AGRICULTURE WORLD

the pulse of global agriculture

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MIONP

भारत का जैविक जागरण

Healthier & Safer Tomorrow

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Mission 2047: MIONP Bharat Ka Jaivik Jagran

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

A proud Initiative of India's Leading Agri-Media Network

At **Krishi Jagran**, we have long believed that **India's future lies in its soil**—not just in how we cultivate it, but in how we **restore, respect, and reimagine it**. With the **Indian Council of Agricultural Research (ICAR)** as our knowledge Partner, we proudly lead **Mission 2047: MIONP, Make India Organic, Natural & Profitable**, under the banner of **Bharat Ka Jaivik Jagran**.

Reaching over **50 million farmers every month**, Krishi Jagran is not just India's largest agri-media network—we are a **movement builder**, a **storyteller**, and an **enabler of India's next agricultural revolution**.

The Spark: A Challenge That Inspired a Mission

Mission 2047: MIONP was born from a bold vision—and a compelling challenge.

During a **Krishi Jagran Chaupal interaction, Dr. Ajay Ranka,** CMD of **Zydex,** challenged our team:

"**Prove me wrong that my technology cannot replace agrochemicals in a single crop cycle. If someone can, I'll pay ₹1 lakh to anyone who takes the challenge.**"

This wasn't just a provocation—it was a powerful spark.

That single moment led to **weeks of discussions** with **scientists, FPOs, startups, agri-input manufacturers, NGOs, and farmers**. And what we discovered was both humbling and energizing: **many stakeholders across India shared this vision**, yet their ideas were not given the platform or priority they deserved.

So **Krishi Jagran stepped forward**—to give voice, structure, and scale to this quiet revolution.

It was this national sentiment-echoing from rural fields to research labs—that **inspired me to coin the term *MIONP*: Mission 2047: Make India Organic, Natural, and Profitable.**
Not just as a slogan, but as a mission to **redefine Indian agriculture** by placing **profit, purity, and planet** on the same pedestal.

We recognize that **agrochemical inputs may still be needed in the short term**, but that must not stop us from embracing and handholding **innovations that promise higher value, resilience, and sustainability** for every stakeholder in the ecosystem. Let us begin—and see how quickly we can return to **regenerative, future-ready farming.**

The Vision: A Jaivik Bharat by 2047

By 2047, as India celebrates 100 years of independence, we envision a nation where:

- Every **farm is organic and natural**
- Every **farmer is profitable from the very first crop cycle**
- And every **agricultural product earns global respect and premium value**

This vision aligns with:

- The **United Nations Sustainable Development Goals (SDGs)**
- India's ambition to become a **$1 trillion agricultural export powerhouse**

- And **Prime Minister Shri Narendra Modi's call** for eliminating chemical inputs to secure a **healthy, high-yielding, and sustainable food system**

With guidance from **Cooperation Minister Shri Amit Shah** and **Agriculture Minister Shri Shivraj Singh Chouhan, the foundation has been laid. Now,** it is time to scale—together.

The Grand Challenge: Profitable Transition Starts Now

Despite awareness of the benefits of organic farming, **mainstream adoption remains low** due to a lack of validated, scalable proof-of-concept models. That's why we launched the **MIONP Grand Challenge**—a nationwide initiative urging India's agri-industry to:

Reduce chemical inputs by 50–100% in just one crop cycle—while ensuring equal or higher profitability for farmers.

This challenge is being implemented through **real-world demonstrations,** backed by scientific rigor, and begins with **Kharif 2025,** in collaboration with **ICAR.**

The Workshop: Science, Strategy, and Global Insights

In **March 2025,** we hosted a landmark **two-day National Workshop** at the **NASC Complex, New Delhi,** attended by **over 300 stakeholders**—including scientists, policymakers, farmers, FPOs, NGOs, and industry leaders.

Highlights included:

- **Inaugural Keynote:** Making India a Global Leader in Nutrient-Dense Agro Produce
- **Global Best Practices:** Shared by experts from organic-transitioned nations
- **Technical Sessions:** Focused on bio-inputs, composting, water use, crop care, and market strategies
- **Valedictory Ceremony:** Launch of the **Kharif 2025 demonstration timeline**

Pillars of a Profitable Organic Ecosystem

The workshop identified **eight critical interventions** to guide the profitable organic transition:

- **High-quality compost and organic manure** availability
- **Soil fertility restoration** and increase of **Stable Organic Matter (SOM)** to 5–7%
- **Biological crop protection** and yield enhancement
- **Smart water conservation** through ponds, check dams, and recharge systems
- Use of **botanical inputs** such as **neem-based crop care**
- **Precision and digital agriculture:** AI, IoT, drones, blockchain
- **Organic certification and traceability infrastructure**
- **Strengthening indigenous organic seed systems and supply chains**

Ten MIONP Vertical Collectives

To institutionalize and accelerate MIONP's impact, **Krishi Jagran**, under the **Mac Krishi Jagran Foundation,** launched **Ten Strategic Collectives,** supported by **ICAR, CIRDAP, BASSAI, and BIPA:**

- **Farmer Collective:** Mobilizing progressive farmers
- **Industry & Allied Partner Collective:** Driving field-ready innovation
- **Funding Partner Collective:** Engaging CSR, donors, and public programs
- **Implementing Partner Collective:** On-ground support via NGOs, FPOs, cooperatives
- **Research & Scientist Collective:** Scientific validation and direction
- **Market Place Collective:** Creating Organic-Natural Produce Centres at Taluka HQs
- **Value Creator Collective:** Strengthening post-harvest and rural enterprises
- **Consumer Collective:** Building trust and demand through transparency
- **Exporter Collective:** Connecting Indian produce to premium global markets
- **Global Collective:** Sharing and scaling ideas across borders

From MIONP to MGONP: Dream 2100

And now, we go further.

"We will soon be advocating under **MGONP – Make Globe Organic, Natural and Profitable."**

This is not just a policy shift.

This is a Dream.

Dream 2100: Make Globe Organic, Natural and Profitable.

By the turn of the next century, we believe the entire world can return to farming that is **rooted in nature, powered by science, and nurtured by shared prosperity.**

I call it a dream because **every transformation begins as a thought.**

Let us **plant this thought now**—and together, **make it blossom into a global reality by 2100.**

India will lead. The world will follow. And together, we will co-create **a sustainable Earth for generations to come.**

A Movement for India. A Model for the World. A Dream for the Globe.

Mission 2047: MIONP is not just a campaign—it is India's agricultural awakening.

It is a mission to **empower farmers, regenerate soils, create new markets, protect biodiversity, and establish India as a global leader in sustainable agriculture.**

But our journey does not stop at India's borders.

We now dream beyond 2047—towards a global future of harmony between **nature, nourishment, and nations.**

Dream 2100: MGONP – Make Globe Organic, Natural & Profitable

Let us **dream boldly, act decisively,** and **inspire the world to transition—together.**

We invite **farmers, scientists, institutions, startups, policymakers, NGOs, and global allies** to join us.

Let's **Make India Organic, Natural & Profitable.**
Let's **lead the world in Jaivik Jagran.**
Let's **make the globe organic, natural, and profitable—by 2100.**

MIONP
MAKE INDIA ORGANIC NATURAL & PROFITABLE
भारत का जैविक जागरण

Jai Kisaan, Jai Jaivik Bharat, Jai MGONP.

FROM THE MD

EDITOR'S DESK

Organic and Natural Farming – The Opportunities

Organic and natural farming present numerous opportunities for farmers, consumers, and the environment. With the rising demand for chemical-free, healthy food, farmers adopting organic practices can tap into premium markets, ensuring better prices for their produce. This method reduces dependency on synthetic fertilizers and pesticides, lowering input costs and improving soil health over time.

Governments and organizations worldwide are promoting organic farming through subsidies, training, and certification programs. This support helps small and medium-scale farmers transition to sustainable agriculture, improving their livelihoods. Additionally, organic farming encourages biodiversity, conserves water, and reduces pollution, making it an environmentally sustainable choice.

Consumers are increasingly conscious of their health, leading to a growing preference for organic food. This shift creates business opportunities in organic food processing, packaging, and exports. Entrepreneurs can explore farm-to-table models, organic grocery stores, and online marketplaces to cater to this demand.

Natural farming techniques reduce costs while maintaining productivity, making farming more sustainable in the long run. With technological advancements and policy support, organic and natural farming can revolutionize agriculture, ensuring food security and ecological balance while offering economic benefits to farmers and businesses.

Shiny Dominic
Managing Director

Making Organic and Natural Farming Profitable

As consumer demand for healthy and environmentally friendly food increases, organic and natural farming presents a viable and sustainable business opportunity. However, profitability remains a challenge for many farmers due to high input costs, lower yields, and market competition. By implementing strategic approaches, farmers can enhance the profitability of organic farming while maintaining sustainable practices.

One of the most effective ways to increase profits in organic farming is through diversification. By growing a variety of crops and raising livestock, farmers can maximize their income streams and reduce the risks associated with market fluctuations and seasonal dependencies. Intercropping and crop rotation also improve soil health and reduce pests, further lowering costs.

Processing raw produce into value-added products such as organic jams, herbal teas, or dairy products significantly increases profitability. Direct marketing strategies, including farmers' markets, farm-to-table partnerships, and online sales, help farmers bypass intermediaries and retain a larger share of the profits.

Minimizing expenses is crucial for profitability. Farmers can use composting, vermiculture, and natural pest control methods to reduce dependency on expensive organic fertilizers and pesticides. Additionally, water conservation techniques like drip irrigation and rainwater harvesting lower utility costs.

Obtaining organic certification enhances credibility and allows farmers to access premium pricing. Branding and storytelling about the farm's natural methods and ethical values help attract dedicated customers willing to pay a premium for high-quality organic produce.

Community-Supported Agriculture (CSA) Programs - CSA models provide upfront financial support from consumers who subscribe to receive fresh organic produce regularly. This system not only ensures steady revenue but also strengthens consumer relationships and loyalty.

Utilizing modern and Data-Driven farming technology such as precision agriculture, AI-driven soil monitoring, and automated irrigation can optimize resource usage and increase productivity. Keeping detailed farm records helps farmers make data-driven decisions to maximize yields and efficiency.

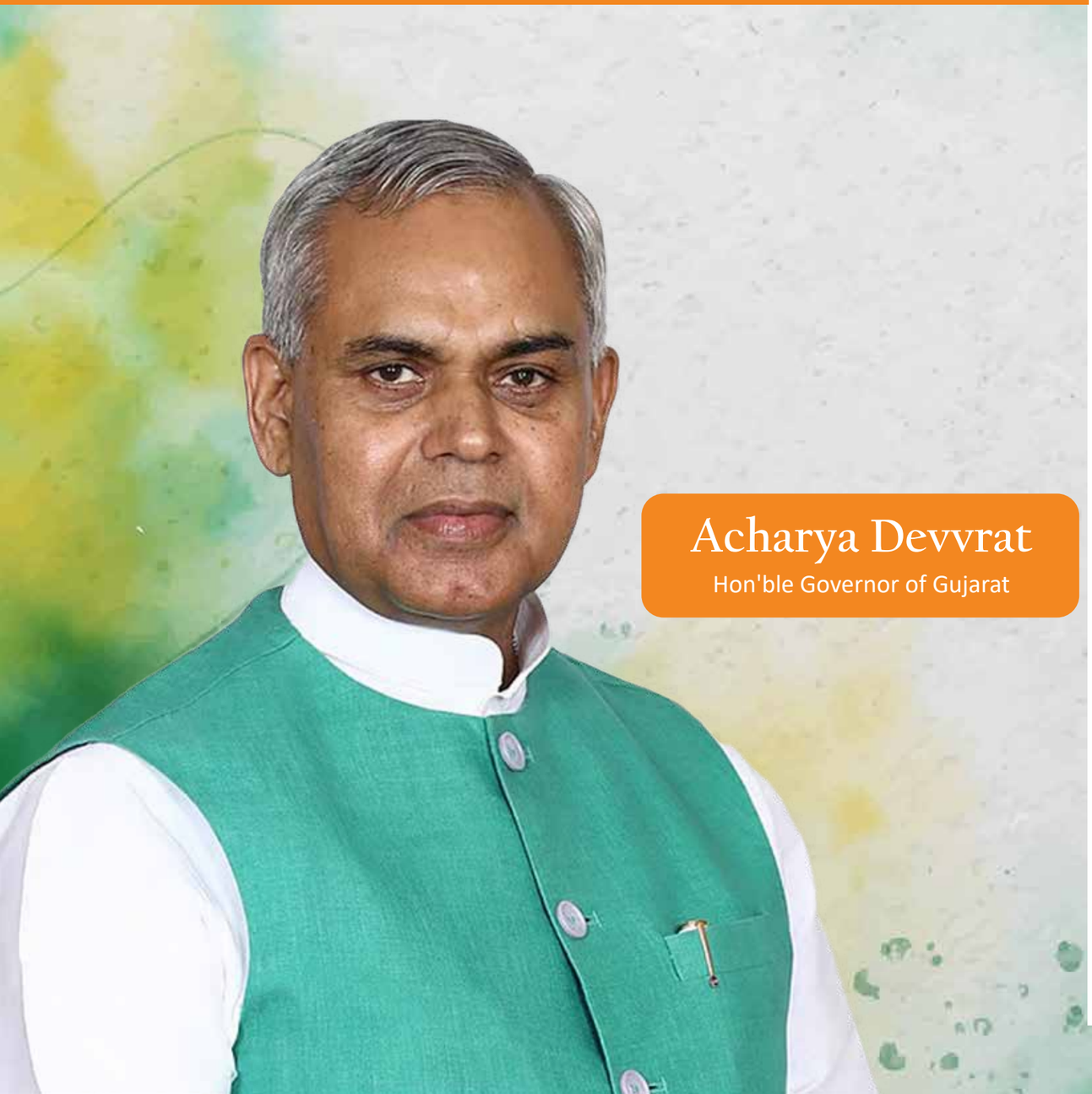
Many governments and NGOs offer grants, subsidies, and training programs to support organic farmers. Utilizing these resources can significantly reduce initial investment costs and improve financial sustainability.

