mechanization. Consequently, mechanization should be reconceptualized as a holistic facilitator throughout production, processing, and

logistics. Effective, scalable, and contextually relevant mechanization can enhance biomass utilization, decrease labor reliance, mitigate post-harvest losses, and create value addition opportunities, thus fostering rural agri-industrialization.

Current actions to be implemented by the Government of India

The Government of India provides assistance to farmers via several initiatives

a) Sub-Mission on Agricultural Mechanization (SMAM): This scheme offers financial assistance (40–50%) for the purchase of tractors, agricultural machinery, and post-harvest equipment. Additionally facilitates the development of Custom Hiring Centres, Agricultural machinery banks, and high-tech hubs. Crop Residue Management (CRM): Addresses the issue of paddy straw (parali) burning by endorsing machinery such as the super straw management system, reversible mould board plough, mulcher, straw choppers, smart seeder, super seeder, happy seeder, hay rake, balers, and reaper binder, through subsidies for individual farmers and Self Help Groups (SHGs)/FPOs/Societies, among others.

b) CRM scheme for sustainable crop residue management through mechanization: Paddy straw (Parali) burning causes severe air pollution. Mechanization offers eco-friendly alternatives, supported under the CRM scheme through subsidies. Crop Residue Management (CRM), addresses the issue of paddy straw (parali) burning by endorsing machinery such as the super straw management system, reversible mould board plough, mulcher, straw choppers, smart seeder, super seeder, happy seeder, hay rake, balers, and reaper binder, through subsidies for individual farmers and Self Help Groups (SHGs)/FPOs/Societies, etc. These machines reduce pollution, improve soil health, and support sustainable farming.

Under the SMAM and CRM initiatives, millions of machines have been provided to farmers at a subsidy of 40–50%. CHCs receive up to 80% funding, rendering machinery accessible for small-scale farmers. This aids the agricultural community in developing and

contributing to national progress. The government has launched several path-breaking initiatives to support farmers. Unprecedented enhancement in budget allocation has been made. During 2014–15 to 2024–25 an amount of more than Rs. 17000 crore has been allocated under various schemes and programmes of Mechanization for welfare of the farmers and distributed > 63 lakh machinery and established > 90000 Custom Hiring Centers. Ultimately this has reflected in the growth in mechanization by increasing in farm power availability up to 3.04 kW/ha (2021–22), along with the development of suitable technologies, implements and machinery.

c) Namo Drone Didi Scheme - The Scheme's aim is to supply drones to 14,500 designated Women Self-Help Groups for offering rental services to farmers for agricultural purposes, specifically the application of liquid fertilizers and pesticides. The program would provide Central Financial Assistance of 80% of the cost of drones and associated expenses, up to a maximum of ₹8.0 lakhs, to women's Self-Help Groups for the acquisition of drones as a package. The efforts under the project are expected to offer sustainable economic and livelihood support to SHGs, enabling them to generate additional income. The initiative will facilitate the integration of advanced technologies in agriculture to enhance efficiency, increase crop yield, and lower operational costs for the benefit of farmers.

- Training and Testing by FMTTIs: Four Farm Machinery Training and Testing Institutes (FMTTIs) teach farmers, train operators, repair and maintenance of latest agricultural machinery and technology and test the quality and safety of farm machines.

THE FOUR FMTTIS ARE:

- Central Farm Machinery Training and Testing Institute, Budni, Madhya Pradesh (1955)
- Northern Region Farm Machinery Training and Testing Institute, Hisar, Haryana (1963)
- Southern Region Farm Machinery Training and Testing Institute, Garladinne, Anantapur, Andhra Pradesh (1983)
- North Eastern Region Farm Machinery Training and Testing Institute, Biswanath Chariali, Sonitpur, Assam (1990)

Challenges ahead - Amidst advancements, issues persist:

- Machines remain prohibitively expensive for several individuals.
- Dependency on Imports for Agricultural Machinery Excluding Tractors
- Fragmented landholdings restrict the utilization of machinery.

4. Awareness and training levels are inadequate in certain places.

5. Unskilled workforce

Future roadmap

Furthermore, additional steps are necessary to transform the country into a developed Bharat. The solutions encompass the following essential steps as a roadmap.

1. Research and Development Interventions - Research and development in agricultural machinery is essential for enhancing mechanization, increasing efficiency, and alleviating labor burdens for farmers in India. Considering that small and marginal farmers represent > 80% of all landholders. Enhancing research initiatives, fostering public-private partnerships (PPPs), and amplifying new solutions is must for improving output, ensuring resource efficiency, and making mechanization accessible to all.

2. State Government Mechanization revamp - The creation of economical, region-specific, and precision-engineered agricultural equipment is imperative. State governments in India are critical in advancing farm mechanization through the execution of region-specific policies and initiatives designed to address the unique requirements of their agricultural environments.

3. Encouragement of Gender-Inclusive Technology



YATIH NUPUR

Senior Agricultural Engineer, Mechanization and Technology Division, DA&FW, Govt. of India



DR. V. N. KALE

Additional Commissioner, Machinery, Mechanization and Technology Division, DA&FW, Govt. of India

- Women comprise approximately fifty percent of the agricultural workforce currently, and their proportion is expected to rise further. Consequently, gender-inclusive mechanization is vital for the effective involvement of women in agriculture. Make substantial contributions to diverse agricultural activities, encompassing sowing, transplanting, weeding, harvesting, and postharvest processing. Implementing gender-inclusive mechanization for women farmers and workers will boost agricultural productivity and economically empower women by facilitating their participation in agri-preneurship, mechanized farming services, and post-harvest processing ventures.

4. Directorate/Department of Agricultural Engineering in every State in the Nation - The establishment of a Directorate of Agricultural Engineering is crucial for the methodical planning, execution, and oversight of agricultural mechanization and engineering initiatives at the grassroots level. A specialized Directorate would function as a central coordinating entity to amalgamate research, policy development, and field implementation of mechanization initiatives.

5. Advocating for Precision and Innovative Agricultural Technologies - Precision and Smart Farming Technologies are currently accessible to align with the latest technical advancements for improved agricultural mechanization in India. Precision agriculture employs GPS-guided tractors, AI-driven automation, IoT monitoring, and drone technologies to facilitate site-specific agricultural management, maximize input efficiency, and decrease operational expenses. Intelligent sensors and data-centric analytics enable farmers to assess soil health, identify crop stress, and enhance irrigation and fertilizer usage sustainably. GPS-equipped tractors, Conserve fuel and operate with precision. Agricultural Drones, Apply pesticides and assess farmland. Robotic instruments: Automate activities such as weeding.

6. Make in India Campaign for Agri-Tech Startups and Agricultural Machine Manufacturing - India imports numerous agricultural tools and machinery, except tractors, which incurs significant taxation. Indian producers do not meet the requisite standards of quality assurance. We intend to promote the systematic adoption of BIS standards among Indian firms. We should definitely think about financing testing expenses to motivate producers. It is recommended to terminate subsidies on imported equipment. A timeframe for the full indigenization of agricultural machinery production in India should be established, with a gradual reduction in the percentage of imported components. The majority of agricultural equipment requirements are seasonal. We could think about funding 'Services' rather than the

acquisition of equipment.

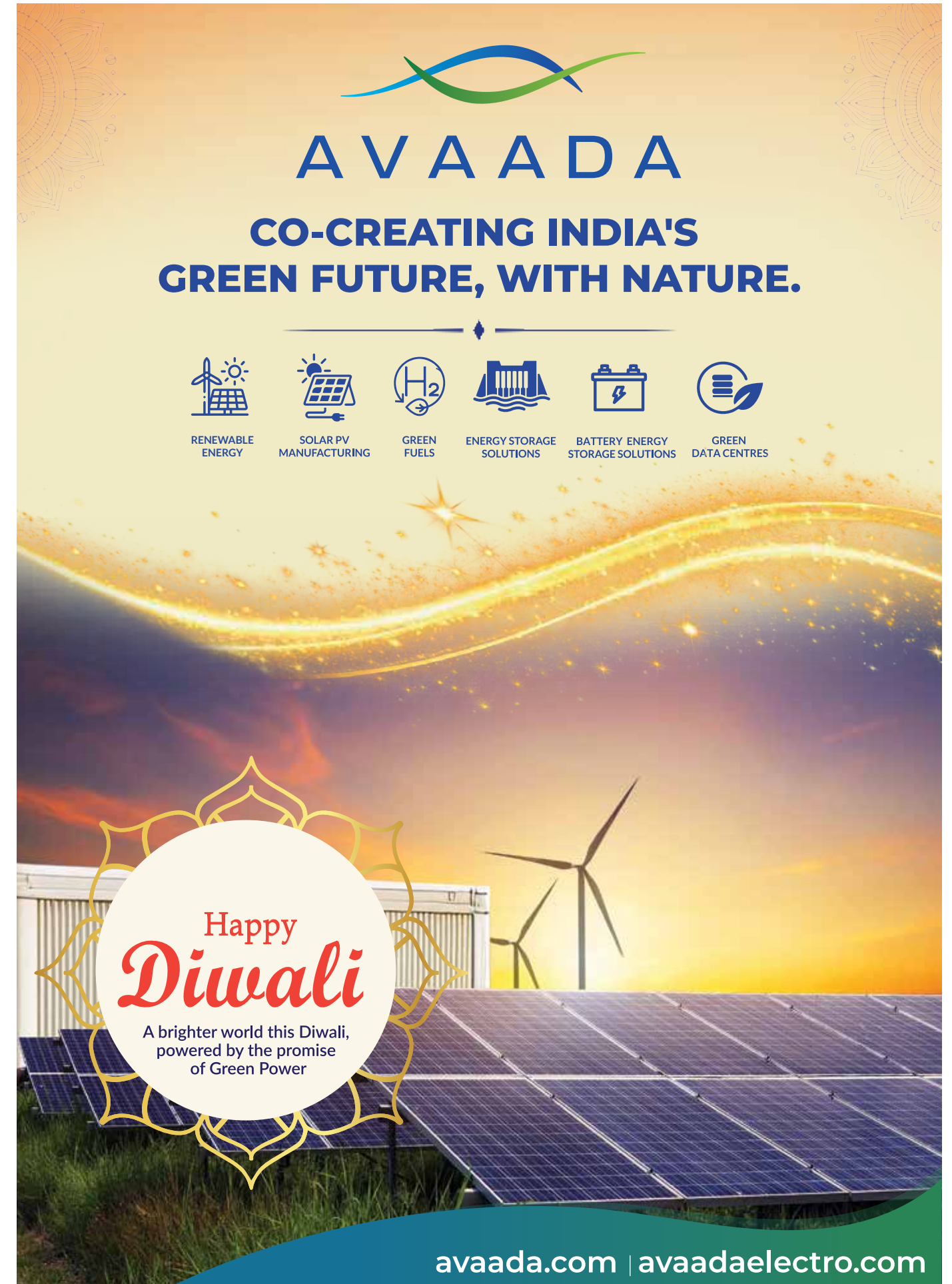
7. Promoting Public-Private Collaborations - Promoting public-private partnerships is essential for expediting farm mechanization in India, facilitating broad access to sophisticated agricultural machinery, and closing the divide between invention and execution. The private sector, leveraging its proficiency in technological development, production, and service delivery, may augment government initiatives to enhance mechanization, increase affordability, and broaden access for small and marginal farmers. Additionally, strengthening PPPs to create leasing and rental models through CHCs and Agri-Tech platforms will allow smallholders to access mechanization without heavy capital investment.

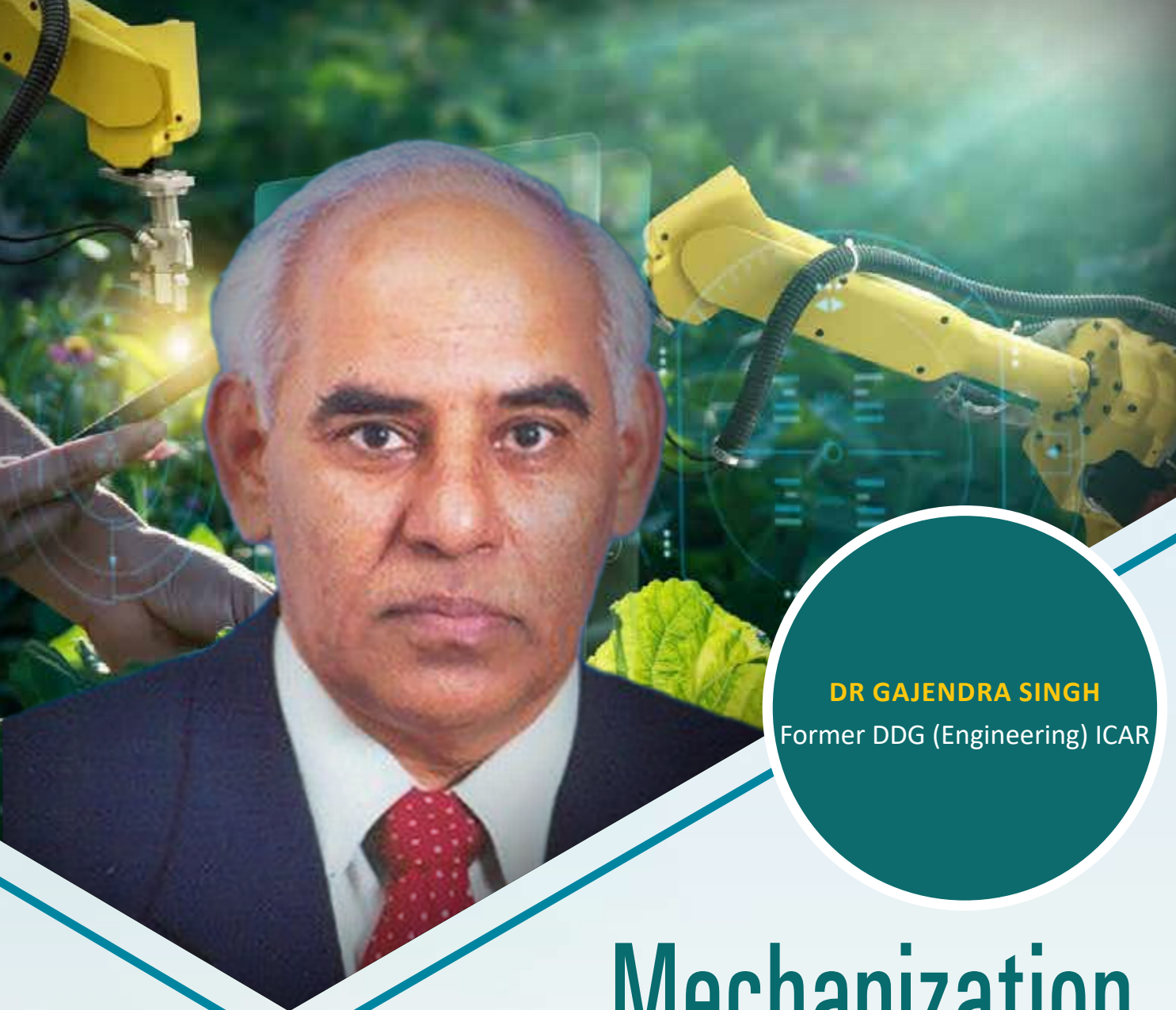
8. Building a Proficient Workforce - Fostering a proficient workforce is essential for expediting agricultural mechanization in India. The rise of precision farming, AI-driven automation, and IoT-enabled machinery has created an escalating demand for technically proficient individuals, machine operators, and rural agricultural technicians.