Organic and natural farming can be highly profitable when combined with diversification, value addition, efficient resource management, and strategic marketing. By embracing sustainable practices and innovative business models, farmers can not only achieve economic success but also contribute to a healthier environment and food system.

Mamta Jain
Group Editor & CEO

Agriculture Facing Challenges Globally

Natural Farming Is The Answer



Acharya Devvrat

Hon'ble Governor of Gujarat

I am extremely happy to see the progress we are making with natural farming in Gujarat. The state is committed towards making the farmers prosperous and also ensuring healthy, nutrient-rich and chemical free agricultural produce. We recently organized a training camp for 2500 farmers at Adalaj. We are training the trainers here. We are organizing more such training camps all over the state. Farmers who have adopted natural farming are very happy.

The yield from their farms is the same as before or has increased. Their farms are emerging as model farms where the neighbouring farmers can visit. They can see firsthand the benefits of natural farming and they shall also feel encouraged to adopt it. Globally, agriculture is facing multiple challenges. With global warming, new challenges have arisen.

Natural farming is the answer to the diverse difficulties being faced by the farmers. This is the reason why we are working on war footing to promote
natural farming.

The damage

Chemical farming is aggravating the challenges being faced by agriculture. Chemical farming is highly challenging for the soil and also for the environment. We are facing multiple climate crises. Many years ago when I followed chemical farming, I was shocked to learn that men used to faint while spraying the insecticide. This is what we are feeding ourselves with chemical farming.

In addition, we are polluting our soil, our groundwater with chemical farming. In villages, we used to have water from the ground. Thanks to chemical farming and multiple other factors, water has become so polluted that you cannot consume it directly. Land fertility is dropping. Earthworms multiply land fertility, but chemical farming kills the earthworms.

On the other hand, farming done using the gobar and gau mutra of desi cows allows the earthworms to flourish. The friendly pests, the friendly worms, the birds – all creatures flourish.

Chemical Farming Is Slow Poison'

We damaged the ecosystem so much with chemical farming. But what did we achieve? The input cost kept increasing. In addition, we had to pump in more and more urea, more and more fertilizers, pesticides and insecticides. What are we giving ourselves in turn? If we consume food made with deadly products, we will get deadly diseases. It is a slow poison and we are all getting exposed to it.

Study the statistics of cancer, heart attack, diabetes and other diseases 50 years ago. Study the current statistics. You shall be shocked. A major factor here is the highly adverse impact of chemical farming.

Natural farming is science-based

We have the agricultural scientists of leading agriculture universities on board. They have studied the farms which have adopted natural farming. They call it an "adbhut karyakram". In order to pursue natural farming, we got the gobar of buffalos, HF cows, horses, goats etc tested in a lab. The tests revealed that the gobar of the desi cow had the highest strength of friendly bacteria which boost soil fertility. No other animal matches it. The gobar of stray cow has even higher concentration of friendly bacteria because its energy is not diverted to milk production.

These friendly bacteria become the fertilizer for the farm. No additional fertilizer is required. All the essential minerals needed for plant growth get catalysed and released from the soil. The earthworms flourish and hence the crop also flourishes. This is the same principle that applies in the jungle. Nobody applies fertilizers, insecticides or pesticides there. The jungle prospers without any human inputs.

Natural farming must not be confused with organic farming. Natural farming is based on the gobar and gau mutra of the desi cow.

The government is spending lakhs of crores on fertilizer subsidy. Plus chemical farming has a detrimental impact on health. It is highly encouraging to observe that farmers are getting inspired to shift to natural farming on observing the benefits.

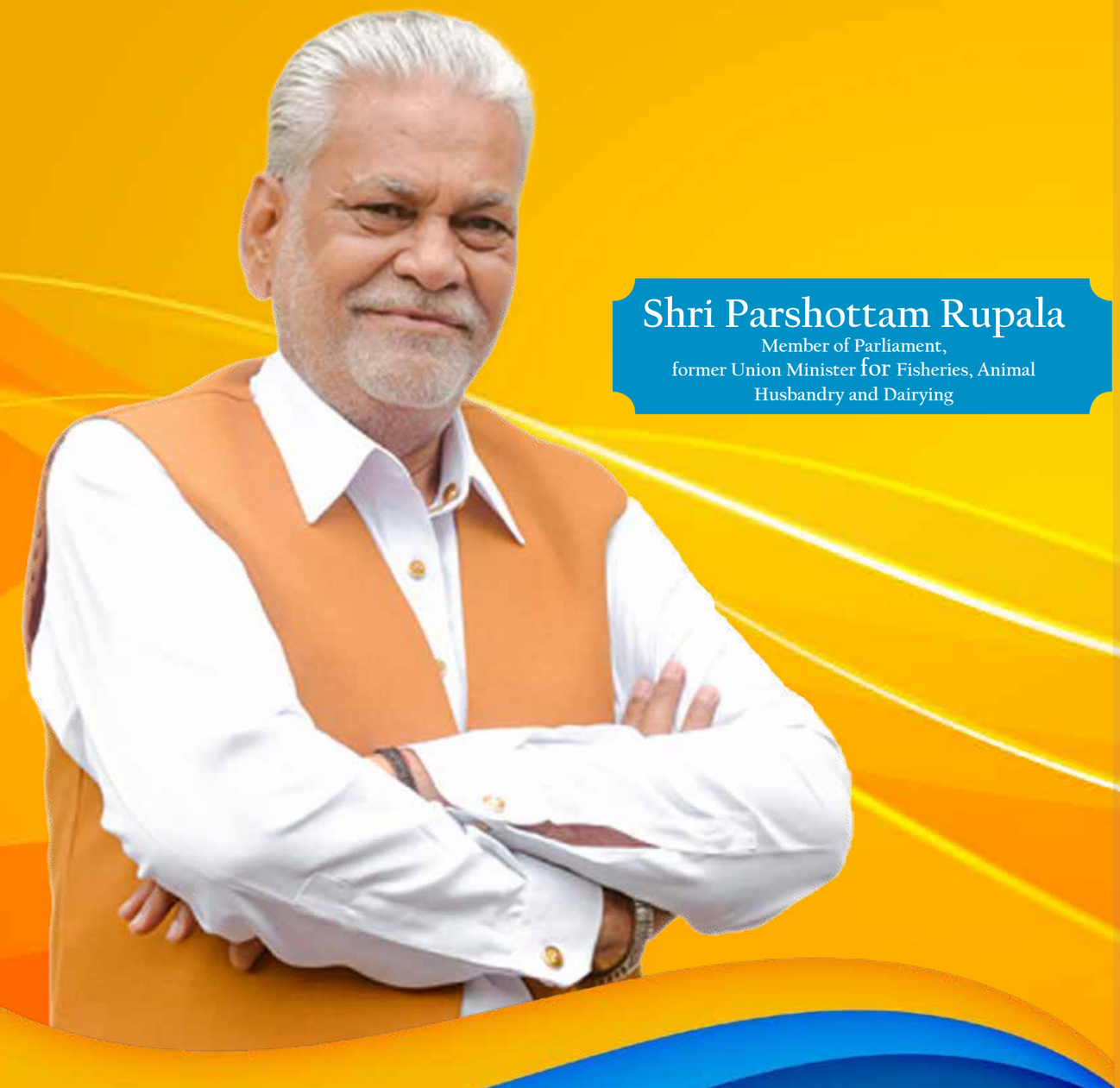
Prime Minister Shri Narendra Modi has ensured that farmers get the handholding they need for making the shift to natural farming. The change has started happening. Green revolution was required at that time when it happened. But for many years, it has been known that drastic damage to the environment is taking place. Because of the chemical residue in crops, our export has started getting impacted.

Our people are suffering because we are eating products for which harmful inputs have been used indiscriminately. We urgently need to leave chemical farming and adopt natural farming. Natural farming will benefit all and will also save the environment. Kaam ek, laabh anek.

Now farmers are enthusiastically practicing natural farming in Gujarat. Earlier I was the Governor of Himachal Pradesh. We introduced natural farming there. The farmers saw the amazing and highly positive results of natural farming. Now an impressive number of farmers practice natural farming in Himachal Pradesh, also in other states. This number shall steadily increase.

Farmers Unite, Show The Way To Success

The Inspiring Story From Morbi, Gujarat



Shri Parshottam Rupala
Member of Parliament,
former Union Minister for Fisheries, Animal Husbandry and Dairying

It is a matter of pride for our country that in Bagathala village in Morbi District, 1200 farmers have formed an FPO to engage in Samuh Kheti or Group Farming. Five entrepreneurs with a passion in agriculture joined forces to create BKISAN (GUJ). This is an FPC (Farmer Producer Company) created with the objective to help traditional farmers improve their livelihood by giving them an improved direction involving core agricultural practices.

Farmers with small land holdings such as one to five acres have to incur a myriad of expenses for resources such as water, drip-system, tractor, motor, room, boundary, electricity system etc. Their expenditure is similar to those farmers who own larger tracts of land.

Major benefits of FPC

One of the core objectives of forming the FPC is that such costs can be avoided if we join forces, seek supportive policies and get support from the government to do collective farming. Presently, farmers have to incur major expenses like chemical fertilizers, Pesticides and excessive wages. Therefore, after much deliberation and consultations with experts was born the concept of "Collective Bamboo Natural Farming". This has emerged as a sustainable initiative in support of "CARBON NET ZERO" mission of our Honorable Prime Minister Shri Narendra Bhai Modi, a true global Leader.

Collective Natural Farming For Bamboo

Thereafter the farmers submitted a formal proposal to the Gujarat government requesting ease in formalities and process time from submission to formation of the FPO. The state government helped their efforts. This made their journey a smooth flow and enabled them to move forward.

Introduction and encouraging rampant use of chemical fertilizers and pesticides used by farmers led to a certain level of employment generation and also became a way of life. But on the flipside, it led to degeneration of soil, loss of microbes and micro-nutrients and hence lack of nutrition in food, contamination of food with harmful fatal disease-causing elements, air and water pollution etc.

Rejuvenation of soil, forestation and sustained scientific and Vedic practices are needed to be implemented at mass scale with the support of the governments to counter the deterioration and breakdown that has happened over the last 60 to 100 years. Our Collective Bamboo Natural Farming is an initiative in that direction.

Geographical Area

The geographical belt lying 45 kms inland from the Gujarat coast and running along 225 Kms between Dwarka to Samakhiali has several climatic and water quality challenges due to proximity to the ocean and extreme weather conditions. Combined with wrong agricultural practices over several past years, the soil has become very acidic and saline.

One of the very few options that we can use to rejuvenate and reverse the process over a period of time is to make the soil live with humus formation, trap Organic Carbon, generate high amount of oxygen. This shall provide income, livelihood, establish industries, and above all fight global warming, climate change etc. Large tracts of land can be taken under collective farming as has been done in Bagathala village. Bagathala Village of Morbi will be a leader in being referred to as the Mega Oxygen Park.

Inspiring Story of Bagathala village at Morbi

Morbi in Gujarat is famous for its ceramic industry, especially ceramic tiles and sanitary ware. India exports the ceramic products and sanitary ware made at Morbi to several nations globally.

Unfortunately, some units had to be closed due to some operating challenges. This led to unemployment for a large number of people. The lockdowns caused by the pandemic in 2019 and 2020 led five businessmen friends to brainstorm and come up with the brilliant idea of moving into a regenerative way of life, taking the entire community along towards prosperity.

Nothing seemed to be working for this area for nearly two years. People were dejected and mentally exhausted. They had seen a lot of deterioration, breakdown of confidence and stress buildup. The inspiring concept of community farming and using bamboo as the major resource came as a blessing for them. This created huge opportunity of creating social upliftment – much larger than had been envisaged.

The five friends took the initiative to educate the villagers about this new concept. They urged the villagers to be part of the vision through classrooms and Panchayat level sessions called Kisan Pathshala. The five friends also worked tirelessly in preparing presentations and meetings with the government to seek ease of putting the words into action. They had a clear roadmap for the development of the area. They sought subsidies and support for the initial three years until the plantations started to yield the bamboo which could kick-start the local economy.

Make India Organic, Natural & Profitable (MIONP)

> “THE MIONP MISSION WILL ADDRESS THE BOTTLENECKS IDENTIFY THE GAPS AND ADDRESS THE ASPECT OF DEGRADED LAND WITH DEPLETED WATER TABLES

MIONP, is mission movement to achieve, Profitable Transition for Jaivik Bharat (PTJB) a reality. This ambitious initiative envisions full successful transition to a fully organic, natural, and profitable farming in India by 2047. The mission will also align with the United Nations Sustainable Development Goals (SDGs) and India’s aspiration to become a global powerhouse for sustainable agriculture through achieving $1 Trillion agro export target by 2047.

It is widely known that the adoption of chemical farming system using chemical fertilizer & crop care chemicals such as chemical herbicides, fungicides & insecticide are having a undesirable impact on public health. The parliamentary committee under the chairmanship of Shri. Murli Manohar Joshi has documented that Indian agro food chain has lost 48% of nutritional value. The increase in cancer & many other diseases are getting strongly influenced by the residual toxicity in the food chain. We have also experienced reduction in the shelf life & loss of original taste.

India is likely to become 7 to 8 times wealthier and world is also going to become 2-3 times more prosperous. This means customer will demand nutritionally dense food with safety, tasty and freshness as key parameters for high quality food.

The Indian farmers and the agro sector must rise to understand the challenge and emerging trends and adopt the best technology, the products and the protocols to achieve profitable, organic/natural farming techniques with modern material and nutritional science for India to become the global organic superpower.

The climate advantage of India

With the Himalayan wall in the north gives us one of the largest arable land with a tempered soil temperature zone between 10 to 35degrees centigrade which is ideal for biological activity critical for providing nutrient and bio-metabolites to the plants. With large coastline we are blessed with an average of 100centimeter of rainfall across India. We are also blessed with 250 to 300 days of sunshine for a very efficient photosynthesis process. The best part is nobody sends us a bill for these key inputs for agro production. This gives a possibility of 2/3 crops every year. The efficiency of organic farming to be profitable will be decided by biological species, their biomass and their activity to ensure nutrient availability and resistance to diseases and India has perfect climate condition for maintaining the highest efficiency.

Carbon Sequestering 12 Giga Tons is also possible by adopting new bio and natural farming practices by increasing carbon % in soil from 0.4% average today to 2-3% across Indian farm land which is a critical parameter to improved fertility. The key technology to be adopted is to maximise photosynthesis potential which will power high sugar production and increase exudates in rhizosphere and grow the biomass which will be key to increasing carbon content (SOM) with every crop cycle. The key is to make soils soft and porous which is now possible and reduce tillage to reduce ability of bacteria to consume our carbon. We also need to focus to restore fungal dominance by increasing their biomass to 3:1 compared to bacteria.

The MIONP mission will address the bottlenecks identify the gaps and address the aspect of degraded land with depleted water tables.

Tackling the transition

Profitable easy transition to Organic/ Natural Farming is claimed by many but have not been adopted by the mainstream. A scientific and commercial framework for majority of the crops have not been used to validate the claims and demonstrations by many. The key aim of this first of the series, the conference and workshop on 20th March and 21st March 2025 is to launch this mission. The purpose is deliberate and create a group of dedicated contributors for this mission. The objective of the workshop will be identifying the best techno commercially feasible technology products and protocols which are sustainable and practical with higher profitability. The scientist, the academician, the practicing farmers and the input providers (manufacturers) will create the framework and define the criteria to evaluate, analyse and document the best practises to achieve a profitable organic/ natural farming.

India has large depository of Vedic, natural, farming techniques based on desi cow and has been evolving as one of the option. Unfortunately long transition of 4-5years and managing the crop care protocols and high labour intensity and complex protocols have resulted into 1-2% land being converted into organic/ natural farming.

Very large subsidy to chemical fertiliser amounting to greater than 1lac crore every year, with no regulatory restriction to control their inputs knowing fully well that only 25% of such input are taken up by the plant we are marching towards degrading our soil at rapid pace. It is common knowledge that higher chemical fertiliser input will lead to higher water consumption and increase pathogen and pest pressure on the crops.

The significance of MIONP

MIONP will create a grand challenge, define the success parameters and measure the restoration of soil fertility and the water table. It will be for the community to take this challenge and demonstrate profitable transition and validate the technologies, the products, and the protocols for at least top 20 commercial crops to start with. This must be universal for all types of Indian soils and climatic zone and ultimately valid for all the crops we grow.

To start with this Grand Challenge can offer 3 categories of transition 1) 50% reduction in chemical fertilizers and crop care inputs; 2) 75% reduction and 3) 100% reduction in first crop cycle itself but making 100% sure, equal or higher profitability for the farmers at the market price. (No premium for the organic produce to be assumed except which can be paid for quality-like taste, size and the look)

This workshop initiative will ensure scientific rigor and suggest actionable insights. The workshop will bring together key stakeholders from India and around the world to address the challenges of achieving a profitable transition to Organic/ Jaivik/ Natural farming from the very first crop cycle. Primary focus will be “One crop transition to profitability compared to current commercial chemical farming”.

The primary focus will be on creating the techno commercial and legal framework to evaluate the success and failure criteria of such demonstration in the grand challenge. These demonstrations should also provide solution and address the following.

Key areas of farming ecosystem

1. Enhancing Organic Manure/ Compost quality and availability.
2. Restoring Soil fertility – in Saline and degraded land by achieving better gas exchange, (Breathability) water retention, inoculating and restoring good biology & their population with an effort to increase the Stable Organic Matter (SOM) content of soils to 5-7%.
3. Technologies such as bio-fertilizers, bio-stimulants, and micro nutrients to increase growth and yields, reduce the crop stress, and to maintain good immunity. Cow based natural products can also be part of such products to be evaluated.
4. Reducing water consumption per unit production and increasing water infiltration to restore ground water table and address the water storage needs like ponds, check dams & dams.
5. Effective Crop care through biological pesticides & botanical oils like Neem etc.
6. Precision Farming – Use of satellite, drones, sensor technologies, tissue analysis, sap analysis with adoption of digital technology for advisory and market connect.
7. Capacity building for precision testing of inputs and output (produce) for Organic Certification
8. Organic / Traditional seed identification, improvement, and utilization

The major thing is to ensure development and demonstration of the best technologies, products, and protocols which are scalable, sustainable, and restoring the environmental and bio-diversity damage which has happened in the last 50-60 years. The grand challenge must ensure the protocols which are easy and labour efficient.

Department of Agriculture at the Central and the State governments should play a role through the ICAR research centre and KVK centres along with the Universities to monitor, document based on the agreed evolved framework and the reports can be presented every 6 months till the MIONP is fully achieved.

To be part of this Grand Challenge, input producing companies, their consortium, NGO groups, Start-ups, Cooperatives, Research Institutions or individuals can participate where during the first year they demonstrate the protocols with top 20 crops in 5 - 1 Acre plots in different agroclimatic zones which can be guided by ICAR. The demonstrations should be done with progressive farmers already doing high profitable farming with their existing practices.

Proposed Top 20 crops

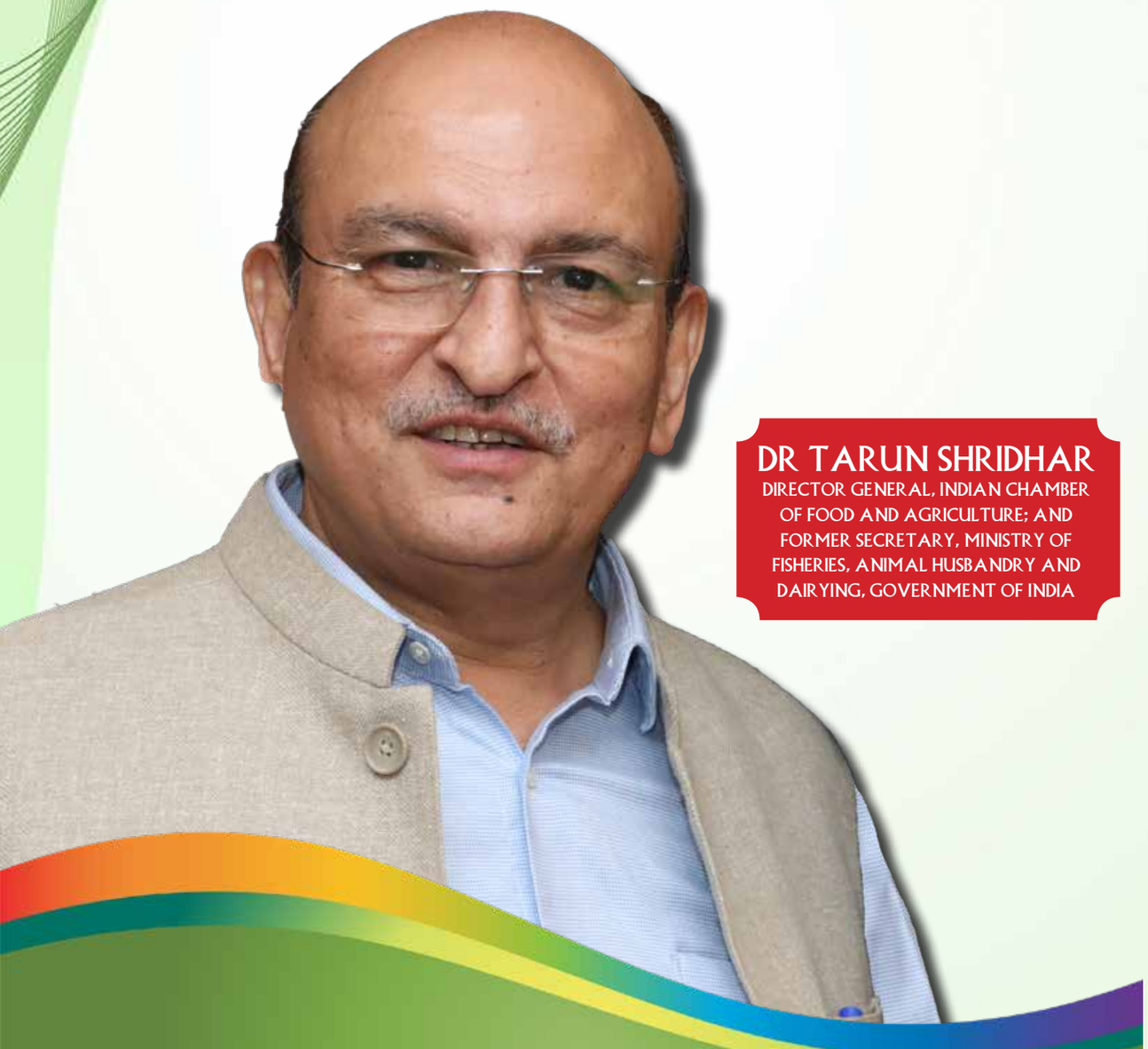
Field crops

1. Paddy	2. Corn
3. Groundnut / Soybean	4. Wheat
5. Mustard	6. Tobacco
7. Sugarcane	Cash crops Vegetables
8. Cotton	9. Banana
10. Potato	11. Tomato
12. Brinjal	13. Okra
14. Chilli / Capsicum	15. Onion / Garlic
16. Turmeric / Ginger	17. Mango/ Litchi Orchards
18. Orange / Kinnow	19. Pomegranate
20. Guava	

Dr Ajay Ranka
Chairman and MD of the Zydex Group

AGRICULTURE: A TRIBUTE TO THE INDOMITABLE HUMAN SPIRIT

The human spirit must prevail over technology."
Albert Einstein.



DR TARUN SHRIDHAR
DIRECTOR GENERAL, INDIAN CHAMBER OF FOOD AND AGRICULTURE; AND FORMER SECRETARY, MINISTRY OF FISHERIES, ANIMAL HUSBANDRY AND DAIRYING, GOVERNMENT OF INDIA

There would be no dearth in the list of technology driven interventions in agriculture, livestock and fisheries which have significantly impacted growth: genetics to high yield seeds; nutrition to fertilisers; crossbred to hybrid; automation; precision farming; irrigation; nanotech, smart farming, IoT et.al. The Green and the White Revolutions, followed by Blue Revolution, may not have been as sexy as today's technologies, however, they have, primarily and strongly, been technology driven; and these have been genuine revolutions. Undoubtedly, each of the modern and emerging technologies has contributed to enhancement of productivity, yet they don't offer a holistic perspective of what technology is, and what it means to agriculture. It is the farmer who is the most outstanding innovator, the wisest of all.

The origin of modern humans or Homo sapiens from the great apes is said to date back to 200,000 years ago, and till about 12,000 years ago hunting of wild animals and gathering of wild plants were the primary means of subsistence for our ancestors. The transition to domestication of plants and animals commenced when, as what is known as, the ice age began melting down. The occurrence of this phenomenon is recognised to have started in the Fertile Crescent, the crescent shaped region of the Middle East and west Asia, China, Mesoamerica, Andes/Amazonia, Eastern United States, tropical West Africa, Ethiopia, and New Guinea.

From these handful of initial homelands of agriculture, a small and restricted number of domesticated species were progressively introduced across the globe as the new bred farmers began migration to new regions. This gradually resulted in societies exercising control of food production conferring to these farmers huge demographic, technological, political, and military advantages over neighbouring hunter-gatherers, allowing them to impose their now stationary lifestyle. The history of the past millennia consists of tales of hunter-gatherer societies being driven out, infected, conquered, or exterminated by farming societies all across the world. Today, most people on Earth consume food that they produce themselves or that someone else produces for them. Now the few handful communities of hunter-gatherers are at the verge of abandoning their lifestyles and shall soon disintegrate, thereby ending our millions of years of commitment to the hunter-gatherer lifestyle.