9. Focus on Renewable Energy in Agriculture - As per research findings, on an average the agriculture accounts for 10 % of diesel consumption in India and account for around 14% of national greenhouse gas emissions. India has promised at the COP26 conference to double the share of renewable energy in the country's electrical output by 2030, but the sector currently accounts for only 25% of total generation. India plans to reach its goal of "Net Zero Emissions" by the year 2070. In current scenario, more than 80 % of energy demand is met by fossil fuels like, Coal, oil and gases. We need to begin using renewable energy sources like solar, biogas, wind, biodiesel, geothermal, etc. High installation costs, low efficiency, and a lack of information have prevented these energy sources from gaining widespread acceptance despite the efforts of research teams. Therefore, it is high time to do research and development on utilization of these renewable source of energy.

CONCLUSION

Agricultural mechanization is the catalyst that will facilitate Viksit Bharat. India is advancing towards sustainable, inclusive, and high-tech agriculture, bolstered by robust government backing, proficient farmers, contemporary technologies, and proven machinery. By empowering small farmers and providing safe and intelligent instruments through FMTTI training and testing, we can enhance Indian agriculture significantly.





DR GAJENDRA SINGH
Former DDG (Engineering) ICAR

Mechanization

The Backbone for Agricultural Transformation

Summary: This roadmap outlines a strategic plan to significantly expand the adoption of mechanization and automation in Indian agriculture by 2047. It envisions a long-term, structured transformation of farming practices—making them more efficient, climate-resilient, and less labor-intensive—through widespread use of modern machines, smart tools, and automated technologies.

1. Introduction

As India approaches its 100th year of independence, the agricultural sector is poised for a crucial transformation. While the Green Revolution helped the country transition from food scarcity to surplus, today's challenges—such as declining resource quality, climate volatility, labor shortages, and low productivity in non-cereal crops—demand a new revolution: one driven by mechanization and automation. The goal for 2047 is not just to feed a growing population, but to make farming a high-tech, profitable, and environmentally sustainable enterprise.

2. Current Landscape and Challenges

Currently, only about 50% of agricultural operations in India are mechanized. Most mechanization is centered on cereals like rice and wheat, while critical crops such as sugarcane, cotton, and horticulture remain largely dependent on manual labor. The Indian tractor market, often mistaken for full mechanization, reflects this imbalance—tractors make up 80% of farm machinery but are primarily used for land preparation and transport.

Mechanization has a direct impact on productivity. Farm power availability in India increased from 0.28 kW/ha in 1960 to 2.76 kW/ha in 2021, corresponding with a nearly threefold rise in food grain productivity. However, regional disparities, affordability, small landholdings, and limited custom hiring infrastructure still restrict access for small and marginal farmers.

3. Strategic Vision for 2047

The vision for 2047 is to develop a mechanized and partially automated agricultural ecosystem that:

- Improves productivity and resource efficiency
- Reduces drudgery and manual labor
- Increases profitability for farmers
- Strengthens resilience to climate change
- Supports sustainability and low-carbon practices

Mechanization must be crop-specific, region-specific, and scale-sensitive, integrating digital technologies, AI, robotics, drones, and precision tools into mainstream agriculture.

4. Key Focus Areas for Mechanization and Automation

A. Modernizing Core Farm Operations: A variety of machinery must be developed and widely adopted for seeding, transplanting, spraying, harvesting, post-harvest handling, and irrigation. Machines should be tailored to India's diverse agro-climatic zones and small farm sizes.

B. Expanding Beyond Cereals: Mechanization must target under-served sectors such as:

- Sugarcane and cotton (high labor and climate-sensitive)
- Horticulture (perishable and high-value)
- Livestock, poultry, and fisheries (non-crop sectors with growing demand)

C. Digital and Smart Farming: Automation must go hand in hand with smart technologies:

- Drones for monitoring, spraying, and imaging
- AI-enabled robots for precision weeding and harvesting
- Laser-guided and sensor-based tools for precision input use
- IoT-based irrigation and fertigation systems for water-use efficiency

5. Policy and Institutional Reforms

To support this transformation, several policy shifts are essential:

- **Service-Based Subsidies:** Replace purchase-based machinery subsidies with service-based support, especially for smallholders using Custom Hiring Centres (CHCs).
- **Support to MSMEs:** Promote domestic manufacturing of agricultural machinery by supporting MSMEs and regulating imports of subsidized foreign equipment.
- **CHC Modernization:** Enable CHCs to procure and maintain advanced tools and attachments through concessional loans, subsidies, and digital monitoring.

- **Skilling and Human Resource Development:** Introduce targeted training programs in agricultural universities and technical institutes for operating, maintaining, and innovating machinery.

6. Infrastructure and Industry Integration

India's vast tractor manufacturing industry, projected to grow at 3–5% CAGR, must diversify into smart, precision equipment beyond land preparation and transportation. The roadmap encourages:

- Developing multi-functional attachments compatible with 30–50 HP tractors
- Promoting 'Lend-to-Rent' systems for better utilization of existing machinery
- Building test and training centers across agro-climatic zones for field trials and demonstrations

7. Climate and Sustainability Alignment

Mechanization must align with environmental priorities:

- Use conservation agriculture machinery to minimize tillage and soil erosion
- Deploy low-emission equipment to reduce GHGs
- Promote bio-circular economy tools like composters and biomass processors
- Integrate mechanized support in zero-carbon agriculture initiatives

8. Research and Development Roadmap

To support future-ready mechanization, the agricultural R&D system should prioritize:

- Development of smart, modular equipment for diverse crops
- Automation of post-harvest processes including storage, packaging, and logistics
- Genetic and agronomic research aligned with mechanized practices
- Systems for real-time data integration and decision support in machinery use

9. Conclusion

The transformation of Indian agriculture through mechanization and automation is both urgent and achievable. With the right policies, targeted investments, and inclusive innovations, India can become a global leader in smart, sustainable farming by 2047. The roadmap calls for a national commitment—bridging science, policy, industry, and grassroots—to ensure that every farmer, regardless of scale, can thrive in the era of precision and automated agriculture.

The journey to 2047 is not just about replacing labor with machines; it's about empowering farmers with technology to produce more, waste less, and build a resilient food system for generations to come.

Acknowledgement

This article is based on chapter "Farm Mechanization" in the book titled "Roadmap for Indian Agricultural Research, Education and Extension during Amrit Kaal 2047" edited by Himanshu Pathak, et al. Several experts from academia and industry contributed to the chapter on farm mechanization, notably Syed Ismail and Pitam Chandra.



KUNAL GUPTA

Head

Rice Procurement & Dhuri Unit

Reimagining Rice Milling: *India's Shift to Smart, Sustainable Solutions*

Rice has been one of the staple meals of people worldwide for thousands of years. Even today, one of the key players of the agricultural industry is the cultivation of rice. And one of the key players in global rice cultivation is India. Within the last few decades, India has evolved into one of the largest players in the global rice market. The areas around the Indo-Gangetic plains, the Eastern and Western Ghats, and the Brahmaputra Valley have the perfect climate, soil, and rainfall needed for rice cultivation. As such, rice and India have become inextricably intertwined with each other in the global market. However, the traditional rice milling practices are now facing limitations in this ever-evolving world. The increasing costs of the raw materials, the outdated technology, improper disposal of waste, financial problems: these are only some of the issues plaguing the development of rice production in India. These issues, and more, are resulting in an increasing need for transformation, which will better the efficiency, traceability, and sustainability of these practices.

Throughout the world, there is a rising demand for quality rice that is transparent and traceable. This trend is further solidified by changing consumer preferences for clean-label, sustainably produced rice. To address these concerns, a blockchain has been established in agriculture. By recording all transactions within a decentralised ledger, it guarantees that anyone can track the journey of the products from farm to plate.

Alongside this, there are multiple Government policies pushing for further modernisation within the agricultural sector, like the PM-FME scheme, the subsidies provided for agricultural technology, and more. These allow technologies to replace the traditional rice farming practices, such as IoT-enabled machines, which monitor the milling parameters in real time. Or automated machines, which reduce human error and also reduce the risk of any sort of contamination, leading to betterment in the hygiene of the product. Even AI and machine learning is being harnessed to both optimise the yield and sort the grains more efficiently.

Another major player behind this shift are the

environmental concerns. Traditional rice milling practices are heavily dependent on the usage of massive amounts of energy and water, which in turn, release a substantial amount of carbon emissions. To combat this, solar energy and biomass-based boilers are being used, which use clean energy. These biomass boilers are also powered by rice husks, so that a Zero Waste environment is created within the production of the rice. To reduce water usage, closed-loop water systems have been constructed so that the water is reused rather than being discarded. Finally, eco-friendly packaging and reduction in plastic usage removes any other worries about waste management in the rice production processes.

The shift to this more sustainable process has both benefits and challenges. On one hand, it increases operational efficiency and reduces the cost per unit. It allows for a more consistent and higher quality of grain to be produced. It furthers consumer trust by being transparent, through both sourcing and certifications. It also enhances the brand equity and increases potential for global export. On the other hand, these processes need high capital investment and the knowledge to operate these technologies. This requires a skilled and trained workforce, which takes time and resources. And most importantly, this treads on tradition, facing major resistance from farmers conducting traditional rice milling processes.

Even with these challenges, the first step has been taken. Public-Private partnerships have been established globally, believing in this modernisation and conducting themselves according to these new standards. Partnerships like the Sustainable Rice Platform (SRP), or the Market Oriented Smallholder Value Chain (MSVC) programs in Vietnam are global leaders in the development of this ideology. Even in India, startups and Agri-Business Incubators (ABIs) are democratising access to these bettered practices for farmers. The Government is also taking measures to build better digital infrastructures and capacities for the farmers to rely on, creating a vision of India as a global benchmark for smart, sustainable rice milling.

KJ KRISHI JAGRAN

3rd Edition

AWARDS

MFOI



Millionaire Farmer of India
DECEMBER 7-9, 2025 | NEW DELHI

MFOI Awards 2025 : Where Farmers Shine!

75K+ NOMINATIONS

1,000+ AWARDS

30+ COUNTRIES

15,000+ ATTENDEES

15+ Sessions 400+Events

300+ Categories

NATIONAL & INTERNATIONAL MEDIA COVERAGE



Co-organizer



2023-24 Sponsors/Exhibitors

SKYROCKET YOUR SALES
DIRECT ACCESS TO FARMERS
PAN INDIA REACH
SHOWCASE YOUR SOLUTIONS

JOIN US NOW!



Sanjay Kumar +91 93133 01029 | Nishant Kumar Taak +91 99537 56433

Sujeet Pal +91 98918 99197 | Abdus Samad +91 98918 89588

MAXIMIZING AUTOMATION

The Blueprint

Globally, mechanization has been one of the most significant drivers of agricultural transformation. Developed countries have achieved near-complete mechanization, primarily due to large farm sizes that enable economies of scale, robust industrial capacity for advanced farm machinery, and strong institutional support through subsidies, R&D, and training. For instance, in the United States, where farms average over 180 hectares, large machinery such as combine harvesters and planters operate with high efficiency, resulting in mechanization levels exceeding 97%, alongside widespread adoption of precision agriculture and digital tools. Similarly, in Germany and Western Europe, mechanization is almost universal, supported by technological innovation, cooperative machinery use, and advanced manufacturing. China has also demonstrated remarkable progress, increasing mechanization from less than 30% in the 1980s to nearly 80% by 2022, driven by strategic investments, state subsidies, and innovations in both large and small machinery to suit diverse farm sizes. In contrast, Southeast Asia presents a mixed picture: Vietnam and Thailand have achieved mechanization levels of 65–75% through rice sector modernization and government subsidies, while Indonesia has expanded mechanization in paddy cultivation but remains below 60% in other crops.

In the 21st century, the urgency to promote agricultural mechanization in India has intensified. Climate change, labour shortages, rising input costs and the growing demand for sustainable and competitive agriculture call for renewed focus on mechanization. Effective mechanization not only enhances productivity but also supports environmental goals by reducing greenhouse gas emissions through precision input use, enabling conservation agriculture, and promoting renewable energy-based farm operations.

Status of farm mechanization in India

Several structural and socio-economic factors explain the lag in India's farm mechanization. Small and fragmented landholdings, with over 86% of farmers operating on less than two hectares, restrict the economic viability of owning large machinery.