Technology is the way forward

According to the United Nations Food and Agriculture Organisation (FAO), in the year 2023, the world's primary agricultural production was more than 9.9 billion tonnes representing a 27% increase compared to 2010. While a large number of crops are cultivated and harvested around the world, just four individual crops accounted for half the global production of primary crops in 2023: sugar cane (21 percent), maize (13 percent), rice (9 percent) and wheat (8 percent). Potatoes and soybeans each accounted for an additional 4 percent of world crop production. Globally, less than two-thirds of crop production is allocated to human food, versus 35% to animal feed, and 3% for bioenergy or other industrial products.

It is important to highlight that only about 15 plant species and less than 10 animal species supply more than 90% of worldwide agriculture and livestock production. Four crops (wheat, rice, corn, and potato) account for more food production than all other crops combined.

Inversely, hitherto robust and lively hunting and gathering have today become secondary, and most often recreational, activities that contribute little to global food security; the only significant exception being the consumption of wild meat in a few regions, notably in Central Africa. Even the toughest of humans now consume a diversity of food products across the globe from these same domesticated plant and animal species. How has this been possible? The answer lies in one word: Technology.

We commonly associate the term technology with tools and machines, mechanisation and industry. Nothing could be a greater travesty of knowledge than expounding upon the virtues or otherwise of technology on the basis of this specious definition, bordering upon ignorance. Before we readdress our subject of agriculture and livestock, let us dwell a bit upon the meaning of technology. The word technology comes from two Greek words, transliterated techne and logos. Techne means art, skill, craft, or the way, manner, or means by which a thing is gained. Logos means word, the language by which inward thought is expressed, a saying, or an expression; in simple terms a study. It was around the year 1859 that "study of mechanical and industrial arts" got defined as technology with further examples of "spinning, metal-working, brewing" etc., thus severely curtailing the scope of knowledge of technology.

There are definitions aplenty. The popular dictionaries define it as "the practical application of knowledge especially in a particular area", or "the application of scientific knowledge for practical purposes, especially in industry" etc. A comprehensive and sound exposition has been done by John Kenneth Galbraith, the American diplomat who has also been his country's ambassador to India. "Technology means the systematic application of scientific or other organized knowledge to practical tasks", he defines.

Human creativity and spirit of innovation

We would be best served by embracing these multiple and diverse definitions; therefore, technology would essentially mean human creativity and spirit of innovation. Thomas P Hughes has been one

“Agriculture, including Animal Husbandry, is undoubtedly, one of the most significant, if not the best, innovations of mankind. It is an innovation that marks the beginning of human civilization as we live it today
The 19th century American statesman Daniel Webster sums it up, “When tillage begins, other arts follow. The farmers, therefore, are the founders of human civilization”

of the most respected historians of technology in the world. In his book, Human-Built World: How to Think about Technology and Culture, he writes, so very appropriately, “Technology is messy and complex. It is difficult to define and to understand. In its variety, it is full of contradictions, laden with human folly, saved by occasional benign deeds, and rich with unintended consequences….” “Defining technology in its complexity is as difficult as grasping the essence of politics.” Such radical views notwithstanding, Hughes goes on to offer his own definition of technology as “a creativity process involving human ingenuity.”

Innovation is precisely this innate spirit of human ingenuity; creating an outcome not anticipated by usual techniques or form and not known or done by a person with ordinary skills in the art. Innovation begins with an idea, building on existing information, using intuition and knowledge to make new connections for a novel result. An innovation enhances economic productivity when it is brought to a market and achieves commercial success.

Mistakenly, we have relegated innovations to the confines of only science and technology, and technology in the narrow sense of machines, though they surely are important components of economic growth. The Innovation Policy of our country is steered by the Ministry of Science and Technology and the Atal Innovation Mission (AIM) too is heavily inclined towards technological i.e. machine-driven interventions. In the process, we seem to ignore that Innovation is more than science and machinery; it is ideas, it is approach, it is perspective; above all it is a challenge to the status quo. In fact, we should consider innovation and technology as synonyms.

Livestock rearing

What could be a bigger innovation for mankind than domesticating the plants and animals? Domestication is distinct from taming. Taming implies exercising control over an individual animal, teaching it to obey; taming is a tedious business as it has to be repeated again and again for each single animal. Domestication, on the other hand, happens to a whole species or a population. It also leads to the genetic modification and manipulation, aka controlled breeding, of a wild species to establish a new breed or say, cultivated variation which lives symbiotically alongside humans. The earliest agriculturists kept some semi-domesticated animals to assist in hunting. Sometime later, actual keeping of livestock specifically as a food source began in tropical or semi tropical regions of the Middle East.

The early farmers also discovered that whenever water was available, crops could be produced during most of the year. Thereafter, domesticated animals became an invaluable resource with smaller ruminants, goats, sheep, pigs and poultry kept for food production and large ruminants providing the power to operate irrigation systems, ploughs and other farm implements. Further innovations were exploitation of the milk of mammals, and this graduated to selection of individuals for prolonged lactation, leading to development of dairying. Also, the discovery of methods for incubating birds' eggs without nesting hens led to increased availability of poultry products. The Romans were the first to recognize and adopt improved farming methods such as irrigation systems and oxen drawn ploughs. These techniques were subsequently introduced throughout western Europe, along with the Roman-devised crop rotation and fallow systems to rejuvenate land resources.

The chemical compounds forming animal flesh are recognised to be concentrated, easily digested and capable of satisfying all human nutrient requirements. Thus, the earliest Homo sapiens were carnivorous. Since game was abundant, it supplied the entire dietary needs of the population. Hunting other animals required considerably less time and effort than the drudgery of gathering plants. Jack Cohen, the American Biologist has another interesting theory which asserts that a taste for animal flesh was a prerequisite for the development of intelligence since: "You don't need much intelligence to sneak up on a blade of grass."

Soon domestic animals or livestock became the societies’ major source of animal protein, and today we get most of our animal protein from cows, pigs, sheep, and chickens, with game such as venison or wild boar just a rare delicacy, even though illegitimate in several countries. In addition, some big domestic mammals are a boon to the vegetarian communities serving as sources of milk and of milk products such as butter, cheese, and yogurt etc., thus yielding several times more calories and nutrition over their lifetime than if they were just slaughtered and consumed as meat.

Big domestic mammals also interact with domestic plants in two ways to increase crop production. First, as any farmer knows, crop yields can be greatly increased by manure applied as fertilizer. Even with the modern availability of synthetic fertilizers produced by chemical factories, the major source of crop fertilizer today in most societies is still animal manure. Manure has been valuable, too, as a source of fuel for fires in traditional societies.

The Science of Animal Husbandry

The ever evolving knowledge and experience of domestication of erstwhile wild animals developed into the modern science of Animal Husbandry, a terminology derived from the word “Husband” whose archaic meaning is quite at divergence from the commonly assigned meaning today. The word “husbandry” has nothing to do with marriage, at least not in this day and age. In fact, the word “husband” itself didn't mean a married man when it first showed up around the year 1000 or so. To husband is to use with care, to keep, to save, to make last, to conserve; in short a holistic and responsible management. Portia, the rich and beautiful protagonist in Shakespeare’s popular play The Merchant of Venice meaningfully says, “Lorenzo, I commit into your hands / The husbandry and manage of my house.” In fact, most and perhaps all of industrial agriculture's manifest shortcomings and even failures are the result of an attempt to make the land and livestock produce more and more without husbandry. Husbandry, in other words, is plain and simple “Sustainable Development”, an innovation par excellence.

Against the backdrop of this history, it is a logical inference universally accepted that domesticating plants, and more importantly animals marked a major and dramatic turning point for humans: the beginning of an agricultural way of life and more permanent and stable civilizations. The domesticated creatures also became integrated into the most basic and widespread rituals of the culture. Curiously, all across civilisations and religions, the domesticated animals came to symbolize order as opposed to the chaos of the untamed world.

Agriculture: the fountainhead of innovation

Therefore, we must recognise that agriculture has always been the fountainhead of innovation, and Animal Husbandry is still smarter. What a brilliantly smart and innovative idea at the time: collect seeds from the wild, dig the earth, sow the seeds, nurture them and harvest the crop for food. While it is good to extol the virtues of natural farming, we must recall that farming itself was unnatural to begin with. The advent and subsequent growth of agriculture owes to smart initiatives, what we call innovation. Still greater innovative initiative was taming the animals, which to begin with were all wild, and thereafter domesticating the entire species. Could there be a bigger example of innovation? Both the ideas would surely have been condemned as absurd, bordering upon madness.

Let us recapitulate. Agriculture, including Animal Husbandry, is undoubtedly, one of the most significant, if not the best, innovations of mankind. It is an innovation that marks the beginning of human civilization as we live it today. After all, how did one ever imagine that a seed collected from the wild can be planted in soil to produce an edible crop. Seed is benign, but one or some of our ancestors also tamed and domesticated wild, as also dangerous, animals to give us food as diverse as milk and meat and eggs; something for each and every one. But then can one consume all or either of it raw. Yes may be the literal answer, but should one? No would be a definitive answer. So here comes the next innovation, processing these raw products in multiple ways, each innovative; freezing, pasteurising etc., and more importantly cooking.

Traditional native wisdom and the innate human spirit of innovation made it happen. Since then agriculture, livestock farming and aquaculture have been the ever growing source of human nutrition in general, and the protein requirement in particular. Innovation, the guiding spirit, supported by technology, especially the emerging technologies such as digitalisation offer immense scope to reinvent the entire gamut of agriculture management, even leapfrogging it from a mere livelihood activity to a vocation and business of choice. Further, it would be a key to nutritional security of our burgeoning population.

The 19th century American statesman Daniel Webster sums it up, “When tillage begins, other arts follow. The farmers, therefore, are the founders of human civilization.”

MAKING INDIA ORGANIC, NATURAL, AND PROFITABLE BY 2047

Opportunities and Challenges

PROF. M. S. REDDY
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India, a land of diverse Agro-climatic zones, has a rich history of organic and natural farming. However, the rapid industrialization of agriculture has led to excessive reliance on chemical fertilizers, pesticides, and genetically modified crops, raising concerns over soil health, environmental sustainability, and farmers' income. As the country marches towards 2047, the centenary of its independence, the vision of making India organic, natural, and profitable is both an opportunity and a challenge.

Opportunities in Organic and Natural Farming

1. **Growing Global Demand for Organic Products:** The global organic food market is expanding, driven by increased consumer awareness about health and environmental sustainability. India, with its vast arable land, has the potential to become a major exporter of organic produce.

2. **Government Initiatives and Policies:** The Indian government has introduced schemes like Paramparagat Krishi Vikas Yojana (PKVY) and the National Program for Organic Production (NPOP), which support organic farming through subsidies, training, and certification. The Sikkim model, where the state achieved 100% organic farming, serves as a blueprint for other regions.

3. **Enhanced Soil Fertility and Biodiversity Conservation:** Organic farming improves soil fertility by enhancing microbial activity and increasing organic matter. It also promotes biodiversity by reducing chemical contamination and preserving indigenous crop varieties.

4. Cost Reduction and Higher Profitability for Farmers: By reducing dependency on expensive synthetic fertilizers and pesticides, organic farming lowers input costs. Additionally, organic products often fetch premium prices in domestic and international markets, increasing farmers' earnings.

5. Employment Generation and Rural Development: Organic farming and related sectors such as compost production, Agro-tourism, and organic retailing create employment opportunities in rural areas. Small-scale farmers, women, and self-help groups can benefit from these economic activities.

6. **Climate Resilience and Sustainability:** Organic and natural farming methods, such as crop rotation, agroforestry, and integrated pest management, enhance resilience to climate change by reducing soil erosion, improving water retention, and minimizing greenhouse gas emissions.

7. Growing Domestic Awareness and Consumption: Rising health consciousness among Indian consumers is driving demand for organic food. Urban markets are increasingly supporting organic brands, and e-commerce platforms have facilitated access to organic products.

Challenges in Transitioning to an Organic and Natural Economy

1. Productivity Concerns and Yield Gaps: Transitioning from conventional to organic farming may initially result in lower yields, affecting food security and farmers' income. Bridging the yield gap through research, innovation, and improved organic techniques is crucial.

2. High Certification Costs and Bureaucratic Hurdles: Organic certification is often expensive and time-consuming. Small farmers, who constitute the majority of India's agricultural workforce, find it difficult to afford certification and meet regulatory requirements.

3. Lack of Awareness and Technical Knowledge: Many farmers lack the necessary training in organic farming practices, leading to improper implementation. Strengthening of extension services, training programs, and farmer-to-farmer learning networks is essential.

4. Market Accessibility and Supply Chain Challenges: Farmers often struggle to access organic markets due to inadequate infrastructure, fragmented supply chains, and limited storage facilities. Building robust farm-to-market links, organic cooperatives, and digital platforms can help bridge this gap.

5. Resistance from Agrochemical Industry: The chemical fertilizer and pesticide industries have a strong influence on agricultural policies and practices. Overcoming this resistance requires sustained policy support and incentives for organic alternatives.

6. **Price Sensitivity and Affordability Issues:** Organic products are often priced higher than conventionally grown produce, limiting their accessibility to middle- and lower-income consumers. Enhancing productivity and economies of scale can help reduce prices.

7. Land Conversion and Transition Period Challenges: Shifting to organic farming requires a transition period during which the land detoxifies from synthetic chemicals. This period can be financially challenging for farmers, necessitating financial support through subsidies and incentives.

Strategies for Achieving the 2047 Vision

1. Policy Support and Incentives: The government should enhance incentives for organic farming, provide tax benefits, and streamline certification processes to encourage more farmers to adopt organic practices.

2. Investment in Research and Development: Agricultural research institutions must develop high-yield organic farming techniques, pest-resistant indigenous crop varieties, and organic fertilizers to bridge the productivity gap.

3. Strengthening Market Linkages: Creating organic produce hubs, farmers' markets, and digital e-commerce platforms dedicated to organic products can improve market access and profitability.

4. Public Awareness Campaigns: Educating consumers about the benefits of organic food through media campaigns, school programs, and food labeling initiatives can drive demand and justify premium pricing.

5. Encouraging Farmer Cooperatives and Community Farming: Farmers' cooperatives can help reduce costs, share resources, and collectively negotiate better prices for organic produce. The Amul model in dairy can be replicated in organic farming.

6. Integration of Organic Farming with Tourism and Agri-Business: Promoting Agro-tourism, organic farm stays, and eco-friendly agribusiness ventures can generate additional income streams for farmers and attract global tourists.

7. Leveraging Digital Technologies and AI: Utilizing artificial intelligence, blockchain for traceability, and precision agriculture can enhance productivity, reduce losses, and build consumer trust in organic certification.

8. Local Self-Sufficiency and Sustainable Urban Farming: Encouraging organic rooftop farming, community gardens, and urban organic markets can promote local self-sufficiency and reduce reliance on long-distance transportation.

MAGA Plus MIGA Coupled with MAHA

The vision of making India organic, natural, and profitable by 2047 can be accelerated by integrating the principles of MAGA (Make Agriculture Green Again), MIGA (Make India Green Again), and MAHA (Make Agriculture Holistic Again). By combining these approaches, India can establish a robust agricultural ecosystem that prioritizes sustainability, regenerative farming, and economic prosperity. MAGA emphasizes restoring ecological balance through organic farming, MIGA promotes large-scale afforestation and green initiatives, while MAHA focuses on a holistic approach to farming that integrates traditional wisdom with modern advancements.

Together, these principles can pave the way for a self-sufficient, profitable, and environmentally sustainable agricultural sector in India. . The journey towards an organic India will not only ensure better health and environmental sustainability but also enhance rural prosperity and long-term food security. If strategically planned and executed, this transition can serve as a model for sustainable agriculture worldwide, positioning India as a pioneer in the organic revolution by its centennial year of independence.

> “THE GOVERNMENT SHOULD ENHANCE INCENTIVES FOR ORGANIC FARMING, PROVIDE TAX BENEFITS, AND STREAMLINE CERTIFICATION PROCESSES TO ENCOURAGE MORE FARMERS TO ADOPT ORGANIC PRACTICES

Microalgae: Nature's Tiny Powerhouse, Revolutionizing Agriculture

The Unsung Heroes of Sustainable Agriculture

Mr Debabrata Sarkar

Vice President of Asia Pacific, AlgaEnergy

Microalgae, microscopic aquatic organisms, are emerging as a potent force in sustainable agriculture. These tiny organisms, often overlooked, possess extraordinary capabilities that can revolutionize the way we cultivate crops.

The Role of Microalgae in Agriculture

- **Nutrient-Rich:** Microalgae are packed with essential nutrients like nitrogen, phosphorus, and potassium, which are vital for plant growth.
- **Soil Health:** They improve soil structure and fertility, enhancing water retention and nutrient absorption.
- **Reduced Chemical Dependency:** By using microalgae-based fertilizers, farmers can reduce their reliance on synthetic chemicals, promoting sustainable agriculture.
- **Plant Growth Promotion:** Microalgae-derived biostimulants can accelerate plant growth, increase yield, and improve overall plant health.
- **Stress Tolerance:** They can help plants withstand adverse conditions like drought, salinity, and extreme temperatures.

AlgaEnergy: A Pioneer in Microalgae Technology

AlgaEnergy, a leading company in microalgae biotechnology, is at the forefront of harnessing the power of these tiny organisms. Our innovative solutions are transforming agriculture and contributing to a more sustainable future.

AlgaEnergy's Impact:

- **Sustainable Agriculture:** Our microalgae-based solutions are helping farmers reduce their environmental footprint and improve crop yields.
- **Food Security:** AlgaEnergy contributes to global food security by increasing agricultural productivity.
- **Circular Economy**: Our sustainable production processes minimize waste and maximize resource efficiency.

As we face increasing challenges in agriculture, such as climate change and soil degradation, microalgae offer a promising solution. By embracing innovative technologies and sustainable practices, we can ensure a healthy planet and a prosperous future for generations to come.

Contribution of Agricultural Engineering to Mechanization and Indian Agriculture

> “Leveraging technology for precision farming allows farmers to optimize inputs like fertilizers and pesticides, reducing environmental impact

Mr Bharatendu Kapoor
President – Sales & Marketing, TAFE

Agricultural engineering is a crucial discipline that merges engineering principles with agricultural practices to improve farming efficiency and productivity. In India, where agriculture is a primary source of livelihood for a significant portion of the population, the contribution of agricultural engineering to mechanization has been transformative. Post our first census in 1950, where population was just 380 million & over 60% of food grains were getting imported to 2024 when population is over 1400 million country is non only self-sufficient but also exporting food grains, we explores the various ways in which agricultural engineering has impacted productivity thru mechanization and the broader agricultural landscape in India.

Historical Context

Historically, Indian agriculture relied heavily on traditional methods, which were labour-intensive and often inefficient. The Green Revolution of the 1960s marked a significant turning point, introducing high-yielding varieties of crops, chemical fertilizers, and irrigation techniques. However, the success of these innovations necessitated a shift from manual labour to mechanized farming. Agricultural engineering emerged as a critical field to support this transition, developing machinery and systems that could enhance productivity.

Mechanization in Indian Agriculture

Mechanization involves the use of machinery to perform agricultural tasks, which significantly reduces the dependency on manual labour. Agricultural engineers have played a pivotal role in the design, development, and implementation of various machinery and tools tailored to the specific needs of Indian farmers. Key contributions include:

1. Tractors and Power Tillers: The introduction of tractors and power tillers revolutionized land preparation. These machines reduced the time and labour required for ploughing, harrowing, and tilling, allowing farmers to cultivate larger areas more efficiently. Agricultural engineers have worked on designing tractors suitable for Indian soil conditions and crop patterns, focusing on fuel efficiency and ease of use.

2. Seed Drills and Planters: Traditional seed sowing methods were often inefficient, leading to uneven crop stands and wastage of seeds. Agricultural engineers developed seed drills and planters that ensure accurate seed placement and optimal spacing. This mechanization not only improves crop yields but also conserves resources by minimizing seed wastage.

3. Harvesting Equipment: Harvesting is one of the most labour-intensive processes in agriculture. The development of combines and reapers has significantly reduced the time and labour associated with harvesting crops like wheat and rice. Agricultural engineers have tailored these machines to handle the diverse crops grown in India, ensuring adaptability to various conditions.

4. Irrigation Systems: Efficient water management is vital in Indian agriculture, given the variability in rainfall. Agricultural engineering has contributed to the design and development of advanced irrigation systems, including drip and sprinkler systems. These technologies help optimize water usage, reduce wastage, and improve crop yields, especially in arid and semi-arid regions.

5. Post-Harvest Technology: The role of agricultural engineering extends beyond production to post-harvest management. Innovations in storage, processing, and packaging technologies have minimized losses and improved the quality of agricultural products. Engineers have developed solutions like silos, cold storage, and processing units that ensure farmers can store their produce safely and access markets effectively.

Enhancing Sustainability

The mechanization of agriculture, guided by agricultural engineering, also holds significant potential for enhancing sustainability. With increasing pressure on natural resources, sustainable practices are essential for long-term agricultural viability. Agricultural engineering promotes:

1. Precision Agriculture: Leveraging technology for precision farming allows farmers to optimize inputs like fertilizers and pesticides, reducing environmental impact. Agricultural engineers develop sensors and data analytics tools that enable farmers to make informed decisions based on soil health, moisture levels, and crop needs.

2. Soil Conservation Techniques: Mechanization can contribute to soil health through practices like minimum tillage and contour farming, which reduce soil erosion and degradation. Engineers design equipment that supports these practices, helping maintain soil fertility and structure.

3. Renewable Energy Integration: The integration of renewable energy sources, such as solar and wind, into agricultural practices is another area where agricultural engineering is making strides. Solar-powered irrigation pumps and wind-driven grain mills are examples of how engineers are promoting sustainable energy solutions in farming.

Challenges and Future Directions

Despite the significant contributions of agricultural engineering to mechanization in Indian agriculture, several challenges remain. The high cost of machinery can be prohibitive for smallholder farmers, over 80% farmers having a land size lesser than 2 acres, who constitute a large segment of the agricultural workforce. Access to credit and financing options is crucial to enable these farmers to invest in mechanization.

Moreover, there is a need for comprehensive training, adopting to digital solutions like drones for spraying of fertilizers & pesticides and education to ensure that farmers can effectively operate and maintain modern machinery. Agricultural engineers must engage in outreach programs to educate farmers about the benefits and usage of new technologies.

Looking forward, the future of agricultural engineering in India lies in innovation and adaptability. As climate change poses new challenges to agriculture, there is a pressing need for engineering solutions that address these issues. Technologies that enhance resilience, such as climate-smart agriculture practices and advanced breeding techniques, will be essential.

The Game Changer

The contribution of agricultural engineering to mechanization has been a game-changer for Indian agriculture. By improving the efficiency and productivity of farming operations, agricultural engineers have played a vital role in transforming the agricultural landscape. As India continues to grapple with challenges related to food security, resource management, and sustainable practices, the role of agricultural engineering will only become more critical. Continued investment in research, development, digitisation and education in this field will be essential to ensure that Indian agriculture can thrive in the face of future challenges, ultimately leading to improved livelihoods for millions of farmers across the country.

NATURAL FARMING

Healthy Desi Cow is a Prerequisite

Dr Falguni Thakar
Director Animal Husbandry,
Government of Gujarat

To overcome the ill effects of chemical-based farming as well as organic farming, natural farming is a viable and sustainable option. As per concept, all essential as well as micronutrients required by the crop/plants are present in soil but are in unavailable form. Plants use nutrients from soil through mineralization and billions of microorganisms are available in soil for this job. But continuous use of chemical fertilizers and pesticides has reduced the population of these useful microbes and needs to be rejuvenated.

Cow dung and urine of domestic Indian cows is a good source of these microbes, and its use has given promising results.

For harvesting the benefits of natural farming, a healthy desi cow is a prerequisite. To provide free of cost veterinary services to livestock at all the government veterinary institutions across the state, "Mukhyamantri Nishulk Pashu-Sarvar" scheme has been implemented from January 2015. The objective of the scheme is to enable livestock owners to run the dairy farming more profitably and to avoid unfavourable effects on their livelihood.

The Significance Of Animal Health Care

"Mobile Animal Disease Diagnosis Laboratory" and "Ambulance van for Veterinary Polyclinics". Under Rashtriya Krishi Vikas Yojna; facility of 23 ambulance vans for veterinary polyclinics and a facility of 17 mobile laboratory vans for animal disease investigation have been established with an aim of creating mobility of animal health care. Well-equipped mobile disease diagnosis facilities for prompt and accurate diagnosis has played a vital role effectively in containment of various diseases of zoonotic importance like Bird flu, Crimean-Congo Hemorrhagic Fever (CCHF), Glanders, Brucellosis, Rabies etc.

For immediate care and cure of ill, wounded, deserted animals; total of 37 "Karuna Animal Ambulance-1962" have been made operational in the state with on-call free services. This facility is one of its kind for the first time in India for treatment of orphan/ownerless animals. From launch in October 2017 to till date, more than 3.50 Treatment for lakhs of animals has been provided by these ambulances.

Conservation And Breeding Of Native Indigenous Breeds

For conservation and breeding of livestock of native indigenous breeds having more disease resistance power and good production capabilities in local climatic conditions such as Gir and Kankrej Cow, Mehsani, Surati, Jaffrabadi and Banni buffalo and to impart training to Artificial Insemination workers and professionals to improve the quality of Artificial Insemination services and semen doses, Gujarat Livestock Development Board has been established in the state in 2002. GLDB has also been appointed as State Implementing Agency (SIA) for various Centrally Sponsored Schemes pertaining to bovine breeding.

GLDB has established Private Artificial Insemination Centers all over the state which are called "Gopalmitra Kendra" to deliver doorstep AI services to livestock owners Facility of Quarantine Station, Central Semen Bank, Frozen Semen Distribution Station with ultra-modern facilities for sufficient production and constant supply of semen doses in the State have been created under GLDB. Constant supply of Liquid Nitrogen (LN2) to all Artificial Insemination Centres is ensured by GLDB with a network of 27 Silo for LN2 storage in the state including 12 silos under GLDB and 15 Silo provided under various Dairy Unions.

On World Milk Day, 2018; three AI technicians of Gujarat state have been awarded with the Best AI Technician Award by Government of India under Rashtriya Gokul Mission. Gujarat has successfully implemented two phases of Nationwide Artificial Insemination Programme in 21 districts identified by Government of India. In the 3rd phase also, 1.76 lakhs AI have been conducted till 03.12.2021 in Gujarat.