High capital costs make equipment such as harvesters and precision planters unaffordable without subsidies or collective ownership models, while low utilization rates due to seasonal cropping further reduce returns on investment. The lack of well-established custom hiring and service models also limits access, as Custom Hiring Centres (CHCs), though promoted, still have inadequate coverage. Moreover, insufficient R&D for small-scale machinery leaves hilly and fragmented farms underserved, since most equipment is designed for large fields. Finally, awareness and training gaps persist, with many



Prof. B.N. Tripathi is Vice Chancellor, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu & Former Deputy Director General, Indian Council of Agricultural Research, New Delhi

farmers lacking adequate knowledge of the potential benefits and proper operation of modern machinery.

While promoting mechanization, one should understand that mechanization is not merely a technological intervention but also a critical economic decision for farmers, who weigh the costs and benefits before adoption. On the cost side, they consider fixed expenses such as purchase price, interest, depreciation, and insurance, along with variable costs including fuel, maintenance, repairs, and operator wages. The benefits, in turn, arise from higher productivity, timeliness of operations, reduced labor dependence, and improved crop quality, e.g., in the large farms of Punjab and Haryana, the payback period for a combine harvester may be as short as 3–4 years due to intensive utilization across extensive areas. By contrast, in small and fragmented farms of Bihar or the North-Eastern states, where machinery use is limited, the payback period can stretch beyond 10 years, rendering direct ownership economically unviable.

Farmers hesitate to invest in mechanization mainly due to high costs, low utilization, and credit constraints. Tractors cost ₹5–8 lakh, while harvesters exceed ₹20 lakh, making them unaffordable for smallholders. Limited use (20–40 days a year) and uncertain returns from crop or market risks further discourage investment. As a result, farmers prefer versatile tractors, which now account for nearly 90% of India's farm power.

Government efforts to promote mechanization

The Government of India has launched several initiatives to promote farm mechanization, notably the Sub-Mission on Agricultural Mechanization (SMAM), subsidies for machinery purchase, and support for establishing Custom Hiring Centres (CHCs) to provide shared access to tractors, harvesters, and specialized equipment. New programs also include targeted support for drone adoption in agriculture, with subsidies to encourage their use in spraying, monitoring, and precision farming. In Jammu & Kashmir, farm mechanization is further supported under the Holistic Agriculture Development Programme (HADP) and the J&K Competitiveness Improvement of Agriculture and Allied Sectors Project in UT of J&K (JKCIP), which emphasize machinery support for smallholders and promotion of farmer-friendly technologies. Despite these efforts, the reach of CHCs remains limited, with inadequate coverage in remote, hilly, and tribal regions. Challenges such as poor maintenance, shortage of skilled operators, and weak business models restrict their long-term effectiveness, leaving many marginal farmers still dependent on traditional practices.

Gaps in adoption

In the United States, near-universal mechanization and

rapid adoption of precision agriculture are driven by large farm sizes and strong farm economics, which make investment in advanced machinery profitable. China achieved rapid mechanization through a coordinated policy–industry–services approach, combining stable machinery purchase subsidies, a robust domestic manufacturing base, and cooperative service networks that enabled both large and small farmers to access modern equipment. In Southeast Asia (Vietnam and Thailand), growth was propelled by service providers and small, fit-for-purpose machines tailored to local farm sizes. By contrast, India's mechanization is slower, dominated by tractors, with adoption of specialized and precision equipment limited due to small and fragmented holdings, high capital costs, and inadequate service models. Thailand and Vietnam expanded mechanization by using service providers and small machinery to replace peak labour, supported by local manufacturing and light-asset service entrepreneurs.

Roadmap to promote farm mechanization in India



Prof. Pawan K. Sharma is Head, Agricultural Economics, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu

For India, the future of mechanization lies in a service-first, innovation-driven approach that allows even smallholders to access the right machinery at the right time, achieving verifiable yield and cost gains that encourage repeat use. Given India’s dualistic farm structure; highly mechanized, productive pockets alongside vast areas of small, fragmented, and difficult-to-mechanize holdings, a successful roadmap must pursue two complementary tracks: a high-intensity, precision-mechanization path for large plains and a service-centric, lightweight, women-friendly mechanization path for small and hilly farms. Both tracks should be supported by common enablers including local manufacturing, outcome-linked incentives, digital service platforms, trained operator networks, and systematic monitoring of economic outcomes such as NPV and IRR.

India’s diverse farm structure calls for a differentiated mechanization strategy that addresses large plains; small and hilly holdings and the specific needs of women farmers.

I. Model for large states with large holdings (Plains & high-intensity zones)

The goal for having a specific model for large states with large holdings is to accelerate the transition to precision, high-throughput mechanization that improves timeliness, lowers unit costs, and enables precision nutrient and water management. The key features of this intervention are discussed below:

Clustered high-capacity CHC hubs

Establish CHC hubs at block or cluster level equipped with fleets including combine harvesters, large planters, precision seeders, boom and drone sprayers, laser land-levelers, and soil-mapping rigs. These hubs should operate commercially with guaranteed uptime SLAs and digital booking platforms, in line with the CHC emphasis under SMAM.

Precision farming bundles

Provide subsidies or credit to support integrated bundles; soil testing, variable-rate applicators, GPS seeders, and advisory subscriptions evaluated for NPV/IRR at the cluster level before subsidy release, using outcome-linked vouchers. Evidence from the U.S. demonstrates that precision technology adoption succeeds when economic benefits are clear.

Large-scale contracting & service entrepreneurs

Promote private contractors and agribusinesses to deliver end-to-end services from land preparation and sowing to pest management and harvest. Structured contracts ensure high utilization and predictable IRR for investors, as demonstrated by China’s contractor ecosystem.

Industry-led innovation cells

Co-fund R&D pods in clusters involving ICAR, state agricultural universities, and OEMs to adapt implements to local soils and crops, and to pilot automation solutions such as robotic harvesters and telematics. China’s rapid mechanization growth was supported by such domestic innovation and policy nudges.

Finance & economics

Leverage the Agriculture Infrastructure Fund (AIF) and long-tenor leasing products for CHC hubs, requiring baseline IRR/NPV assessments. For example, projects should demonstrate a cluster-level IRR above 10% and a payback period of less than seven years to qualify for concessional funding.

Implementation steps

- Map crop calendars and block-wise acreage to design an optimized CHC fleet tailored to local cropping patterns.
- Issue outcome-linked vouchers redeemable exclusively through registered CHCs or certified service providers.
- Train certified machinery operators and establish maintenance and spare-parts networks via OEM franchises.
- Monitor key performance indicators, including machine utilization hours, cost per acre, yield improvements and farmer satisfaction, and compute cluster-level NPV/IRR on an annual basis.

II. Model for small & hilly states with small/marginal holdings (Hill, NE, Tribal Areas)

The goal here is to deliver fit-for-terrain, low-cost, low-energy, and women-friendly mechanization through service models, local fabrication, and SHG/FPO-led operations. The key features are:

Micro-mechanization kits & lightweight power units

Promote mini-tillers, battery-powered weeders, hand-operated seeders, portable threshers, and small transplanters adapted for terraces and narrow plots. These are cheaper, easier to operate and maintain, and designed for low draft and slope. (Examples found across SE Asia and pilot projects in India.)

Village Machinery Banks (VMBs)

Small, SHG/FPO-managed VMBs that provide hourly rentals of micro-kits and offer operator services. Finance through micro-credit and NABARD/FPO support; technical backup from local technicians.

Mobile Mechanization Teams

Teams (operator + mechanic + transport) travel across

hamlets during peak windows to provide services using compact implements-this reduces idle downtime and increases per-unit returns.

Local manufacturing & repair hubs

Strengthen MSME clusters and vocational institutes to fabricate and service small implements; apply “Make in India” incentives for mini-implements. China’s small-machine manufacturing lessons are instructive.

Outcome-oriented subsidy

Smaller cap on per-unit subsidy but higher on service providers: e.g., service vouchers for women farmers, and higher subsidy for eco-friendly electric micro-tools.

Implementation steps

- Conduct block-level suitability mapping for terraced/steep terrain.
- Create SHG/FPO VMBs linked with a digital booking app and local field agents.
- Offer entrepreneur grants for youth to run mobile mechanization teams (AIF + NRLM synergy).
- Ensure spare parts & training through MSME and polytechnic collaboration.

III. Reducing drudgery for farm women

Women perform a disproportionate share of labour in many Indian farms, especially in hill and smallholding contexts. Mechanization strategies must be gender-responsive:

Women-centric equipment design

Mechanization strategies for women should prioritize ergonomically designed tools that reduce physical strain and are easier to handle, e.g., hand-operated seeders, lightweight reapers, small grain cleaners, battery-powered weeders, and shoulder-strap ergonomic carriers. To encourage adoption, government procurement and subsidy programs should explicitly include women-friendly implements and offer higher incentive rates.

SHG & Mahila CHCs

Self-Help Group (SHG)-run micro Custom Hiring Centres (CHCs) can focus specifically on women’s needs, such as post-harvest processing, dehushing, threshing, and small-scale drying. These centres not only reduce manual drudgery but also create ownership and income opportunities for women. Programs like NRLM and DAY-NRLM can play a key role in implementing and supporting these initiatives.

Time-saving technologies & energy access

Solar-powered processing units, including solar dryers and solar water pumps, can significantly reduce the time

women spend on fuel collection and cooking-related tasks. Schemes such as PM-KUSUM and decentralized solar programs can be leveraged to deploy these energy-efficient, time-saving technologies at scale.

Training & certification

Women operators should be trained and certified through institutions like ATMA, KVKs, and polytechnics. Offering stipends for training participation can encourage attendance, while certification improves trust in their skills and opens up opportunities for service-based income.

Social norms & incentives

Mechanization policies must address social barriers by providing higher subsidies or preferential access to women-led enterprises. Incentivizing FPOs to hire women operators and conducting behaviour change campaigns can help shift traditional male-centric norms around machine operation, ensuring broader acceptance and empowerment.

Conclusion

Farm mechanization is a key to enhance productivity, reduce drudgery, and ensure timely operations, especially amid labour shortages, rising input costs, and climate challenges. India’s roadmap must adopt a dual-track approach: precision, high-intensity mechanization for large plains via CHC hubs, technology bundles, and private service entrepreneurs, and lightweight, fit-for-terrain, women-friendly mechanization for small and hilly holdings through SHG/FPO-led machinery banks, mobile teams, and local fabrication. Gender-responsive tools, training, and incentives are critical to reduce drudgery and ensure inclusive adoption. A digital platform and data system should maintain a national registry of CHCs and VMBs, track equipment inventories and utilization, collect farmer feedback, and integrate booking, payment, and outcome reporting to compute cluster-level NPV/IRR. Outcome-linked incentives should tie subsidies to demonstrated results timeliness, yield gains, or residue-free sowing, rather than providing upfront asset grants alone, following China’s recent approach. Local R&D and standards can be developed through ICAR, SAUs, and industry hubs to create protocols for small implements and hilly terrain, supported by government grants. Finance and leasing mechanisms, including low-cost leasing, pay-per-use models, and AIF backing, can de-risk investments for private contractors. Finally, monitoring and evaluation should mandate economic assessments before major investments and publish annual mechanization dashboards covering utilization, cost per acre, and drudgery metrics.



DR C. R. MEHTA

Director

ICAR - Central Institute of
Agricultural Engineering

Agricultural Mechanization & Automation by 2047

Introduction

The production and productivity in Indian agriculture cannot be enhanced by primitive and traditional practices of farming. The average farm size in India is small (1.08 ha) and small and marginal land holdings (less than 2.0 ha) account for 86% of land holdings. The population dynamics shows that by the year 2047, the population of agricultural workers in the country will be about 202 million (26% of total workers) of which 60% will be the female workers. With continued shrinkage in average farm size, more farms will fall into the adverse category thereby making individual ownership of agricultural

machinery progressively more uneconomical.

Agriculture is transforming rapidly and the Vikshit Bharat is going to be of technology driven for a sustainable, affordable, and environment friendly agriculture. Efforts for modernization of agriculture are now required not only for making the agriculture profitable but also for increasing input use efficiency, reducing drudgery in agricultural operations and making the work of agricultural labour respectable in the modern context. The Vikshit Agriculture by 2047 would be dealing with more aware stakeholders, be it consumers, producers, processors or other intermediate functionaries. The

future agricultural worker would also need to have real time information on natural resources including weather data to precisely plan the production activities utilizing the modern machinery.

The targets of food production in Vikshit Bharat would be governed by the population growth of India and the world in broader sense. A need to develop sustainable infrastructure for modernization of agriculture gives an opportunity for adopting mechanization/automation in agriculture. The partnership among academic, researchers, industries in public and private institutions would increase for mutual growth and problem solving in efficient, cost effective and time bound mode. Virtual reality will play a very important role in knowledge dissemination and also in conduct of research experiments.

Roadmap for Farm Mechanization & Automation by 2047

The roadmap for agricultural mechanization and automation in India by 2047 is as follows.

1. Farm Mechanization

The overall level of farm mechanization in India currently stands at approximately 47% (Mehta et al., 2023). Among various field operations, seedbed preparation exhibits the highest level of mechanization (over 70%) for major crops, while harvesting and threshing operations remain the least mechanized (below 34%), except in the case of rice and wheat. The mechanization levels for planting and transplanting operations are also relatively low, with only 25% for sugarcane and 35% for rice.

The crop-wise mechanization levels are as follows: rice – 53%, wheat – 69%, maize – 46%, sorghum and millets – 33%, pulses – 41%, oilseeds – 39%, cotton – 36%, and sugarcane – 35% (Mehta et al., 2023).

As outlined in the 58th Report of the Parliamentary Standing Committee, there is a need to enhance the average level of farm mechanization in the country from the current 47% to 75% by 2047, in order to ensure timeliness, efficiency, and improved quality in agricultural operations.