Artificial Insemination and Other Breeding Services

Currently, a robust network of 9,053 AI centres and 26 Intensive Cattle Development Blocks are taking care of Artificial Insemination and other breeding services of livestock in the state. There has been a rise of 284 % in Artificial Insemination activity in the last two decades in the state. (2000-01: 22.99 Lakhs AI and 2020-21: 88.35 Lakhs AI). In 2019-20, out of total 787.48 Lakhs AI performed in India, 83.25 Lakhs AI (2nd highest next to Uttar Pradesh) was conducted in Gujarat which is nearly 11% of the country.

In 2010, State Frozen Semen Production and Training Institute was established at Patan under National Project for Cattle and Buffalo Breeding (NPCBB) for production of Frozen Semen by maintaining breeding bulls of different breeds. Since establishment, the institute has been awarded "A Grade" for four times consecutively during evaluation by the Central Monitoring Unit of Government of India. This institute spread over 108 acres has installed capacity of 25 Lakh frozen semen doses per year.

Looking to 89% female calves birth rate through use of sex sorted semen in a pilot project in Amreli District, Gujarat Livestock Development Board has established Sexed Semen Production facility at Patan with assistance under Rashtriya Gokul Mission with objectives of faster breed improvement and more female animals with good milk production potential resulting in more milk revenue generation.

Thus, the Department of Animal Husbandry contributes in the promotion of natural farming by a robust system of animal disease diagnosis and ensuring health and production of the livestock of the state. Efforts to develop animals with high genetic merit and sex sorted semen technology will certainly play a pivotal role in the development of the economy of the state which will help to double the income of the farmers by the year 2022 as envisaged by our Hon'ble Prime Minister.

> "THE DEPARTMENT OF ANIMAL HUSBANDRY CONTRIBUTES IN THE PROMOTION OF NATURAL FARMING BY A ROBUST SYSTEM OF ANIMAL DISEASE DIAGNOSIS AND ENSURING HEALTH AND PRODUCTION OF THE LIVESTOCK OF THE STATE"

Revolutionizing Indian Agriculture through Innovations in Mechanization & Digitalization

Prof. (Dr.) Indra Mani

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As the global population continues to grow and the demand for food rises, the agricultural sector faces the challenge of increasing productivity while minimizing resource consumption. In India, a country with a significant agrarian economy, the need to enhance farming practices is of paramount importance. The innovative technologies such as farm mechanization, drones, and robotics has potential to revolutionize farming practices in India. Like other economic sectors, agriculture is increasingly affected by the digital revolution. The use of advanced technologies results in precise matching of agricultural inputs with needs and thus significantly increases profitability. By using technology as a sustainable and scalable resource, agriculture of the country can be taken to new heights, keeping farm to fork in our future. In July, 2021, Honourable Prime Minister addressed chiefs of top 100 technological institutes emphasized that inventions and innovations in agriculture are very important. Agriculture was listed among key sectors like Defence, Education, Health, climate change and cyber security. He also urged scientists to provide solutions to various issues in agriculture through modern biotechnology, artificial intelligence, block chain technology and drone technology to counter issues like hunger, poverty and malnutrition. Future agriculture will be led by knowledge, technology innovation and skill. In fact, mechanization and automation in agriculture has been one of the top 20 invention of 20th century in the world. Traditional farming practices often rely on manual labor and outdated methods, leading to inefficiencies, resource wastage, and yield variability. The integration of advanced technologies like mechanization, drones, and robotics holds the promise of addressing these challenges and propelling Indian agriculture towards greater productivity and sustainability.

Innovations in Farm Mechanization

Agriculture mechanisation is essential for modernising and commercialising the sector since it boosts efficiency and productivity in agricultural operations, supports value addition, lowers cultivation costs, and facilitates adaptation to climate change. In India, agricultural mechanisation is anticipated to expand quickly in light of national driving factors in relation to global driving forces. Therefore, there is no question that mechanisation needs to be improved in order to increase agricultural productivity and stabilise the economy. In light of the existing demand, modern agricultural machinery has enabled farmers to finish seed-to-seed tasks as quickly as possible and even free up equipment for special-order hiring by neighbours. However, farm mechanisation in India, at 40-45%, remains low compared to the rest of the world; in the US it is 95%, Brazil 75%, and China 57%.

Broad Bed Furrow Planter developed by VNMKV, Parbhani

Despite low levels of farm mechanization in India, skills shortages and a lack of awareness among farmers about technology and machinery management pose significant obstacles to progress. A strong focus on integrating science and technology into farm mechanisation would open up new avenues for opportunity and accelerate the development of agricultural mechanisation toward Mechanisation 2.0, which combines automation with the farm mechanisation. The mechanization industry in India has a lot of potential to grow and can play a crucial role in improving the productivity and efficiency of the agriculture sector. The Farm Machinery Industry is an industry sector that produces and supplies a range of machinery, equipment, and tools used in agriculture and farming activities such as ploughing, planting, harvesting, and more. These machines are designed to improve productivity and efficiency in farming operations, and the industry encompasses both small-scale and large-scale farming equipment. However, the industry faces a lot of challenges such as high cost of machinery, lack of awareness, lack of credit facilities, and poor infrastructure. The government, the mechanization industry, and other stakeholders need to work together to overcome these challenges and promote mechanization in agriculture. Following are some of the key interventions for bringing innovations in agricultural mechanization of the country.

- Mapping dynamic changes in agri practices and design agri equipment for all operations.
- Manufacturing operator friendly equipment to minimise farmer anxiety (fear of operator skill requirements).
- Assuring quality and durability of equipment to ensure 'Lower Cost of Ownership' in longer run.
- Developing 'Responsible & Accountable' Service Network.
- Ensuring clusters of eco-system for quick availability of genuine spares parts.
- Tractor industry has about 15000 Dealerships across the country. Leveraging this strong network for 'effective penetration' of agri equipment. These Dealerships to be used as 'Knowledge Spring-Boards' to 'Educate & Demonstrate' the advanced agri equipment.
- Agro chemical manufacturers should engage in 'contractual collaboration' with farmers making advanced crop care equipment available at farmer's doorstep to complete all crop care applications without human intervention.
- The government, SAUs, and corporate sectors can conduct awareness campaigns to educate farmers about the benefits of mechanization. This will help in increasing the demand for machinery and will also create a market for the mechanization industry.
- Tractor training centres, KVKs, and industry should be made responsible for training young farmers / owners / operators on how to select, operate and service farm machinery. They should also provide information on developments in mechanisation including the availability of new and better farm equipment for different applications.
- Front-line demonstration of farm machinery should be strengthened and handheld training to users of new generation farm machinery may encourage the extension and adoption of farm power.
- The Agricultural Skills Council of India should work at the district level to address skills shortages on the demand side.
- The collaborative efforts between government institutes, private companies and farmers groups are necessary to boost the agricultural mechanization. The Custom Hiring Centres of farm machinery may be especially useful, and Indian Council of Agricultural Research (ICAR) institutes and SAUs can offer short courses that address skills shortages on the demand side.

Climate smart agriculture through innovative water and energy saving interventions

Managing sustainable food production with judicious use of water, energy and land has become a matter of global concern due to

environmental security under changing climate. Rainfed agriculture is crucial to the country's economy and food security. In 2022-23, of the 141 million hectares of gross sown area in the country, nearly 73 million hectares, or 52%, had irrigation access, up from 41% in 2016, according to updated data from Niti Aayog. Climate-smart agriculture emphasizes the sustainable management of resources to adapt to climate change while enhancing productivity. Innovative water and energy-saving interventions, such as farm ponds, advanced irrigation techniques, and automation, play a crucial role in ensuring climate resilience. Farm ponds serve as on-farm water reservoirs, reducing dependency on erratic rainfall and supporting irrigation needs during dry periods.

The VNMKV, Parbhani has developed 56 farm implements, both animal and tractors drawn, for different operations. An innovative farming techniques like Broad Bed Furrow (BBF) serves the purpose of in-situ moisture conservation as well as drainage channel if excess water is found apart from providing proper aeration in the seedbed and root zone. Mechanization contributes more in conservation agriculture because of timeliness in farm operations. VNMKV developed multipurpose Broad Bed Furrow (BBF) planter for rainfed agriculture accomplishes bed making, sowing and fertilizer application, seed covering and weedicide application in one go. The newly developed five row BBF planter with sprayer and seed covering device can be recommended for cultivation of soybean, red gram, cotton, maize, sorghum under dryland agriculture.

Machinery powered by non-conventional energy sources are now-a–days also gaining importance looking into the excessive use of fossil fuels and their rising cost as well as harmful emissions. Non-conventional energy sources need to supplement the fossil fuels due to their reliability and sustainability. India is endowed with vast solar energy potential. About 5,000 trillion kWh per year energy is incident over India's land area with most parts receiving 4-7 kWh per sq. m per day. Solar photovoltaic power can effectively be harnessed providing huge scalability in India. Off-grid decentralized and low-temperature applications will be advantageous from a rural application. VNMKV developed multipurpose solar energy cart which supplies power to spraying unit, DC pump and lighting system. The spray boom could be oriented either in horizontal or inverted L shape for spraying row crops of different heights as per need. Such innovative technological solutions using alternate sources are energy need a major focus for eco-friendly crop cultivation.

Furthermore, the University's efforts in water conservation have led to the construction of more than 30,000 farm ponds across Maharashtra, as per recommended designed of VNMKV's specification. The VNMKV, Parbhani, has brought more than 2,500 acres of barren land under breeder seed production. Special efforts have been made to mechanize the seed and research farms of the University and adopted seed-to-seed mechanization. Last year, the University doubled its breeder seed production. VNMKV has constructed six large farm ponds with a total capacity of 9 crore litres to provide supplementary and protective irrigation for breeder seed production and has set a target to construct additional farm ponds with a total capacity of up to 26 crore litres on wasteland.

Advanced irrigation techniques like drip and micro-sprinkler systems minimize water wastage while maximizing efficiency. Automation in irrigation scheduling, driven by AI and sensor-based technologies, ensures optimal water application based on real-time crop requirements. These innovations contribute to sustainable agricultural practices, conserving essential resources and mitigating the impact of climate change on farming.

AgriPV for energy smart agriculture

Agri-Photovoltaics (AgriPV) is an innovative approach that integrates solar energy generation with agricultural production, promoting dual land use for sustainability. By strategically placing photovoltaic (PV) panels over farmland, AgriPV enables farmers to harvest solar power while cultivating crops, ensuring efficient resource utilization. This technology not only enhances energy security and reduces carbon emissions but also provides shade, reducing water evaporation and improving crop resilience to extreme weather. As India moves towards sustainable farming practices, AgriPV emerges as a promising solution for balancing food production and renewable energy generation. VNMKV, Parbhani signed a MoU with the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (Germany) for collaborative R & D of Agricultural Photovoltaic (AgriPV) technology. The goal of the research is to devise executable crop cultivation strategies for the selected crops under the different Agrivoltaic structures, that would benefit from the environment created by the solar panels to generate higher yields or higher revenues via shifting the timing of production to off season cycles.

Digitalization in Agriculture

Digital Agriculture leverages the smart use of data and generally involves the processes of data creation and analysis, decision making, and implementation through management interventions. These processes are becoming increasingly computational, data-inten¬sive, real-time, and precise. The main Digital Agriculture tools that exist today include cross cutting technologies such as sensors and controllers and com¬putational decision tools. Field-based activities are also enabled by technologies such as geo-locationing, communication (cellular, broadband, and others), geo¬graphical information systems (GIS), yield monitors, precision soil sampling, proximal and remote sensing, unmanned aerial vehicles, variable rate technologies and auto-steer, guidance, and robotics. With the country achieving sufficiency in food production, there is an immediate need for the agricultural sector to adopt cutting edge digital and precision agriculture technologies to improve input use efficiency and enhance farmers' profitability by increasing productivity, reducing cost of cultivation and adding value to farm produce. The digital revolution has introduced several emerging technologies that enhance precision and decision-making in agriculture:

- Sensors and IoT: Internet of Things (IoT) devices and sensors monitor soil moisture, temperature, humidity, and crop health, enabling real-time farm management.
- Drones: Agricultural drones assist in precision spraying, crop monitoring, and disease detection, reducing input costs and improving yields.
- Robotics and AI: Robots are used for planting, weeding, and harvesting, while Artificial Intelligence (AI) and Machine Learning (ML) analyze farm data to optimize agricultural practices. The VNMKV has two grafting robots for automated plant grafting. These robots enhance precision and efficiency in grafting operations.
- Machine Learning (ML): Predictive analytics based on ML help farmers in weather forecasting, pest management, and yield prediction.

VNMKV, Parbhani has actively engaged in research and training on digital agriculture, including the use of drones for precision farming

Future Farming through Drone Technology

Drone is one such technology that has the potential to revolutionise the farming industry through need-based precise and variable input application leading to input saving, timeliness, reduction in cultivation cost and ensuring farmers' safety from direct exposure to chemicals. Drones have proven to be among the most promising technologies emerging from the fourth industrial revolution. Drones can be used for targeted input application, timely diagnosis of nutrient deficiency, crop health monitoring, rapid assessment of crop yield and crop losses. The drones have capability to fly at low height (1m-3 m) over the crop canopy. This makes them suitable for spraying of crop protection chemicals as well as nutrients and is more adoptable compared to aerial spray. Unlike ground spraying, spraying through drones can be carried out when field conditions prevent movement of wheeled vehicles. It enables the timeliness of spray treatments without inflicting soil compaction.