• Farm Power Availability

The production and productivity of food-grains are considered as factors of available mobile farm power sources. The combine share of agricultural workers and draught animals in total farm power availability in India reduced from 60.8% in 1971-72 to less than 6% in 2021-22. The cropping intensity in Indian agriculture was 120% with farm power availability of 0.36 kW/ha during 1975-76 and increased to 142% with increase in farm power availability to 3.04 kW/ha (Mehta et al., 2023). The average farm power availability needs to be increased

from 3.04 to 7.50 kW/ha by 2047 to ensure timeliness and quality in field operations in Vikshit Bharat.

3. Tailored Mechanization for Small & Marginal Farmers

Given that 86% of Indian farmers own less than 2 hectares, owning machinery is often economically unviable.

- Expand Custom Hiring Centres (CHCs): Widely promoted under SMAM and other schemes, CHCs already number in the thousands and help democratize access to machinery.
- Boost FPOs and SHGs: Cooperative models give collective buying power for shared or rented machinery, enhancing efficiency.
- Scale app-based rental platforms: Digital “Uber-like” services such as J-Farm, Krish-e, etc can make accessing equipment seamless, even for remote smallholders.

3. Robust Financial & Policy Backing

- Strengthen subsidies: SMAM currently offers 40–50% subsidies on most of farm machinery and tractors. Similar high-impact programs, like Andhra Pradesh’s 50% front-end subsidy model, have shown remarkable uptake (25,000+ farmers impacted).
- AI-driven-select systems: Uttar Pradesh’s e-lottery mechanism ensures transparent, timely subsidy distribution for residue management machinery.
- Support for innovation & manufacturing: Production-linked incentives for farm machinery manufacturing can boost affordable farm-tech manufacturing tailored for India’s varied agro-climatic zones.

4. Technology Integration: Agri 5.0 and Beyond

• Smart mechanization: In Vikshit Bharat, agriculture is expected to be dominated by precision and cloud based data and supported by advanced infrastructure like smart tractors, unmanned aerial vehicles, wireless technology and unmanned autonomous vehicles for multi-purpose field works. Techniques like precision agriculture, AI-driven sensors, GPS mapping, drones and robotics can boost productivity by 30–40%. There is a need to simplify these technologies to rudimentary levels to suit Indian conditions, and make them cost-effective for maximum acceptance by the farming community. The development of indigenous and affordable systems and devices is essential to make India self-sufficient (Aatmnirbhar) in the field of farm mechanization.

- Climate-smart tools: Subsidize solar-powered, zero-tillage, and micro-irrigation machinery to conserve resources and align with sustainable development goals.
- Block-chain for traceability: Advanced tracking

systems ensure transparency and better market integration for food products.

- AI policy frameworks: Maharashtra's high-value agri AI policy (₹500 cr over 3 years) supports digital innovation hubs, AI advisory systems, and data platforms - a blueprint for scalable digitalization. Similar schemes need to be formulated and implemented in other states.

5. Skill Development & Institutional Support

- Training programs: With over 731 Krishi Vigyan Kendras (KVKs), these channels should intensively train farmers and youth in mechanization operation and maintenance.
- Demonstrations and R&D: Front-line demonstrations, industry partnerships, and enhanced R&D are needed to make mechanization affordable, reliable and accessible.
- Quality assurance: Expand testing labs and BIS-certified manufacturing to ensure equipment reliability and compatibility.

6. Infrastructure & Regional Nuances

- Digital & power infrastructure: Strengthen broadband and reliable electricity in rural areas to support smart farming tools.
- Regional strategies: Tailored solutions for rainfed or hilly regions - compact and multi-purpose farm machinery, mobile CHCs are key.

Conclusions

Indian agriculture will experience a major shift by 2047 toward smart, mechanized farming, driven by the

integration of IoT, AI, robotics, and automation. These technologies will not only boost productivity but also promote environmental sustainability, ensuring more efficient use of resources. Some of the technologies currently considered as high-end and expensive, would be easily available at affordable cost and would prove their worth while performing arduous tasks. Mechatronics, robotics, drones, micro-bots, UAVs, 3-D printing, bio-sensors, IoT, cloud-seeding, data-cloud, green energy, portable energy packs would be some of the major highlights in the agricultural domain by 2047. By aligning robust policy frameworks, smart technologies, inclusive models like CHCs and FPOs, and skill & infrastructure development, India can realistically aim to achieve 75% mechanization by 2047 - an essential milestone for productivity, rural prosperity, and sustainable agriculture.

Bibliography

1. Anonymous (2022). Vision 2047. Unpublished technical bulletin, ICAR-CIAE, Bhopal.
2. Mehta, C.R., Chandel, N.S., Senthilkumar, T. (2014). Status, challenges and strategies for farm mechanization in India. Agricultural Mechanization in Asia, Africa and Latin America (AMA), 45(4), 43-50.
3. Mehta, C.R., Chandel, N.S., P C Jena, Anamika Jha (2019). Indian agriculture counting on farm mechanization. Agricultural Mechanization in Asia, Africa and Latin America (AMA), 50(1), 84-89.
4. Mehta, C.R., Bangale, R.A., Chandel, N.S., Kumar, Mohit (2023). Farm mechanization in India: Status and way forward. Agricultural Mechanization in Asia, Africa and Latin America (AMA), 54(2), 75-88.



**Kyunki hum kisan jante hai,
Sab humare bharose hai,
ISILIYE HUMARA BHAROSA! GROMOR**

**JINKE BHAROSE DUNIYA,
UNKA BHAROSA GROMOR**

**AWARDED
Superbrands
INDIA
Consumer & Industry Validated
2025**

**Gromor is
Superbrand**

Why Palm Oil Can Be a Healthy Choice When Used Right



Hadi Sugeng,

Secretary General,
Indonesian Palm Oil Association (IPOA)

Palm oil is everywhere yet rarely understood. It slips quietly into our kitchens, our packaged foods, even our infant nutrition formulas. For some, it has become shorthand for unhealthy diets; for others, it is simply the most affordable cooking oil on the market. However, neither caricature does justice to its real significance. Palm oil is not just another edible oil. It sits at the intersection of nutrition, health equity, and sustainability.

Addressing malnutrition in India while ensuring food remains affordable means palm oil cannot be overlooked. It deserves to be examined honestly - its risks acknowledged, but its contributions and possibilities understood with equal seriousness. Used wisely, palm oil can be part of the solution to some of India's most pressing public health and development challenges.

More Than Its Reputation

Few oils do more than add flavor and calories. Palm oil is one of them. Red palm oil is one of the richest natural sources of beta-carotene - a precursor to vitamin A. In a country where vitamin A deficiency remains a silent but significant public health issue, recent studies confirm its widespread presence; especially among adolescents. To address this, fortified oils in government food programs are formulated to deliver 25–30% of the daily recommended intake of vitamin A and D, with palm oil often serving as the base oil.

Even less known is palm oil's role as one of the few natural sources of tocotrienols - a unique form of vitamin E with antioxidant and neuroprotective potential. Research has shown promising links between tocotrienol intake and reduced risks of stroke and certain cancers. While science is still evolving, it is clear that palm oil's nutritional profile is more complex and more useful than it is usually given credit for.

A Kitchen Reality

While public debates about oils tend to be dominated by expert panels and urban consumers, most food decisions in India happen at the household level. And in Indian kitchens, frying isn't occasional; it's habitual. Palm oil's high oxidative stability at high temperatures makes it well-suited to this context. Unlike oils that break down and form harmful compounds when overheated, palm oil holds up to repeated use.

But palm oil isn't only about what happens on the stove. It also plays an irreplaceable role in infant nutrition. Palm oil fractions are used in many milk formulas to mimic the fat structure of human breast milk. They help deliver

palmitic acid in a form that supports energy needs and calcium absorption in infants. Without this component, achieving the required nutritional profile in formula feeding would be significantly more difficult.

Palm Oil: Equity, Responsibility, and Beyond Food

Palm oil is often dismissed as the "lesser" option, chosen only because it is affordable. Yet this affordability is exactly what gives it significance. Premium oils like olive or avocado will never be able to feed India at scale. In contrast, palm oil is versatile, highly traded, and often the only edible oil households have access to. What makes it not a weakness, but a potential: enrichment with micronutrients and consumed in conjunction with a diversified diet, palm oil is a nutrition delivery system that reaches the masses, not just the elite.

But affordability must go hand in hand with responsibility. As one of the world's largest importers with imports worth around USD 8.7 billion, India has a stake in how palm oil is produced. Supporting certified and ethical sourcing through frameworks like Indonesia's ISPO and industry-wide NDPE (No Deforestation, No Peat, No Exploitation) commitments is what turns palm oil from a commodity into a force for good. It serves as a long-term investment in ensuring edible oil supplies that are cost-effective, sustainable, and socially responsible.

Palm oil's value also extends beyond food. From palm-based biodiesel that strengthens energy security, to bioplastics and oleochemicals that power everyday products and offer alternatives to fossil-fuel dependency, its role in a bio-based economy is expanding. These applications diversify farmer incomes, build resilience, and create pathways for industrial innovation and green growth.

The Case for Balance

Palm oil has become an easy target, perhaps because it is everywhere. But it deserves better than a binary verdict. The real question is not whether we should use palm oil, but how we should use it. In moderation, in combination with other oils, fortified where it makes sense, and sourced through responsible channels, palm oil can play a positive role in India's public health strategy.

Its nutritional contributions are real. Its economic reach is wide. Its potential in clean energy and sustainable industry is just beginning to unfold. Few other oils combine nutrition, affordability, and industrial potential at this scale. Palm oil is not a dilemma to be debated but a resource to be managed - and its outcome depends on our choices.



PROF. MAMTA TIWARI
Former Director, Human Resource Development
Agricultural University, Kota, Rajasthan

Pioneering Agrimechanization Hurdles & Pathways to Farmers Empowerment by 2047

India pathway toward becoming a developed nation by 2047, just hundred years after independence, agriculture must transform from a labor-intensive sector to a automated engine of growth. Agri mechanisation and automation, can revolutionize how we sow, grow, and harvest. This transformation is not just a possibility, it is a necessity to ensure food security, climate resilience and farmer prosperity in the decades ahead.

To become a developed India there is an urgent need for Agri Mechanisation and Automation. India's agriculture still relies heavily on manual labor and therefore sometimes results into low productivity, increased drudgery, especially for women and elderly farmers, rising input costs and labor shortages and delayed operations due to climatic variability.

India envisions a self-reliant, technologically advanced

nation by 2047, agriculture must undergo a paradigm shift from traditional, labor intensive practices to a digitally driven, automated system. But the journey from present to future is filled with complex challenges. To truly maximize agri mechanisation and automation by 2047, India must address these obstacles through structured, inclusive, and innovative approaches. There are numerous challenges to Agriculture Mechanisation and Automation.

Farmers are having fragmented land. More than 85% of Indian farmers are small and marginal with landholdings less than 2 hectares. Due to this high cost machines are unaffordable to farmers and inefficient for small plots. Through FPOs this problem can be minimised. Promotion of Land Pooling and Farmer Producer Organisations (FPOs) is required which can encourage voluntary pooling of land for shared mechanised farming. It Increases efficiency, reduces individual cost burden and enables use of large-scale machinery.

High cost of machinery and poor credit access is a big problem. Capital intensive equipment like autonomous tractors or precision seeders are out of reach to the farmers. Therefore low adoption of advanced technologies especially among smallholders are in practice. The only solution for this situation is to create a National Digital Agri Mechanisation Mission and develop a central platform integrating equipment rental services, predictive maintenance tools, AI-based advisory for machinery use and UPI-based payments linked to Aadhaar. This will result in to one stop digital solution for farmers to access modern tools affordably.

Low digital literacy is found in rural areas which is a very crucial problem. Most of the farmers are unfamiliar with digital platforms, IoT, AI, or drones. As a impact even when technology is available, lack of knowledge becomes a barrier. The only solution is to establish Custom Hiring Centres (CHCs) in every Panchayat. Public-private partnerships to deploy smart equipment on a pay-per-use model is in practice at many districts in the supervision of Agriculture Universities and Krishi Vigyan Kendras which makes high end machinery accessible without ownership.

Farmers are facing lack of Infrastructure facilities, poor rural connectivity, unreliable electricity and limited internet penetration. Therefore digital mechanisation tools cannot be implemented or sustained. Rural Digital Literacy and agriculture technology skilling is also poor

among farmers. Solution for introducing mandatory digital training through Krishi Vigyan Kendras (KVKs) is possible. As a impact the next generation of farmers can be empowered to adapt and innovate new technologies

We are loaded heavy dependence on imported agricultural technology and lack of India specific innovation due to limited Research & Development and indigenous manufacturing. Equipment is either unsuitable or overpriced for Indian conditions. There is an urgent need to invest in Indigenous R&D and Make in India Agricultural Technology.

Immediate action is required to incentivize startups, universities, and manufacturers to develop low-cost, modular equipment and design tools in such a manner that it would be suited to India's climate and cropping patterns.

It will ultimately reduce the dependency and increase the adoption through affordability.

Presently India is facing inadequate Custom Hiring Models, therefore sometimes mechanisation fails to reach the last mile farmer. It is necessary to strengthen and integrate mechanisation with rural electrification, 5G and satellite internet and smart warehousing & cold storage units. Mechanisation at very large scale can lead to soil compaction, fuel emissions, and e-waste if not regulated and guided sustainably. Therefore promotion of Green Mechanisation by encouraging usage of solar powered and electric machines, biofuel compatible tractors and battery operated drones with low environmental impact is required. This will insures sustainability while scaling operations.

A Strategic Roadmap to 2047 requires policy support and fiscal incentives by expansion of subsidy schemes. Introduce tax rebates for adoption of agriculture technology and green machinery which will attracts investment and reduces financial barriers for farmers. The digital empowerment revolution is important as enabler of change. It is the backbone of future agricultural transformation. By 2047, a truly digitally inclusive rural India can drive. Similarly robotics for fruit picking and weeding, smart irrigation systems with automated water release and vertical Farming Units equipped with automated light, humidity, and nutrient controls would be popularized in farming community. This evolution will make farming faster, more efficient, and less dependent on human labor, while improving yields.