Science led policy on Standard Operating Procedures (SOPs) for Drone Use in Agriculture

To promote the use of drone technology in agriculture, the Ministry of Agriculture and Farmers Welfare, Government of India, constituted five national-level committees to develop standard guidelines and Standard Operating Procedures (SOPs) for various agricultural drone applications. The work of the first fifth committees is now complete.

The first committee, chaired by Dr. K. Alagusundaram, Deputy Director General (Agricultural Engineering) at ICAR, and convened by Dr. Indra Mani, Head of the Division of Agricultural Engineering at the Indian Agricultural Research Institute (IARI), this committee developed comprehensive guidelines for the safe, efficient, and environmentally friendly use of drones for pesticide application.

The second committee, chaired by Dr. Indra Mani, focused on drafting SOPs for spraying soil and crop nutrients using drones. It covered aspects such as dosage, application methods, and safety protocols to optimize nutrient management with drones. The Ministry released the Generic SOP for crop spraying with pesticides and nutrients in 2022.

The third committee, chaired by Dr. Ravi Prakash, Plant Protection Adviser at the Central Insecticides Board & Registration Committee (CIB&RC) in Faridabad, developed SOPs for applying crop protection products using drones. This committee developed detailed procedures for drone operation, pesticide application techniques, and safety measures to ensure effective and safe crop protection.

The fourth committee, chaired by Dr. Indra Mani, developed Standard Operating Procedures (SOPs) for the application of pesticides using drones for ten selected crops: rice, maize, cotton, groundnut, pigeon pea, safflower, sesame, soybean, sugarcane, and wheat. These crop-specific SOPs, released by the Ministry in 2023, aim to tailor pesticide application processes to the specific needs of different crops, thereby enhancing pest management's effectiveness and efficiency.

The fifth committee, chaired by Dr. Indra Mani, on the Use of Drones in Various Agricultural Activities Other than Spraying Pesticides and Liquid Fertilizers recently submitted its final report to the Ministry of Agriculture and Farmers Welfare, Government of India.

The crop-specific SOPs were formulated for the application of various pesticides and fungicides via drones, focusing on several key parameters: drone parameters (such as flying speed and height above the crop canopy), sprayer parameters (including nozzle and swath characteristics), crop parameters (such as canopy volume, growth stages, water volume per hectare, pesticide concentration and dosage, and optimal spraying times), and weather conditions (temperature, humidity, and wind speed) tailored to specific locations and climatic zones. Emphasis was placed on achieving optimal bio-efficacy and avoiding phytotoxicity.

VNMKV initiative for promotion of Drone Technology

The University has taken a leading role in promoting the use of digital technology in agriculture, focusing on innovation such as drones, robots, and sensor technology. The VNMKV, Parbhani has singed MoUs with national and international reputed institutes and companies for agricultural research and capacity building regarding advance mechanization viz., Kansas State University, University of Florida, Washington State University, MoU with Rajiv Gandhi Science & Technology Commission, TAFE, CNH (India) Industrial Pvt Ltd, ISRO-SAC, Ahemadabad, CIPHET, Ludhiana, IISR, Lucknow etc.

A six month professional Agri Drone Course has been started by the University, specifically designed to foster skills and entrepreneurship among agricultural graduates, farmers and rural youth. In addition, the university has established a Custom Hiring Centre to provide drone services for insecticide spraying to farmers at a reasonable price. Furthermore, it has collaborated with the drone industry to set up Remote Pilot Training Organization (RPTO) Centre, offering training and drone pilot license facility. A Centre of Excellence (CoE) in Digital and Sustainable Agriculture has been sanctioned from the Dept of Science and Technology, Govt. of India.

Revolutionizing Indian agriculture

Innovations in mechanization, drones, and robotics are set to revolutionize Indian agriculture by transforming traditional farming practices into a modern, efficient, and sustainable system. These technologies enhance productivity, resource efficiency, and climate resilience, addressing key challenges faced by farmers. The rapid advancements in digital tools, automation, and precision farming will not only improve agricultural outputs but also attract young professionals, startups, NGOs, and FPOs to the sector, fostering an environment of entrepreneurship and innovation. The integration of advance engineering and technology in agriculture is crucial for achieving sustainability, food security, and economic growth. With strong collaboration among policymakers, researchers, and industry stakeholders, India is making significant strides in agricultural modernization. Coupled with vibrant industry participation and supportive government policies, mechanization and automation are poised to drive India towards the vision of Viksit Bharat @ 2047, ensuring a resilient, productive, and technologically empowered agricultural sector.

Biologicals in Focus

HOW CLIMATE-RESILIENT SOLUTIONS ARE ADDRESSING GLOBAL FOOD SECURITY

> “IPM (INTEGRATED PEST MANAGEMENT) WHICH INTEGRATE MICROBIAL PESTICIDES AND CHEMICAL USE ALTERNATIVELY IS GAINING GROUND AS A SUSTAINABLE PEST SOLUTION”

The planet is in the midst of a whirlwind transformation in climate, which is throwing a wrench into global food systems and putting food security in jeopardy. The temperature of the planet has increased beyond the normal rate, and the world is now facing severe droughts regularly, which is running agricultural vitality. This crisis is not an isolated phenomenon; rather, it is part of a broader pattern of climate-induced agricultural distress. A report published by NASA in 2021 suggests that global agriculture output is expected to drop by more than 24% by the late century. This growing hostility to the agricultural sector is due to the increase in extreme weather conditions like floods, heat waves, and cyclones, which is intensifying animosity towards the agricultural industry and rendering food production increasingly unsustainable.

These concerns will likely escalate substantially in the following decades if mitigation efforts are not intensified. NASA even expects a reduction of 17% in wheat and 24% in maize by 2030, signifying a major disruption to global food supply chains. It is crucial to understand that such reduction extends beyond just economic output as the entire agricultural systems are impacted, leading to cascading effects on farmers, food availability, and nutritional security. Higher temperatures and erratic rainfall foster the development of many pests and diseases that attack plants, further threatening agricultural stability. For instance, the damage inflicted by the Spodoptera frugiperda (fall armyworm) on maize crops in sub-Saharan Africa & many parts of the world including India seen as one of the most alarming occurrences. Changing distribution ranges of previously stable crops and unprecedented insect attacks make future agriculture increasingly challenging, necessitating urgent intervention and adaptation measures.

Challenges That Agriculture Faces

The Institute of International Food Policy Research (IFPRI) has established that by 2050, global insect harm will cause declining of the overall crop yield by 40%. This situation is particularly concerning for developing countries where agriculture remains the major economic activity and where food insecurity is already a pressing issue. In South Asia Agriculture Productivity will be expected by 25% in the year 2025 due to increased temperatures and substantial water deficits, further stressing food supply chains.

Adding to this crisis, the rising shortage of water and elevated sea levels are accelerating soil salinization, negatively impacting coastal agricultural areas. Drought-induced salt stress, along with photosensitive phytopathogenic microorganisms such as Fusarium oxysporum and Ralstonia solanacearum, which are recognised causes of vascular wilts and bacterial wilt disease, facilitates invasion, making crops more vulnerable to failure. Addressing these complex issues necessitates innovative, climate-resilient agricultural transformations that can withstand extreme environmental conditions and mitigate the effects of these damaging forces.

Tackling Food Shortages with Innovative Biological Approaches

Biological solutions are revolutionizing agriculture which can help break yield ceilings and address issues like food residues, pest resurgence, resistance etc. Biologicals offer new approaches that significantly improve the environmental effectiveness of agricultural practices and increase the tolerance of plants to various challenges. Biological agents help improve nutrient absorption, root system development, and stress tolerance in crops under Biotic and abiotic stresses.

The use of these innovative methods finds further support from market trends. In 2025, the agricultural biologicals market is estimated to reach USD 43.53 billion by 2035 and the Indian market will attain 1,646.03 million by 2032, which is a staggering milestone. Research by ScienceDirect showed that biofertilisers have the remarkable capability of boosting agricultural productivity between 10% and 40%, making them one of the most potent approaches to counteract the damages caused by climate change.

Microbial solutions based on Rhizobium, Azotobactor & Azospirillum help in nitrogen fixation whereas, phosphate solubilizing bacteria & potash mobilizing bacteria solubilize and make phosphate & potash available to plants reducing fertilizer requirement by 20-25% which may slash GHG emissions from fields and help farmers to earn extra income through claiming carbon credit from the market.

Common strains like Trichoderma usage help tackle soil-borne diseases as well as chemical fungicides reducing the need for overuse of chemicals creating a positive impact on the environment and soil health. Likewise, plant growth-promoting rhizobacteria (PGPR) act to increase the physiological activity of the plants by inducing phytohormones and aiding the development of systemic resistance of the plants against pests and diseases. Such sustainable microbial solutions are constantly evolving and making the future of agriculture promising.

Currently, IPM (Integrated Pest Management) which integrate microbial pesticides and chemical use alternatively is gaining ground as a sustainable pest solution.

All in all, the convergence of climate change effects and agricultural challenges necessitates the immediate adoption of microbial technology. Increased investment must be made towards microbial research and the implementation of biotechnology innovations in agriculture to enhance preparedness for unforeseen climate change impacts. Implementing these new methods would ensure food security for future generations while significantly enhancing environmental conditions, making sustainable agriculture a global priority.

Why Urban Farming Matters for Cities and the Environment

> “Urban farming is not just a trend—it is an important step toward a better future for everyone”

MR MANINDER SINGH NAYYAR
FOUNDER AND CHIEF EXECUTIVE OFFICER, CEF GROUP

As cities expand at an unprecedented pace, they bring with them towering skyscrapers, bustling streets, and a promise of economic growth. But beneath this rapid development lies a pressing challenge—climate change, food shortages, and rising pollution levels threaten the very quality of life urban centers aim to offer. A recent study published on Sustainability shows that urban farming can help by making fresh food easier to get, improving people’s health, and bringing communities closer. As cities expand, farmland disappears, making people depend more on food supply chains that can be disrupted by climate disasters. Urban farming allows cities to grow their food, reducing the need to bring food from far away and making food supplies more secure.

Why Urban Farming is Important

Traditional farming needs a lot of land, water, and resources. It can also harm nature by cutting down forests and causing pollution. Urban farming is different because it makes use of small spaces like rooftops, balconies, and empty land in cities. This helps reduce damage to the environment and makes cities greener.

Climate change is another big challenge for food production. Extreme weather like heatwaves, heavy rain, and floods can destroy crops, leading to food shortages and higher prices. Since urban farms are close to where people live and can use technology to control the environment, they can provide fresh food all year round, even in bad weather. Urban farming also helps cool down cities, makes the air cleaner, and reduces pollution, making urban areas healthier places to live.

New Ways to Grow Food in Cities

Urban farming combines modern technology with farming to grow more food in small spaces. Some new methods include:

- Hydroponics – Plants grow in water instead of soil, getting nutrients directly from the water. This helps them grow faster while saving water.
- Vertical farming – Plants grow in layers inside buildings, using LED lights and climate control to help them grow better.
- Aquaponics – Fish farming and plant growing are combined. Fish waste provides nutrients for the plants, and the plants help clean the water for the fish.

Urban farms also help manage waste better. Instead of throwing away food scraps, they can be turned into compost, a natural fertilizer that helps plants grow. Some farms even turn waste into energy, making farming even more eco-friendly.

How Urban Farming Helps People

Urban farming is not just about food—it also makes life better in cities. Empty or abandoned spaces can be turned into green gardens, bringing nature closer to people. Community gardens also help neighbors connect, learn new skills, and support each other.

Urban farming creates jobs, especially for people who struggle to find work. It teaches useful skills in farming, business, and sustainability, helping people earn a living while also caring for the environment. Since urban farming reduces the need to transport food from far away, it also cuts down on fuel use and pollution, making the planet healthier.

The Future of Urban Farming

As climate change affects farming more and more, cities will need to grow more of their food. Advances in renewable energy, organic fertilizers, and waste-to-energy solutions will make urban farming even more effective. By supporting new farming techniques and eco-friendly policies, cities can become greener, healthier, and more self-sufficient.

Urban farming is not just a trend—it is a real solution for the future. It helps protect the environment, brings people together, and makes food more accessible. With continued investment, new ideas, and support from businesses and governments, urban farming can help create a better, more sustainable world.

How Businesses Can Help

For urban farming to succeed, businesses that care about the environment need to help. Many companies are already supporting eco-friendly farming by introducing better ways to grow food, like hydroponics, vertical farming, and smart irrigation. These methods help farms produce more food while using less space, water, and energy. Companies focused on sustainability also invest in green initiatives that support urban farming. By using these solutions and working with farming experts, cities can grow more of their food, reduce waste, and build a cleaner, healthier future for everyone.

Final Say

Urban farming is a smart way to grow food in cities while also helping the environment and communities. It makes use of small spaces, reduces waste, and provides fresh food close to where people live. It also creates jobs, improves air quality, and helps fight climate change. For urban farming to grow, it needs support from businesses, governments, and communities. Many companies are already helping by introducing new farming methods that save space and resources. By working together and using new ideas, cities can become greener, healthier, and more self-sufficient. Urban farming is not just a trend—it is an important step toward a better future for everyone.

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Amber Crop Science: A Dedicated Company for Farmers' Prosperity and Soil Health

Founded in 2008, Amber Crop Science Private Limited is today one of India's leading agricultural solutions providers. Located in the Sonipat district of Haryana, the company's state-of-the-art factory manufactures high-quality agricultural products that help enhance farmers' crop protection and productivity.