Narinder Mittal,

President & Managing Director,
CNH India

Farms of the Future

*Maximizing Mechanization
and Automation by 2047*

As India approaches its centenary in 2047, agriculture stands ready to play an even bigger role in shaping the nation's progress. It has long been the backbone of food security and rural livelihoods, and today it also holds the promise of driving innovation, sustainability, and global competitiveness. With the right vision, Indian farming can move from strength to strength over the next two decades.

India is already the largest tractor market globally, but genuine mechanization involves more than tractors. In 2024, overall farm mechanization in India is around 47%, and its application is uneven across crops and across regions, with much of it still reliant on rigorous efforts. The differences are strongest where agriculture is most labour-intensive and application of technology is weakest. Closing these gaps is more than about increasing productivity, it is also about making farm work less physically demanding, less debilitating, and more rewarding. By reducing drudgery and creating skilled livelihoods, technology can enable farmers and workers alike, and set a stronger, climate-resilient, and competitive agriculture sector by 2047.

Current Landscape

Indian mechanization presents a mixed picture. In crops like wheat and paddy, machine usage in tillage, sowing, and harvesting is relatively high, but sugarcane tells a very different story. Despite being one of the most important crops for both farmers and industry, only about 6% of sugarcane harvesting is mechanized. This means 94% of the area is still dependent on manual work, showing massive untapped potential to raise yields and reduce costs. The bulk of the work still relies on manual labour, which raises costs, slows efficiency, and places a heavy physical burden on workers. Introducing modern solutions could transform the sector, cutting costs, improving yields, creating stable supply chains, and generating skilled employment opportunities.

Structural barriers are what keep them back. Small, fragmented holdings restrict machine use, the cost of high-tech machinery is typically out of reach of single farmers, and a lot still lack accesses to training and dependable service networks. Change is, however, in the air. Government programs promoting crop-residue management through balers are reducing stubble burning and unlocking new sources of income. Adoption of high-capacity balers, both small and large, is expanding across regions, supported by subsidy frameworks and rental models that make the economics more viable. Overall these measures help decrease the cost and

make equipment more accessible to farmers, paving the way for greater mechanization in various areas. We are actively supporting the Government of India's initiatives on biomass management. Through our balers and high-horsepower tractors, we enable farmers to convert crop stubble into bales instead of burning it—helping reduce pollution in Delhi-NCR while creating additional revenue streams from biomass generation.

Vision 2047

By 2047, when India marks 100 years of independence, the country must usher in an era of tech-driven, sustainable agriculture that combines mechanization with automation, AI, and clean energy solutions. This includes precision technology solutions already available to us, such as use of drones to oversee crops, GPS-equipped machines to seed crops at a precise rate, and smart irrigation systems that conserve water. The wider use of high-end combines capable of harvesting multiple crops with precision-based equipment that can boost yields by 6–7% while easing labour shortages, are examples of how advanced mechanization can redefine efficiency.

For example, despite being the largest producer of sugarcane, Uttar Pradesh still relies heavily on manual practices with very limited mechanization—an opportunity loss that directly impacts yield and farmer income. At CNH, we see this as a space to drive meaningful change. For instance, our ongoing cotton picker trials in Maharashtra are aimed at offering practical mechanized

solutions for this crop segment, improving efficiency and reducing labor dependency.

The youth will play a greater role in this transformation by operating advanced harvesters and encouraging the adoption of new technologies, making mechanization not just a driver of productivity but also a source of employment. Sustainable agriculture will be powered by clean energy and supported by efficient residue management, and guided by continuous soil health monitoring to preserve natural resources. It must also be equitable, with the same opportunities for new solutions being open to small and marginal farmers, who make up the majority in the nation's agriculture scenario. Achieving this vision will not only make India food and nutritionally secure but also position the nation as a trusted global partner for agriculture.

The Roadmap

Attaining of this vision will depend on various factors that will collaborate from here on. Technologies like drones, GPS-guided tractors, and soil sensors need to move out of pilot programs and become mainstream through cost-effective, India-focused solutions. Sustainable solutions such as adopting cleaner powertrains, using balers and mulchers to handle crop residue, and promoting water-efficient systems can also help. Electric and Alternate-fuel tractors powered by methane, gas, or flex-fuel engines are already being demonstrated globally, pointing to a future where clean energy will play a bigger role in farm

mechanization. Similarly, mechanized cotton picking is being piloted in parts of India, though wider adoption will depend on enabling regulations around spraying practices.

Beyond crops, India is also one of the largest milk producers in the world. Here too, mechanization has a huge role to play. From forage harvesters that improve fodder quality to drones that enable precise spraying, CNH is pioneering technologies that reduce costs, improve productivity, and enhance overall quality.

Furthermore, skill development and capability building should be focused on, with training of farmers, operator training, and youth training in rural areas so that they can confidently use and operate sophisticated equipment. Finance and policy are also important contributors. Affordable credit and leasing arrangements will help in enabling quicker adoption. And finally, technology will be a game-changer, in the form of farm apps, analytical summaries, and remote diagnostics to facilitate improved decision-making and improved productivity.

Together, these priorities bring the roadmap for agriculture not only productive but also sustainable and future-proof. This vision will be made possible through the support of enabling policies by government, transformation from the side of farmers, and continuous innovation on the part of industry. At CNH, we have already begun facilitating this journey through investments in research and development, enhanced local manufacturing, and high-technology solutions, ranging from smart tractors

to precision tools, that help Indian fields and also reach international markets. Growing investments in local R&D and manufacturing are already ensuring that India remains at the forefront of designing solutions suited to its unique agricultural conditions, while also contributing to global markets.

Conclusion

Automation and mechanization are not about replacing people but about making farmers work smarter to produce more efficiently, grow their revenues, and make agriculture sustainable. From advanced combines and balers and clean-fuel tractors, mechanization is already showing how it can lower costs, cut drudgery, and open new income avenues for farmers. A digitally empowered and mechanized agricultural sector can free farmers from the uncertainties of manual methods, open new opportunities for rural youth, and ensure that India continues to be capable of feeding itself and the world. If we expand technology wisely, open up finance and markets, and invest in capabilities, India can build a globally competitive, digitally empowered, and sustainably productive agricultural sector by 2047 and beyond. The time is now, the direction is set, and the hour is the hour of action.

By bringing advanced mechanization solutions across diverse segments, CNH is not just improving farm yields but also driving efficiency, sustainability, and long-term prosperity for Indian agriculture.



Digital-first Mechanization

(Such as Drone Spraying, Soil Testing Combined with Scientific Advisory)



TUSHAR TRIVEDI,
Head - Nuture.Farm Vertical and
UPL Retail & New Business Division

Empowering Smallholders To Improve Yield & Cut Inefficiencies

India's agricultural sector is undergoing a transformation. For decades, smallholder farmers, who form the backbone of rural India, have struggled with low productivity, rising input costs, and unpredictable climate conditions. Traditional farming practices, though deeply rooted in local knowledge, are increasingly unable to meet the demands of modern agriculture.

The challenge is clear: how can smallholders access the tools and knowledge needed to farm more efficiently and sustainably?

Making Mechanization Affordable and Scalable

Traditionally, farming is labour intensive and there is heavy dependency on labourers who is not reliable. Such

delays often lead to pest outbreaks or uneven coverage, damaging productivity. Fragmented landholding is the reason for limited farm mechanization. Mechanization has long been recognized as a catalyst for agricultural efficiency. However, high capex and limited technology have kept advanced equipment out of reach for smallholders. For example, self-propelled sprayers, essential for timely and effective crop protection, require significant investment and skilled operation.

This is where innovative models like **FaaS (Farm Machinery as a Service)** come into play. Nuture.farm has pioneered this approach by deploying over 3,000 self-propelled sprayers- high tech precision farming equipment's across India, operated by trained professionals. Through a tech-enabled platform, farmers can book services on demand - much like an Uber for agriculture. This model not only democratizes access to high-end machinery but also ensures timely intervention at scale and at affordable rates. This initiative of nurture.farm, one of the world's largest ground spraying operations in India has helped the farmers to increase the productivity and increasing the profitability at reduced cost of the farming operations.

Our boom sprayers for instance can cover one acre in just seven minutes, ensuring uniform application and timely protection. Farmers do not need to buy the machine or struggle to find labour. They simply book the service on the nurture.farm app the way they would book a cab. The machine arrives at their field, does the job efficiently and the farmer saves both time and money. By now, Nuture.farm has sprayed more than 30 million acres and covered more than 2.5 million farmers since its inception.

For many smallholders, this is the first time mechanisation has felt accessible. By moving to a shared service model, advanced tools are no longer the privilege of large farms. They are affordable, on demand and reliable. This shift not only solves the labour crunch but also raises productivity by ensuring crops get the right protection at the right time.

The move towards mechanisation also brings precision and safety. Drone spraying adds another layer of precision to smallholder farming. Compared to manual methods, drones use up to 90% less water while achieve equal or better coverage, thanks to GPS-guided application. They also reduce farmer exposure to agrochemicals and provide much better spray coverage per day, saving both time and labour. With variable-rate maps, drones target only the affected areas, cutting chemical use by 15-20%.

Nuture.farm is evolving into a platform that will host a full marketplace of farming services -from planting to harvesting -which farmers can seamlessly access through the platform.

Scientific Advisory at Their Fingertips: Localized and Timely

But machines alone are not enough. Farming is unpredictable and technology only creates value if farmers know how to use it effectively. That is why nurture.farm has built advisory directly into its platform.

A flagship feature is Crop Doctor, a tool that allows farmers

to take a photo of a diseased plant and instantly receive a diagnosis. The system not only identifies the problem but also recommends the right solution, including which products to use. nurture.farm has built a platform based on the remote sensing and similar technology. Farmers can access all information at one place without visiting their farms. What once required an expert visit, now happens in real time, saving precious days during a pest or disease outbreak.

This instant and reliable advisory empowers farmers to act with confidence. Whether it is a cotton grower in Maharashtra battling whitefly or a paddy farmer in Uttar Pradesh managing brown planthopper, timely guidance coupled with mechanisation services can be the difference between saving a crop and losing it.

A Digital First, Farmer First Model

What ties all these services together is our digital first approach. Through the nurture.farm app, farmers can access mechanisation service, book spray service, get insurance products. The model is built around simplicity and trust. Farmers know exactly what they are booking, when the service will arrive and how much it will cost.

The shared service design removes the barrier of ownership, allowing smallholders to adopt modern practices without heavy capital investment. In essence, nurture.farm is making agriculture as easy to access as booking a ride or ordering groceries online.

Case Study, a real-life example of the impact we create:

A farmer in Madhya Pradesh, for instance, recalled how delays in finding labourers often meant missing the right window for spraying. "Pehle main mazdoor dhoondhta tha aur der ho jaati thi. Ab machine time pe aa jaati hai, fasal bach jaati hai" (Earlier, I had to chase labourers and spraying got delayed. Now the machine arrives on time and my crop is saved), he said after booking a spray service through the app.

Such testimonies illustrate how digital-first mechanization is beginning to bridge long-standing gaps in rural farming - offering timely interventions, lowering risk, and giving smallholders a chance to protect yields more reliably.

The Road Ahead for Indian Agriculture

India's agricultural landscape is evolving rapidly, and smallholders remain central to its growth. However, traditional methods alone are no longer sufficient to meet the dual challenges of food security and farmer income.

Digital-first mechanization, when combined with scientific advisory, presents a pathway toward more resilient and productive farming. By ensuring accessibility, affordability, and trust, organizations like nurture.farm, are showing how these solutions can be scaled at the grassroots level.

As farmers adopt data-driven and mechanized practices, they are not just improving yields, they are building stronger, more efficient agricultural systems for the future.

Entrepreneurial Skilling Initiative For Developed Nation By 2047

Imagine India in 2047 - not just a vision, but a tangible reality fueled by progress across every sector. It's about an India where no one is left behind, where economic growth is inclusive, and opportunities abound for all. This journey, 'Viksit Bharat@2047', is deeply rooted in humanising development, ensuring it touches the lives of every citizen. Consider the transformation in serving the poor and marginalised. In the recent decade, an inclusive development model has guaranteed basic necessities like water, electricity, healthcare, and education. Initiatives like MUDRA Yojana and Stand Up India are not just schemes; they're springboards for young entrepreneurs from marginalised communities. The fact that over half of the 52 crore loans under MUDRA have been given to entrepreneurs from the SC/ST/OBC communities is a testament to this commitment. It's about empowering individuals with the tools to shape their own destinies. India's entrepreneurial skilling initiative under its Viksit Bharat 2047 vision focuses on transforming the nation into a developed, self-reliant economy by empowering its youth through targeted skilling programs. Key components include re-imagining Industrial Training Institutes (ITIs), fostering collaborations with tech companies and accelerators to integrate modern technologies like AI, nurturing innovation through mentorship and startup ecosystems, and expanding apprenticeship pathways to create a skilled and productive workforce by 2047.

The time has come to re-imagine the whole entrepreneurial skilling initiative as we need to address the rising aspirations of young India in line with the vision of the Prime Minister of making India a 'developed nation' by 2047. In 1982, a historic development took place at Ujire in the Dakshina Kannada district of Karnataka. Here, the first Rural Development & Self Employment Training (RUDSETI) Institute was established. Kudos to



the visionaries who thought of entrepreneurial trainings for rural youth so far ahead of the time. Working hand in hand, Canara Bank, Syndicate Bank and Sri Dharmasthala Manjunatheshwara Educational Trust established 27 RUDSETIs in 17 States. The icing on the cake was the adoption of this model of rural entrepreneurial skilling as the 'Rural Self Employment Training Institutes' (RSETIs) programme by the Government of India (GoI) in 2007-08. This remarkable journey of rural entrepreneurship with a motto of short-term courses (6 to 60 days) with long-term hand-holding (two years) has really sparked a great entrepreneurial movement in the country. This reflects in the establishment of over 600 RSETIs, so far across India. There are other programmes also for self-employment training by different ministries, but considering the scope

Dr. R.S. Sengar, Garima Sharma,
Dr. Shalini Gupta and Dr. Nidhi Singh
Division of Plant Biotechnology
Sardar Vallabhbhai Patel University of Agriculture
and Technology, Meerut

and impact of the RSETIs, it's being discussed here.

Entrepreneurship excellence begets economic growth, poverty alleviation, employment generation, innovation and inclusive development. In fact, entrepreneurs are being hailed as the architects of India's transformation. So, the performance of RSETIs with figures of training of 55.53 lakh rural youth in various subjects (domain entrepreneurship) with a settlement rate of around 73 per cent (40.27 lakh) is really impressive. Further, the bank linkage has also been ensured for 20.40 lakh of these trained candidates to start/strengthen their enterprise. Furthermore, the beauty of this programme is that it aligns perfectly well with the Prime Minister's call to the youth to become job creators rather than job seekers. The youth who are supported to establish/strengthen the enterprises under the above programme not only become job providers to other youth, but they also contribute to the economic development of the rural areas.

However, the enterprise ecosystem has changed drastically in the 21st century with remarkable developments in technology, e.g., artificial intelligence, data analytics, online platforms including Government e-Marketplace (GeM) for marketing, etc. A number of other programmes of the GoI, e.g., the Entrepreneurship Skill Development Programme the Prime Minister Employment Generation Programme (PMEGP) of the Ministry of Micro, Small and Medium Enterprises (MSME), have also explored new areas in entrepreneurship. Collaboration and with such programmes can act as a multiplier for entrepreneurship. Further, working on the principle of 'leaving no one behind', women from marginalised communities, differently abled individuals, tribals and ex-servicemen, etc., need to be made part of the growth journey. In fact,

each group may need a different set of interventions. Then the emerging set of enterprises in logistics, gig and platform-based work, home-based enterprises, etc., present a whole new set of challenges. India has got a remarkable demographic dividend also, which needs to be leveraged properly before it's too late. Around eight million youth are entering the workforce every year in India. So, the time has come to reimagine the whole entrepreneurial skilling initiative as we need to address the rising aspirations of young India in line with the vision of Prime Minister Narendra Modi of making India a 'developed nation' by 2047. In this regard, rural entrepreneurship has a critical role to play. There cannot be a 'business as usual' approach. For this, large-scale skilling along with appropriate mentoring, financing and marketing is required. In fact, we need to think afresh about the whole gamut of entrepreneurial training, as only 4.7 per cent per cent of India's workforce has undergone formal skill training. In Germany and South Korea, the numbers are 75 per cent and 96 per cent, respectively. It is estimated that by 2028, if skill-building does not catch up with the rate of technological progress, India could forgo USD 1.97 trillion of GDP.

To address the above gaps in skilling, we need to look dispassionately at the issue of the present entrepreneurial ecosystem nurtured by the RSETIs. The first and foremost is the limited number of courses being offered. The sixty-odd courses offered hardly reflect the demands of the changing skill sets in the market and aspirations of the youth. Further, very few candidates (750/1000) are being trained in a district against the huge demand. In this also, the mobilisation of marginalised households is below par. The faraway location of the training centre in the district makes it even more difficult for them to join the trainings. The women find it particularly difficult to stay whole days

at the training centre, so the representation of the women from marginalised sections is still low. The bank linkage is also low. Further, there is no scope for re-skilling and up-skilling because, as per rules, a candidate can be trained only once at the RSETI. So, there is no upgradation of the already acquired skills by the candidates, and their enterprises stagnate. There are a number of steps which may be taken to address these issues in skilling and leverage the demographic dividend. First and foremost, there is a need to move from the conventional 'top-down approach' to the 'bottom-up approach' to address the needs of skilling in a comprehensive way. The demand for skilling in different sectors needs to be compiled from the districts in a systematic and structured way. Further, the targets need to be allocated as per this demand rather than distributing the targets uniformly to various States and UTs from the national unit. There is a disconnect with the community in the present setup of skilling, which needs to be addressed. Why can't there be the concept of 'skilling at the doorstep'? The Community Institutions promoted under the Deendayal Antyodaya Yojana National Rural Livelihoods Mission (DAY NRLM) can play a critical role here. These can help in organising the trainings at the village level to ensure inclusive development. The trainings organised under the recent experience of the successful

There is a need to narrow down

Depositor Education Awareness Funds (DEAF) of the Reserve Bank of India (RBI) by involving community institutions, e.g., Cluster Level Federations (CLFs), buttresses this point. Further, there are Community Managed Training Centres (CMTCs) already in a large number of CLFs which can be utilised for these trainings. In fact, the whole training module can be outsourced to the CLFs, as they have their ears to the ground. This will also enable the marginalised and vulnerable population to be covered in skilling, as they find it difficult to move to faraway places for trainings. Further, the community will ensure that only the most deserving candidates are mobilised for the trainings.

provide better e.g., CCTV to specific sets of trainings (4-5) for a particular district depending upon the local resources available and industry demand therein. The sectors which have potential for employment,

especially self-employment, in the particular districts need to be prioritised. Here also, the sectors which remuneration, installation and repairs, plumbing, welding and fabrication, motor rewinding, etc., should be given preference. Focus on particular skill sets for a geographical area may also help in developing clusters; e.g., in banana growing areas, products of banana-fibre may catalyse growth of such an industry in the district. This will not only ensure development of backward linkages but also help in focussed marketing initiatives for particular products or services. Going forward, the Centres of Excellence (CoE) for specific sectors need to be developed in some of these RSETIs in various States/UTs. In fact, we need to develop the spirit of competition for rural entrepreneurship among the districts based on the concept of the Aspirational District Programme.

The timings of the trainings also need to be kept flexible as per the agreement between the trainers and the trainees. The training duration may be kept for 3 to 4 hours per day as per the agreed decision. This will motivate more women to join, as they need to take care of their household chores also. There should also be more focus on 'on the job' trainings as compared to theoretical sessions. Further, these may preferably be arranged at the work sites of the master trainers only, as this will help in a practical and immersive learning experience for the trainees.

The trades which are providing low returns, e.g., areca leaf paper plate making, paper bag making and embroidery, etc., need not be avoided altogether. There are specific issues with each of them which may relate to obsolete machinery, archaic technology, poor designs, lack of access to the market, etc. These problems need to be studied in depth and issues addressed accordingly. However, the critical thing here is to make these products lucrative by ensuring better marketing support for them. The concept of aggregation, leveraging online platforms for marketing and social media, etc., for such products may help in better returns. The persons who are already experts in certain sectors need to be engaged as 'Master Trainers'. They should not be rejected solely on the basis of lack of a proper certificate from some institute.

Their experience in the specific sector is vital. The community may be involved in zeroing in on such resources. Further, they may be provided certain

remuneration (depending on trade and duration) also to motivate them to excel. This not only helps in the recognition of the talent at the local level but also ensures better training as these master trainers work close to the community. Further, it helps the trainees to develop a close bond with the master trainers, which may help them in the future. If the candidates face any difficulty in the future in their enterprises, it will be easier for them to communicate with such master trainers. There may be enterprises which have become successful due to earlier interventions and are now ready to scale up. These need to be supported through higher credit linkages, proper business development plans and further skilling from higher skilling institutes. There are a number of government schemes, e.g., Pradhan Mantri Mudra Yojana (PMMY), Stand Up India and Credit Linked Subsidy Scheme under the Pradhan Mantri Formalisation of Micro Food Processing Enterprises (PMFME), etc., which may be leveraged in this regard. However, some handholding and mentoring may be required to ensure that the benefit of the schemes is availed easily by the beneficiary. Here, the concept of 'business clinics' needs to be developed by the RSETIs, as the entrepreneurship needs become specific.

is As the technology developing very fast, there may be a need for re-skilling and up-skilling of the already trained candidates. However, these courses may be paid, so that only serious candidates are enrolled. In fact, if some candidates desire to move to higher learning institutes, it may also be facilitated. No doubt, fees may be charged for these higher-level courses, but some handholding will still be required to make loose ends meet. In fact, the RSETIs need to become hubs of entrepreneurial efforts. Further, incubator and accelerator support also need to be provided by the RSETIs to the candidates who desire to scale up their enterprises substantially. The RSETIs need to move from old-fashioned physical 'RSETI Bazaars' to online marketing platforms, as this is the future of marketing. The role of WhatsApp and Instagram has been phenomenal in the new-age marketing. For this, structured interventions need to be made so that rural youth can leverage them properly. The key intervention areas here are the development of 'Marketing Sakhis, i.e., Community Resource Persons (CRPs) specifically trained in digital marketing, and the 'Fulfilment Centres' at the district level.

These initiatives of restructured skilling will help in more employment opportunities for youth and women

of the rural areas along with a boost to the rural entrepreneurship. In a nutshell, the time has now come to reimagine the rural entrepreneurial skilling initiative, as we need to address the rising aspirations of young India in line with the vision of the Prime Minister of making India a 'Developed Nation' by 2047. In this regard, large-scale skilling, along with appropriate mentoring, financing and marketing, has a great role to play.

Key Initiatives & Strategies:

Re-imagining ITIs: Aims to reform the Industrial Training Institute system to be more aspirational and aligned with industry needs, focusing on skill development and career progression for a new age economy.

Industry Partnerships: Collaborations with IT companies like Microsoft, Cisco, and Amazon Web Services for industry linkages and modern technology training.

Indian Institute of Skills: Public-Private Partnership institutes to cultivate an Industry 4.0-ready workforce equipped with cutting-edge technology.

AI Skilling: Developing dedicated programs on Artificial Intelligence for various segments, including school children, to drive future innovation.

Startup Ecosystem Support: Continued mentorship and support for the startup ecosystem through incubators and accelerators to foster entrepreneurship and innovation, as seen in the AI-focused accelerators.

Apprenticeship Program Expansion: Broadening the reach of apprenticeship as a mainstream pathway to employment and skilling, with a focus on inclusivity.

Trainer Development: Developing a "Trainer Development Strategy" to ensure educators are equipped to teach 21st-century skills and stay updated with the latest industry developments.

Goals:

Economic Transformation: Create a dynamic workforce and promote economic growth and productivity.

Demographic Dividend: Channel the energy and potential of India's young population to drive national growth.

Technological Advancement: Boost the adoption and development of new technologies, particularly in the semiconductor and AI sectors.

Skilled Workforce: Produce a large pool of skilled and employable youth to meet the demands of a modern economy.

From Strawberries to Scooty: How One Woman is Farming Her Way to Upward Mobility

Farmers in rural Jharkhand have traditionally faced challenges like erratic rainfall, sparse irrigation resources, lack of well-oiled mechanisation and inadequate access to credit and markets. Yamuna Kumari from Bero was no exception. For generations, her family had subsisted on the bare minimum yield due to poor infrastructure, low-value crops, increasing input costs, and knowledge gaps. She grew paddy, wheat, and vegetables on a five-acre land and earned a meagre income. But then something changed, and today Yamuna is being upheld as a shining example of a progressive woman farmer with an annual income of INR 10–11 lakhs. The obvious financial rewards have also given Yamuna, agency as well as mobility. She recently purchased a scooter, which enables her to travel longer distances. How did she get this far?



She was mentored by Transform Rural India's (TRI) Millionaire Farmer Development programme (MFDP) to adopt modern, sustainable agricultural practices, and Yamuna is now reaping healthier, disease-resistant premium crops like strawberries, French beans, and grafted brinjal. Along the way, she has steered a growing community movement to prove that farming is no longer just a male domain.

Yamuna reflects, "I now choose the right fertilisers and seeds that yield healthier crops and good income. Thanks to TRI's support, I have learnt how to do season-appropriate farming in a scientific way. By testing soil as well as using organic fertilisers, my crop is now healthier and more abundant. This has inspired other farmers to adopt newer methods as well."

“Jharkhand's Yamuna Kumari has broken the generational cycle of poverty by embracing sustainable agricultural practices”

Not too long ago, this success seemed unreachable as Yamuna was struggling to make ends meet with her husband, two young children, and four other family members. She was pursuing a postgraduate degree in Geography from KCB College, Bero, but she knew that in order to make farming profitable, she needed to access practical knowledge.

After attending TRI's Farmer Field School (FFS), a training centre equipped with the latest technologies, she, along with other local farmers, received hands-on training and exposure to modern agricultural practices such as polyhouse farming, nursery management, mulching, drip irrigation, root zone irrigation, and trellis systems.

She learnt to break past the dependency on local markets and also went on to access high-quality seeds and fertilisers, deal with water scarcity and protect her crops from pests and diseases with the help of integrated pest management (IPM). TRI's team also organised visits to other districts for her to learn advanced practices.

She now conducts regular soil tests to assess nutrient levels, applies balanced fertilisers and uses farmyard manure (FYM) and vermicompost to enrich soil and promote microbial activity. Organic mulch and polythene mulch enable her to conserve moisture, suppress weeds,



regulate soil temperature and reduce plant stress. Drip irrigation, on the other hand, ensures efficient water delivery, minimises waste and prevents fungal diseases. Neem oil and targeted chemical interventions have helped her to manage pests.

TRI, a development design organisation working on transforming India's bottom 100,000 villages into flourishing communities, guided her regarding area and crop selection, annual crop calendar making and imparted the best practices for fertiliser and manure application. She was also given access to a solar pump set, which supports cost-effective irrigation, along with a training hall and a nursery structure to experiment with new crops and motivate others. The continuous support from Community Resource Persons (CRPs) has played a key role in her journey.

Today she practices round-the-year farming, and grows a diverse range of crops including mangoes, wheat, French beans, potatoes, grafted brinjal, marigold, cauliflower, green pea, ginger, green chili, and strawberry with additional crops during the Kharif season.

Her success is now helping her to empower others, including women farmers who are now following in her footsteps and taking up high-value agriculture. Her own increased income now helps her to provide better education and healthcare to her family, making her a proud 'Mahila Kisan' who is blazing a trail for others to follow.



How Circular Economy Can Unlock \$50 Billion Value in Indian Agriculture



The circular economy is a restorative system which is regenerative with design. In place of linear economy, which produces and discards products, circular economy depletes resources in the process, which again brings back everything to the production cycle.

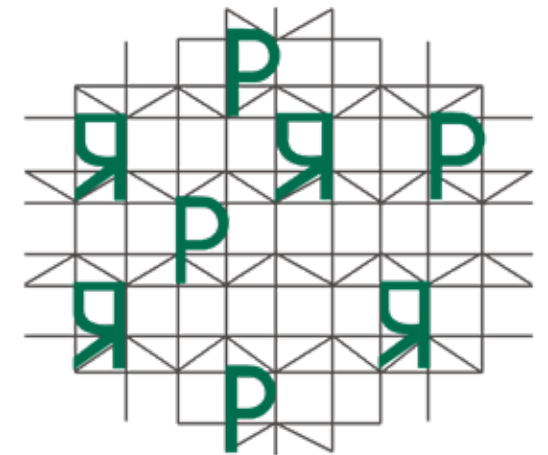
Manufactured goods and by-products are reused, recycled and repurposed using renewable energy. These philosophies dissociate profit from waste and overconsumption, building a global market that benefits both people and agriculture. Circular economy adopts novel models of agriculture like permaculture, precision, restorative, regenerative, organic agriculture, which can improve resource efficiency and sustainable crop production.

There are usually three core principles in circular economy-

- The products should adopt future-proofed designs made of durable materials to last appropriate lifetimes. Agricultural tools, packaging, and

machinery should be designed, keeping in mind durability, longevity, and ease of repair. There should be more use of renewable energy and biodegradable materials like coir, jute, and agri-residue-based composites, which are abundant in India. Innovations like solar-powered irrigation systems and bio-based fertilizers are gaining traction, aligning with India's target of achieving net zero emissions by 2070 and enhancing resource efficiency in agri-inputs. India generates millions of tonnes of crop residue each year, much of which is burned, causing air pollution and carbon emissions. Adopting circular approaches such as agro-residue recycling can play a crucial role in mitigating this problem.

- Rethinking business models by building on the interaction between products and services: Farmers and agri-enterprises are moving from ownership-based models to service-oriented models such as "equipment-as-a-service". In such cases, the high-cost machinery is rented instead of owned. This is not only helping reduce waste but proving access to latest tools by the small holders, who constitute nearly 80% of the farming community. Circular models are also emerging in food supply chains,



such as using surplus crops for processed goods or bioenergy generation.

- And finally, digital technologies can track, monitor, and analyse relevant data across the entire process. Digital tools are today helping with traceability, predictive maintenance, and optimization across the agri-value chain. Platforms powered by AI, IoT, and blockchain are used to track inputs, monitor soil health, reduce food loss. Government's Digital Agriculture Mission is promoting data and precision farming, leading to the more real-time and data-driven ecosystem. Blockchain, augmented reality, and smart mobility are helping optimise resources, break down silos, and connect data, devices, and partners. Big Data analytics, social media apps, and e-commerce platforms are enabling personalisation and helping reach products to consumers across the country. This reduces food wastage and brings balance in price margins.
- Cloud services, social platforms, data visualisation, and virtual reality (VR) encourage engagement and continuous feedback loops for better design throughout the cycle.

Over 1700 agri-start-ups being supported by the government in precision agtech, logistics, organic/regenerative farming, mechanisation, and data-intensive tools. The regenerative agriculture market in India is growing from USD 52.3 million in 2024 to a projected USD 223.9 million by 2033, at a CAGR of 18.3%—reflecting rising value in data-forward farming and service



based agtech offerings.

Circular economy is important in the agricultural ecosystem today as it enables the circulation of valuable resources within the economy. It supports the market for secondary products and materials across all regions, helping create new jobs and also satisfies consumer demand for better, longer-lasting products. Companies also benefit, as they depend less on the volatile prices of raw materials. Circular farming systems like bio-based compost, agro-waste recycling, equipment-sharing, and local recycling of packaging retain value within regional ecosystems, reducing reliance on imported or volatile raw commodities. This method has proven to protect countries from geo-political crisis at the macro level, as supply chains are values across the domestic economy. If India is able to capture even 1% of the anticipated USD 4.5 trillion global circular economy by 2030, the market can grow by USD 45 billion.

Circular economy can also be instrumental in driving investments in the country. India is integrating circular economy with its ESG (Environmental, Social, and Governance) goals to drive sustainable development. Initiatives like the Swachh Bharat Mission, the National Circular Economy Framework, and the E-Waste Management addresses environmental concerns by reducing pollution, resource depletion, and greenhouse gas emissions. Since it can create jobs in recycling, refurbishing, converting waste into renewable energy contributing to social well-being, many investors today showcase interest in companies which do business with an ESG purpose. Along with bringing in investors, sustainability can also bring in consumer loyalty, driving emotional connections that increase lifetime value.

It is high time that the agricultural eco-system which includes government, NGOs, Civil Society organizations, Farmers Produce Organizations all join hands to create circular economy within agriculture, which can reduce the prices of raw materials and thus finished products, create better outreach for consumers and lead to more sustainable economy for India's future.

Transition Towards Sustainable *and* Climate-Resilient Practices



Mr Sanjay Sethi
Food Systems Expert,
United Nations

“India's agriculture sector is witnessing a transition toward sustainable and climate-resilient practices, said Sanjay Sethi, National Technical Coordinator at the Food and Agriculture Organisation (FAO) of the United Nations.

Sethi emphasised that the adoption of integrated nutrient management, integrated pest management, and climate-resilient technologies is helping farmers reduce chemical dependency while maintaining productivity and profitability.

"So when we do integrated nutrient management and when we do integrated pest management, when we take care of kind of cultural practices, mechanization, and ensuring that the farmers have the right kind of knowledge—it is possible to do the cultivation with less chemicals and with more climate-resilient technologies, ensuring that the productivity, and the income as well as the sustainability parameters are all kept in optimum equilibrium," Sethi said, talking to ANI on the sidelines of the Bharat International Rice Conference 2025.

Sethi noted that agricultural production in India continues to rise, with farmers increasingly adopting sustainability-linked and climate-resilient practices.

"We see that the agriculture production in India has been going up, and over a period of time, farmers are adopting sustainability-linked practices and they are also adopting climate-resilient technologies," he said.

Here's the expanded and polished version written in a neutral, journalistic style, combining your ANI quote and your LinkedIn post naturally. It reads like a published news article — factual, balanced, and professionally edited:

India's Agriculture Sector Moving Toward Climate-Resilient Practices: FAO's Sanjay Sethi

India's agriculture sector is witnessing a decisive shift toward sustainable and climate-resilient practices, said Sanjay Sethi, National Technical Coordinator at the Food and Agriculture Organisation (FAO) of the United Nations.

Speaking on the sidelines of the Bharat International Rice Conference (BIRC) 2025, Sethi highlighted that the adoption of integrated nutrient management, integrated pest management, and climate-resilient technologies is enabling farmers to reduce chemical dependency while maintaining productivity and profitability.

"When we implement integrated nutrient and pest management, adopt better cultural practices, promote mechanisation, and ensure that farmers have the right knowledge, it becomes possible to cultivate with fewer chemicals and greater climate resilience—while keeping productivity, income, and sustainability in optimum balance," Sethi told Agriculture World.

He noted that agricultural production in India continues to rise, with farmers increasingly embracing sustainability-



linked and climate-resilient practices. "Over time, we have seen that farmers are adopting sustainability-linked practices and climate-resilient technologies," he said.

The Bharat International Rice Conference, described by Sethi as a timely platform to "reimagine India's rice ecosystem where heritage meets innovation," brought together stakeholders from across the rice value chain. The release of EY's coffee table book on India's rice diversity was a key highlight, celebrating the country's vast rice heritage and biodiversity.

Sethi called the focus on Geographical Indication (GI) rice and traditional landraces "a watershed moment," noting that sustainability begins with recognising and rewarding origins. "Our traditional rice varieties are not just genetic resources but cultural legacies that link biodiversity to livelihoods," he remarked.

He also underlined the importance of scaling up low-emission rice cultivation through practices such as Alternate Wetting and Drying (AWD), Direct Seeding of Rice (DSR), and the Sustainable Rice Platform (SRP) standards. These, he explained, can help India reduce water use and greenhouse gas emissions while opening opportunities for responsible sourcing and global market differentiation.

"It is heartening to see momentum building toward a rice transformation agenda that connects farmers, FPOs, policymakers, and private sector players -all working toward a shared vision of sustainable, profitable, and climate-resilient rice systems," Sethi added.

Fruit Blotching Disorder in Cherry Tomato under Hydroponic Protected Cultivation

Introduction

Cherry tomato (Red) is one of the most attractive and profitable crops cultivated under hydroponics and protected cultivation in India. With rising consumer demand for exotic vegetables and fruits in metropolitan markets, cherry tomato fetches a premium price due to its appealing size, bright red colour, and sweet taste. Uniform ripening and appearance are critical for maintaining this premium quality.

However, many growers face the challenge of fruit blotching or uneven ripening, especially under conditions of high temperature, fluctuating humidity, and nutritional imbalance. Fruits that fail to ripen uniformly are downgraded in quality, reducing their market value by 30–40%.

Adding to the complexity, blotchy ripening is often mistaken for viral infections such as Tomato Spotted Wilt Virus (TSWV) or Tomato Mosaic Virus (ToMV), since the external symptoms appear similar. This misdiagnosis may lead to unnecessary pesticide use and inappropriate management practices.

At the core of this problem lies lycopene, the natural red pigment that gives tomato fruits their characteristic colour. Lycopene biosynthesis is highly sensitive to temperature, light, and nutrient availability. Temperatures above 30–32°C suppress lycopene formation, while inadequate potassium nutrition or excess nitrogen further disturbs the process (Picha & Hall, 1981). As a result, parts of the fruit remain yellow or green, producing the blotchy ripening effect.

Therefore, distinguishing physiological disorders from viral causes is essential for hydroponic and greenhouse tomato growers. This article explains the symptoms, suspected viral look-alikes, underlying physiological causes, and effective corrective measures to minimize losses and improve fruit quality.

Symptoms

Blotchy ripening in tomato shows up as greenish, yellow, or orange patches on the fruit surface, mostly on the outer walls, which fail to ripen uniformly. These discoloured areas are often low in sugars, organic acids, and dry matter.

Closely related disorders include:

- Blotchy ripening – parts of the fruit surface remain green, yellow, or orange due to poor lycopene development.
- Gray wall – brown or gray collapse of the outer fruit wall (Picha & Hall, 1981).
- Internal whitening – fruit walls (outer and inner) become corky and white.

Despite blotching, in most cases the foliage remains healthy and virus-free, which is a key clue that the disorder is physiological and not pathogenic (UMass Extension, 2025).

Suspected Viral Diseases That Can Mimic Blotching

Blotchy ripening symptoms are often confused with viral diseases such as:

- Tomato Spotted Wilt Virus (TSWV)
- Tomato Mosaic Virus (ToMV)
- Tomato Mosaic Virus (ToMV) infection.
- Tomato brown rugose fruit virus (ToBRFV)
- Tomato Fruit Blotch Virus (ToFBV)

These viruses can cause uneven fruit colour, but they are usually accompanied by leaf symptoms (mottling, mosaic, curling, or chlorosis), which are absent in pure blotchy ripening (u.osu.edu, 2024). Correct diagnosis is crucial before adopting control measures.

Causes of Blotchy Ripening

Research and field observations suggest the following causes:

1. Nutritional Imbalances

- Inadequate potassium supply during fruit development (Souza Maia et al., 2019; Song et al., 2023).
- Excess nitrogen and calcium, which ant potassium uptake.
- Too low electrical conductivity (EC) of nutrient solution in hydroponics.

2. Environmental Stresses

- High temperature (>32 °C) reduces lycopene synthesis (Peet, 2009).
- Low light intensity and sudden alternations between cloudy and sunny weather.
- High humidity combined with poor air circulation in dense canopies.
- Heat stress interferes with chloroplast-to-chromoplast conversion, leaving fruits partially green.

3. Crop Canopy and Ventilation

- Excessive vegetative growth creates dense foliage, restricting aeration and light penetration.
- Poor greenhouse ventilation traps heat and humidity, worsening stress (Bayer, 2025).

Corrective Measures and Cultural Practices

1. Nutrient Management

- Ensure balanced fertigation with higher potassium (K) during fruit maturation (Souza Maia et al., 2019).
- Avoid excess nitrogen; maintain optimal N:K ratio.
- Monitor EC of nutrient solution to ensure balanced potassium availability, stable lycopene biosynthesis, and reduced risk of fruit blotching.



2. Environmental Management

- Maintain greenhouse temperatures between 20–30 °C for optimal lycopene synthesis (UMass Extension, 2025).
Avoid extremes below 16 °C and above 32 °C.
- Use shading nets, UV screens, and humidity curtains to regulate temperature and RH.

3. Canopy and Ventilation

- Prune to avoid dense canopy and improve air circulation.
- Operate fans, exhausts, or natural ventilation to reduce humidity and heat buildup (u.osu.edu, 2024).

4. Cultivar Selection

- Choose varieties those tolerant to high temperatures under protected cultivation (Picha & Hall, 1981).

5. Integrated Crop Care

- Monitor and control sucking pest populations to minimize associated viral risks.
- Ensure regular scouting to differentiate between viral and physiological blotching.

Conclusion

Fruit blotching in cherry tomato is a complex physiological disorder, primarily linked to high temperature, fluctuating humidity, and imbalances in potassium nutrition. While the symptoms resemble viral infections, the absence of leaf symptoms and the presence of healthy foliage indicate a non-pathogenic cause.

By ensuring balanced fertigation, optimal greenhouse climate management, and proper canopy ventilation, growers can significantly reduce the incidence of blotchy ripening and maintain high-quality cherry tomato production. Uniform ripening not only improves market value but also strengthens consumer trust in hydroponically grown produce, ensuring sustainability and profitability for protected cultivation systems.



AI IN AGRICULTURE: Time to Move from Demos to Decisions

MS SAMYUKTA

Chief AI and Digital Consultant,
Wadhvani Foundation



There has been a growing hype in the Agri-Tech sector that: “AI will transform Agriculture”. From advisories like NPSS (National Pest Surveillance System) to intelligent governance dashboard, AI is perceived as the game-changer from our policymakers to farmers. While this is a compelling vision, it is also dangerously oversimplified.

It’s time we ask ourselves the tougher question – are we building for impact or are we doing it for the optics?

Over the past year, while companies like Farmitopia, Plantix have explored computer vision for pest and disease management, on the other hand, companies like Sarvam.ai who have displayed potential in terms of reasoning for crop advisories and data-driven policy making. The Ministry of Agriculture and Farmer’s Welfare (MoA&FW) also seems to be a forerunner in adopting AI from building grievance redressal chatbots like e-Mitra to coming up with a centre of excellence like IIT Ropar. The momentum is real, but so is the fragmentation.

There are too many disconnected pilots, too many overlapping proofs of concept, and too few initiatives that scale beyond a single district or demo day. We’re spending a lot of time proving that AI can do things—when we should be focusing on what it should do, and how it will be used in the field.

The Problem Isn’t Technology-It’s Direction

The core issue isn’t whether the AI works. It’s whether we’re deploying it to solve the right problems, rather than force fitting it into something which we perceive to be the problem.

Take crop advisory for example. A multilingual chatbot that tells a farmer when to sow seeds sounds impressive—until you realize it doesn’t understand local soil moisture or regional agro-climatic dynamics. Or governance dashboards: they look sleek at conferences but often lack the granularity district officers need to make field-level decisions.

We are still treating AI as an upgrade, not a redesign. But agriculture—more than almost any sector—demands systems that are deeply local, painfully specific, and built for high-stakes variability. Most LLMs (large language models) and reasoning engines weren’t trained for that.

A Roadmap Is Not a Strategy

Talks are underway for linking efforts from IndiaAI, Sarvam.ai, IITs, and various funders. That’s a welcome move. But a roadmap shouldn’t just be a list of tech integrations. It needs to answer real-world questions: Who owns the data? Who audits the models? What happens when a recommendation goes wrong?

We’ve seen interest in using reasoning modules for policy, AI assistants for scheme delivery, even WhatsApp bots funded by Meta. But we’re yet to see a single unified infrastructure layer that ties these together.

The future we’re aiming for—real-time advisories, adaptive governance, field feedback loops—will only work if the tools are designed for context, not just capability. That means co-building with farmer organizations, district administrations, and local extension workers—not just deploying a model trained in a lab.

The Risk of Techno-Solutionism

Let’s not repeat the mistakes of earlier tech waves, where digital tools were rolled out without ground truthing. In agri-tech, false precision is dangerous. A wrong sowing date or pesticide recommendation isn’t a UX bug—it can mean crop loss and financial distress.

And let’s be honest: many of these AI initiatives are still in their early stages. Some of the reasoning engines (AI systems designed not just to process data but to analyze, infer, and make informed decisions) under development haven’t been field-tested. The data sets remain patchy. Integration with government systems like Agristack is still on paper. Without a serious, long-term commitment to feedback-driven development, we risk building shiny systems that don’t stick.

What Needs to Change

Here’s what we should push for now:

- **Mission-first design:** Build tools based on real agricultural pain points, not just model capabilities.
- **Cross-ministry alignment:** If the same reasoning module can serve agriculture, health, and education, let’s build shared infrastructure—but define domain-specific layers clearly.
- **Accountability loops:** Funders and ministries must demand longitudinal metrics—not just pilot success.
- **Field partnership:** The best AI won’t come from Bengaluru or Delhi alone. It’ll come from co-designing with those in Mandla, Baramati, and Nalgonda.

We’re at a pivotal movement. India can the potential to lead in creating an inclusive, context-aware agriculture AI systems. But we need to move beyond bubble created buzzwords and short-term projects. This isn’t just about “transforming” agriculture through AI; it is about understanding agriculture deeply enough that AI helps.

The potential is huge. But potential remains merely on paper if not appended with execution.

India Navigating a Shifting Landscape:

The Impact of US Tariffs on the Global Fertilizer Market



ABHISHEK WADEKAR
Founder Chairman
Tradelink International

The global fertilizer sector confronts unprecedented disruption as recent US trade policy modifications fundamentally reshape international supply networks. Escalating geopolitical tensions compound these challenges, generating widespread uncertainty across agricultural markets and affecting farming communities worldwide through strained distribution channels. What used to be predictable supply chains are now anything but certain. The latest round of US tariffs is particularly concerning because it's disrupting long-established trading relationships and forcing everyone to scramble for new arrangements. For a country like India, whose extensive agricultural economy relies substantially on fertilizer imports, these developments present significant challenges.

This article delves into the specifics of these US policies, their immediate and long-term implications for the international fertilizer trade, and, most importantly, their ramifications for India.

How New US Tariffs Are Shaking Up Fertilizer Markets

On July 31st, President Trump signed an executive order that's already causing ripple effects across global fertilizer markets. The new "reciprocal" tariffs kicked in on August 7th, and they're hitting some countries much harder than others.

Egypt, Saudi Arabia, and Morocco are now dealing with a 10% tariff on their phosphate fertilizers, while Jordan and Israel got slapped with 15%. This is a big deal, especially for Saudi Arabia, a major supplier of ammonium phosphate to the US. In the nitrogen world, granular urea from Algeria and

Nigeria now face tariffs of 30% and 15%, respectively. Not everyone was affected equally, however.

The tariff implementation reveals notable inconsistencies in application. Potassium fertilizers from USMCA nations such as Canada maintain tariff-free status, while other Canadian exports face substantial 35% duties. Brazil successfully negotiated relief from an initially proposed 50% tariff, securing exemptions for NPK products through diplomatic channels. As a direct result of these announcements, market prices for crucial fertilizers like monoammonium phosphate (MAP), diammonium phosphate (DAP), urea, and ammonia all showed an instant increase on July 31. The whole situation shows just how quickly trade relationships can shift and leave everyone scrambling to adapt.

How Global Fertilizer Markets Are Changing and What It Means for India

The fertilizer industry is experiencing massive growth. The global fertilizer market itself is projected to grow from around \$402.5 billion in 2025 to \$541.2 billion by 2030 which is roughly 6.1% growth annually. This driven by the need to feed a growing world population projected to exceed 9 billion by 2050, a decrease in available farmland and the increasing adoption of modern farming techniques.

For India's agricultural sector, the backbone of its economy, this global situation creates some serious vulnerabilities. India relies heavily on imported fertilizers to sustain its massive crop production. A substantial majority of these imports come from Russia and Saudi Arabia, two countries that are now, directly or indirectly, affected by new US tariffs. This high dependence of import sources exposes India to a significant risk of price shocks and supply disruptions. Even though these tariffs don't directly target India, the ripple effects are unavoidable. When fertilizer prices spike globally, India's procurement expenses will climb, putting immense pressure on farmers which eventually will hurt their profits, raise food costs for consumers, potentially making Indian agricultural exports less competitive worldwide.

India's Strategic Challenges and Opportunities - Way Forward

The situation presents India with a set of distinct challenges and, if handled correctly, can provide the country with valuable opportunities. The immediate difficulties of the

tariffs are evident- extensive dependence on suppliers now encountering fresh trade barriers, susceptibility to international price fluctuations, and inadequate domestic production capabilities. India's import statistics reveal this dependency starkly—approximately 20% of urea, 50-60% of DAP, and nearly all Muriate of Potash requirements come from abroad.

However, these circumstances also present opportunities for comprehensive restructuring of policies. India can pursue import diversification by establishing supply partnerships across Southeast Asia, Africa, and Latin America, reducing reliance on concentrated sources and building resilience against geopolitical disruptions. Current conditions favour accelerated domestic production development. Strategic research investments, private sector incentives, and international collaborations could advance self-sufficiency goals significantly. India's diplomatic channels can negotiate favourable trade arrangements and seek exemptions through various international forums.

Additionally, advancing sustainable agricultural practices through precision farming and nutrient-efficient fertilizer applications can enhance productivity while reducing overall consumption, thereby lessening long-term import dependencies.

Proactive market monitoring can enable strategic procurement timing, potentially leveraging surplus fertilizer as suppliers redirect volumes away from the United States. These coordinated approaches could transform present vulnerabilities into enduring competitive advantages, strengthening India's agricultural foundation while reducing external dependencies that have historically constrained the sector's growth potential.

Conclusion

The US tariff move represents a watershed moment for international fertilizer commerce. For India, it also emphasizes the need to strengthen resilience—through diversification, self-sufficiency, and smart diplomacy. By being forward-looking and acting swiftly, India can insulate itself against risks, stabilize input prices, and position itself to gain from emerging trade alignments in a recalibrated world economy.

BRING PROSPERITY AND HAPPINESS TO YOUR VEGETABLE FARMING WITH THE STIHL POWER WEEDER MH 210!



In India, farming is not just a means of livelihood—it is a symbol of tradition, hard work, and hope. Especially for vegetable farmers, who strive day and night to improve both the quality and quantity of their produce every season. To support their efforts, it is essential to enhance productivity and reduce manual labor through modern technology. In this direction, STIHL has introduced a powerful, reliable, and highly useful solution for farmers—the Power Weeder MH 210, a true boon for vegetable growers. Let’s take a closer look at this revolutionary machine.

Changing Needs of Vegetable Farmers

The biggest challenge in vegetable farming lies in repeated weeding, soil preparation, and proper fertilizer mixing. Traditional methods demand a lot of time and physical effort, which increases both the cost and the workload for farmers. But in this era of technology, farmers now have a better alternative—the STIHL Power Weeder MH 210, which performs all these tasks with speed, accuracy, and efficiency.

STIHL MH 210 – A Partner in Modern Farming

The STIHL Power Weeder MH 210 is designed with German quality and Indian farmers’ needs in mind. It is easy to operate, requires minimal maintenance,

and delivers exceptional performance. The machine is ideal for farmers engaged in vegetable cultivation, fruit orchards, or floriculture.

Its biggest advantage is that it works perfectly even in small and medium-sized fields—whether the soil is light or heavy, the MH 210 ensures outstanding results in every condition.

Key Technical Specifications

Feature	Description
Engine Capacity	80cc (4-stroke engine)
Power Output	2.2 HP
Drive System	Belt Drive
Working Width	15 inches
Working Depth	4 inches
Fuel Tank Capacity	1.6 liters
Weight	28 kg
Warranty	1 year (STIHL Warranty)

Why Is It Perfect for Vegetable Farming?

1. Better Soil Preparation:

For vegetable farming, the soil needs to be soft and even. The MH 210 tills the soil uniformly, ensuring better root development and healthier plant growth.

2. Efficiency in Weeding:

Traditional weeding takes a lot of time and effort. With the MH 210, farmers can weed larger areas in much less time—without hassle.

3. Fertilizer and Manure Mixing:

Proper distribution of organic or chemical fertilizers is crucial in vegetable farming. The MH 210 helps mix manure deep into the soil, providing uniform nutrition to the plants.

4. Ideal for Small and Medium Fields:

Its compact design makes the MH 210 perfect for working in small farms, nurseries, or greenhouses.

5. Low Fuel Consumption, High Productivity:

This power weeder is fuel-efficient and low-emission, making it both eco-friendly and cost-effective.

Benefits of Using the STIHL MH 210 for Vegetable Farmers

1. Saves Time:

While traditional tools may take up to 2 days to prepare 1 acre of land, the MH 210 can accomplish the same task in just a few hours.

2. Reduces Labor Costs:

Farmers become less dependent on manual labor, reducing costs and increasing profit margins.

3. Improves Soil Quality and Uniform Yield:

Uniform tilling ensures even plant growth and improved crop productivity.

4. Low Maintenance, Long Life:

With STIHL’s German engineering, the MH 210 is built to last. With regular servicing, it delivers outstanding performance for many years.

STIHL MH 210 – A Tool Bringing “Transformation” to Farming

STIHL’s motto, “STIHL Upkaran, Laye Parivartan” (“STIHL Tools Bring Transformation”), perfectly describes the MH 210. It is not just a machine—it represents a new way of farming.

Where farmers once spent entire days on soil preparation, weeding, or turning the soil, the MH 210 now completes these tasks within hours. This not only reduces physical effort but also significantly improves farm productivity.

Crop-Specific Advantages – The Magic of MH 210 in Vegetable Farming

1. For Tomato, Brinjal, Capsicum, and Okra:

These crops require loose, aerated soil. The MH 210 keeps the soil around the roots soft, ensuring better oxygen and moisture availability.

2. For Leafy Vegetables (Spinach, Fenugreek, Coriander, Cauliflower, etc.):

The MH 210 helps create fine and even soil texture, ensuring excellent seed germination and uniform growth.

If you want to save time, reduce effort, and increase yield in your vegetable farming, the STIHL MH 210 is your perfect companion in the field. For more details or to place an order, contact your nearest STIHL dealer or call/WhatsApp 9028411222.



 **arquivo**TM
Responsibly Rooted



arquivoTM
Responsibly Rooted



NOW IN INDIA, FOR INDIA



MYCOR^e SUPER



MYCOR^e SUPER
"DO KADAM AAGEY" 



Dhanuka Agritech Limited

Global Gateway Towers,
Near Guru Dronacharya Metro Station, MG Road,
Gurgaon - 122002, Haryana, Tel.: +91-124-434 5000,
E-mail: headoffice@dhanuka.com, Website: www.dhanuka.com

For more information,
contact toll-free number or scan

1800-102-1022



INDIA KA PRANAM HAR KISAN KE NAAM[®]

STIHL UPKARAN, LAYE PARIVARTAN

STIHL

POWER WEEDER MH 210

**MORE POWER,
LESS WEIGHT**



Call or Whatsapp
90284 11222



German Quality and Innovation



✉ info@stihl.in
🌐 www.stihl.in