Sanjay Gupta, Managing Director, Amber Crop Science, believes that healthy soil is the foundation for good crops. Under his leadership, the company has developed several innovative products to promote soil health and organic farming, which not only increase crop yield and quality but are also environmentally friendly.

Sanjay Gupta says, "Our goal is to provide farmers with sustainable and science-based solutions. If the health of the soil is not good, both the quality and yield of the crops will be affected." With this mindset, the company has installed special machines to check soil health, which provide farmers with instant soil reports, helping them make the right decisions. Additionally, the company conducts regular training sessions for farmers to help them better adopt modern and organic farming methods, enabling them to grow high-quality fruits, vegetables, and grains.

Currently, Amber Crop Science focuses on organic and natural products that not only nourish the soil but also enhance the resistance capacity of crops. Some of the company's key products include:

- **Terry Gold:** This organic fertilizer is made from mycorrhizal fungus, which strengthens plant roots and naturally enhances growth. It is useful for rice, wheat, maize, pulses, oilseeds, fruits, and vegetables.
- **Terry Potash:** This product makes the potash hidden in the soil available to plants, boosting crop growth and production.
- **Jimmy L:** A 100% natural liquid product that promotes root growth and increases the shelf life of fruits and vegetables.
- **Manit™:** An organic fertilizer that helps plants absorb nutrients through their leaves, improving yield and quality.
- **Zebra Zinc:** This product makes the zinc content in the soil soluble and enhances the nutritional value of crops.
- **Gochi:** This product improves soil structure and enhances nutrient absorption, leading to quicker crop maturity.

According to Sanjay Gupta, "Our mission is to make farmers prosperous and self-reliant. Organic farming not only keeps the soil healthy but also increases farmers' income. Additionally, our goal is to promote healthy diets and high-quality yields."

He further mentioned that Amber Crop Science is not limited to selling products but works closely with farmers. The company's team visits farms to educate farmers on the proper use of products and teaches them sustainable farming techniques. The company also plans to launch more new products in the future to meet the various needs of farmers. He believes, "If farmers are provided with the right knowledge and resources, they can not only increase their income but also contribute to the country's food security."

He added that the Indian government's goal is to build a developed India by 2047, and Amber Crop Science is playing its role in achieving this target. The company's vision is clear – to make the soil healthy, empower farmers, promote organic farming, and produce healthy food and nutritious yields.

Advancing Sustainable Agriculture through Biologics for a Thriving Future

Biologics, including biofertilizers, organic fertilizers, and biopesticides, are essential in addressing agricultural productivity challenges in India. By incorporating biologics into farming practices, India can improve agricultural growth, enhance food security, and ensure food safety. The transition from chemical inputs to biologics is crucial, with the potential to expand from 5% to nearly 30% of the fertilizer and agrochemical market. This shift will enable farmers to reduce production costs, achieve higher yields, and enhance soil fertility while minimizing pesticide residues in food.

As the global population is projected to reach 9 billion by 2050, food demand will increase by 70-100%. Conventional farming methods reliant on excessive fertilizers, pesticides, and water are unsustainable and harmful to the environment. Microbes, when combined with precision farming, offer an eco-friendly alternative that maintains soil fertility and boosts yields. Harnessing microbial power through biologics can ease the burden on traditional farming systems, creating a more resilient agricultural ecosystem and ensuring sustainable food production.

Kan Biosys: Innovating with Microbial Technology

With over two decades of expertise, Kan Biosys is a leader in microbial technology, offering innovative solutions in four key agricultural segments: Seed Priming, Soil Health Management, Nutrient Management, and Pest & Disease Management. The company's patented liquid biofertilizers, microbial formulations, and seed-dressing technologies ensure residue-free food production, promoting higher yields and sustainable farming.

Kan Biosys focuses on developing microbial technologies that optimize plant nutrition and pest management throughout the crop cycle. By improving soil health and enabling efficient nutrient uptake, these products help farmers grow healthier crops with fewer inputs. This benefits farmers by enhancing profitability while also reducing agriculture's environmental impact.

Biopesticides: A Safer, Sustainable Alternative

As pest resistance to chemical treatments increases and environmental concerns grow, biopesticides like Milastin-K™ and Sudo™ offer effective and sustainable alternatives. These products, developed using advanced microbial technology, protect crops from fungal infections and pests while maintaining a healthy farming environment. Milastin-K™ is the first liquid biofungicide with activator technology, enhancing its effectiveness against various seed and soil-borne plant pathogenic fungi. It contains Bacillus subtilis KTSB 1015, ensuring superior colonization of shoots and foliage, providing long-term protection without harming the environment.

Similarly, Sudo™, formulated with Pseudomonas fluorescens, is a broad-spectrum fungal protection solution for soil and foliar diseases. It improves seed germination and enhances plant vigor, leading to higher yields and healthier crops. This eco-friendly alternative reduces reliance on synthetic chemical pesticides, contributing to residue-free food production.

Supporting Farmer Education and Extension Efforts

One of the main challenges in the biologics sector is the need for extensive farmer education. Many MSMEs (Micro, Small, and Medium Enterprises) producing biologics must invest significant resources in educating farmers and distribution networks, particularly in markets dominated by chemical fertilizers and pesticides.

Effective farmer education and extension programs are vital to increasing the adoption of biologics. A dedicated policy framework, increased research investments, and large-scale awareness initiatives can help accelerate this transition. Public-private partnerships can play a key role in promoting biofertilizers, biopesticides, and organic farming, ensuring food safety and reducing pesticide resistance.

The Promise of Biologics for the Future of Agriculture

India has vast potential to become a global leader in the biologics sector due to its rich biodiversity, trained workforce, and fermentation capabilities. With a supportive regulatory ecosystem, India can drive global advancements in sustainable agriculture. By implementing suitable policies and investments, India can tackle climate change, enhance food security, and promote sustainable agricultural growth.

Biologics provide an effective solution to meet the food demands of a growing population while conserving natural resources and reducing environmental harm. Encouraging research and innovation while supporting manufacturers, channel partners, and farmers can help India emerge as a hub for sustainable agricultural technologies.

Dr Sandeepa Kanitkar

Founder & Managing Director - Kan Biosys

Policy Initiatives Needed at Government Level

1. Residue-Free Farming Certification & Labeling

Residue-free farming acts as a bridge between conventional and organic farming, ensuring yield sustainability. The government should support certification standards and introduce a dedicated residue-free label, increasing consumer awareness and driving demand for such products.

2. Direct Benefit Transfer (DBT) for Biologics

To encourage biologic adoption, the government should implement Direct Benefit Transfer (DBT) for farmers, regulating the use of chemical fertilizers. Incentives for dealers and farmers who sell registered biologics at the Point of Sale (POS) can help boost usage.

3. PLI Scheme for Biologics Manufacturing

The Production Linked Incentive (PLI) scheme for biologics should be expanded, with government funding covering up to 50% of project costs for investments between ₹10 to ₹50 crores. This would boost domestic production and innovation in sustainable agriculture.

4. GST Reduction on Biologics

To make biologics more accessible, the Goods and Services Tax (GST) should be capped at 5%, replacing the current variable 5% to 18% rates. This will help lower costs and encourage widespread adoption among farmers.

5. FSSAI Standards at APMC Level

The Food Safety and Standards Authority of India (FSSAI) should implement stringent standards at Agricultural Produce Market Committees (APMCs) to ensure traders adhere to food safety norms, improving the overall quality of agricultural produce.

6. Catch Them Young' Initiative

Raising awareness among young farmers and consumers about residue-free and sustainable farming is essential for building a healthier India. Programs should be introduced in schools, agricultural institutions, and rural communities to educate future generations on sustainable agriculture.

7. Bharat Carbon Fund

A Bharat Carbon Fund should be created to incentivize farmers for increasing soil carbon levels through sustainable practices like agroforestry. This will promote carbon sequestration, enhance soil fertility, and contribute to climate resilience.

Conclusion: How Kan Biosys Helps Farmers

Kan Biosys supports farmers by offering innovative solutions to enhance soil health, pest control, and crop productivity. With a strong research foundation, high-quality products, and technical support, the company enables farmers to achieve higher yields, lower costs, and improved crop health while reducing environmental harm.

By promoting microbial products, Kan Biosys helps farmers reduce their dependence on harmful chemicals, adopt sustainable practices, and enhance profitability. As Indian agriculture shifts towards biologic-based solutions, Kan Biosys remains at the forefront, playing a pivotal role in ensuring food security and long-term sustainability.

Through continuous product innovation, technical support, and farmer education, Kan Biosys is shaping the future of agriculture, ensuring a healthier, more prosperous environment for farmers, consumers, and the planet.

Protecting Crops, Boosting Yields: Pest & Post-Harvest Solutions

Indogulf Cropsciences Limited commenced its operations in 1993 and primarily operates under three business verticals namely crop protection, plant nutrients and biologicals, to retail and institutional customers focused on improving the crop yield. As agriculture remains the backbone of India's economy, ensuring crop protection followed by efficient post-harvest management is crucial to achieving long-term success.

As the agricultural seasons shift from Rabi to Kharif, the Zaid period presents both challenges and opportunities. This short but significant growing season demands vigilant pest management, as crops like cucumbers, melons, and pulses become highly susceptible to biting and sucking pest. Protecting these crops requires a combination of advanced Integrated Pest Management (IPM) strategies, biological control measures, and targeted chemical solutions. Indogulf Cropsciences Limited provides farmers with insecticides such as Lambda Cyhalothrin 5%, Imidacloprid, and Emamectin Benzoate 5%SG ***(brand name: Dominator).*** Additionally, they offer innovative fungicides including ***Fang-75.***

Beyond pest control, post-harvest management plays an equally vital role in securing the farmer's investment. Rabi crops like wheat and pulses require careful handling to prevent losses during storage and transportation, as poor moisture control, pest infestations, and inefficient storage methods can severely impact their quality and profitability. Farmers can mitigate these risks with scientifically proven methods, including proper drying techniques, hermetic storage solutions, and fumigation practices.

In the ever-evolving landscape of Indian agriculture, staying ahead requires integrating modern solutions with traditional wisdom, Indogulf Cropsciences Limited is committed to driving this transformation with bio-stimulants ***like Empire, Indo Breeza, Root-O-Max Gold and Indo Apache,*** which aims to improves soil fertility and root development. Additionally, plant growth regulators like ***Gajab*** ultra and ***Sriculan gold*** aims to optimize plant growth and productivity, with objective to ensure that farmers achieve superior agricultural outcomes.

Indogulf Cropsciences has experience in undertaking R&D activities as part of their manufacturing operations. Its R&D laboratory is located at the Nathupur, Haryana facility with modern research and development infrastructure. Further, R&D laboratory has received certificate of accreditation from the NABL in accordance with the standard ISO/IEC 17025:2017. Further, the company is currently in the process of developing and upgrading 39 products.

Agriculture is a relentless pursuit, demanding constant adaptation and improvement. With the right strategies and superior crop protection products, farmers can secure their livelihoods and contribute to India's food security. Indogulf Cropsciences Limited endeavours to be a partner in this journey, providing solutions that aim to ensure bountiful harvests and sustainable farming. The future of Indian agriculture is bright—let's cultivate it together!

SANJAY AGGARWAL
MANAGING DIRECTOR

Grow and Secure... In Safe Hands

INDOGULF CROPSCIENCES LTD.

IALF, USA Delegates Engage in Interactive Session Focused on US-India Bilateral Trade and Knowledge Exchange with Bharat Rasayan Limited, India

The IALF delegates' session in New Delhi focused on US-India agricultural trade, innovation, and collaboration. Key discussions included genome editing, sustainable farming, carbon credits, and policy frameworks, highlighting opportunities for technology exchange, market expansion, and mutually beneficial trade relations.

The Illinois Agricultural Leadership Foundation (IALF) delegates were in New Delhi in March 2025 and participated in an interactive session

focused on US - India trade and knowledge exchange at Hotel Shangri La, New Delhi. The session kicked off with a warm welcome to the delegates by Mr. SN Gupta, Chairman of Bharat Group and Mr. RP Gupta, Director & CEO, Bharat Group followed by the introductory

presentation by Mr. Abhishek Aggarwal, President & COO, Bharat Rasayan Limited.

Dr. PK Singh, India's Agriculture Commissioner, expressed optimism about the future of agricultural cooperation. He pointed out that despite challenges like genetically modified (GM) crop trading restrictions, both India and the U.S. are working toward innovation in crop science. He emphasized that technologies like genome editing and sustainable farming practices could open new avenues for cooperation.

Cattle-Based Traditional Farming System

Vital For Good Health

Cattle-based agriculture is a traditional farming system where cattle play a central role in maintaining soil fertility, water conservation, crop productivity, and ecosystem health. This system integrates the natural behaviors and by-products of cattle to create a sustainable, self-sufficient farming model.

Key Principles of Cattle-Based Agriculture

1. Soil Fertility through Dung and Urine

Cattle dung and urine are rich in nutrients, acting as natural fertilizers that enhance soil quality. The decomposition of dung creates soil porosity, improving water retention and aeration.

2. Water Conservation

The decomposed dung helps create tiny holes in the soil, allowing rainwater to percolate and replenish underground water reserves.

This natural water-harvesting process ensures that plants access moisture through vapor percolation.

3. Crop and Soil Synchronization

Cattle manure supports microbial activity in the soil, balancing the ecosystem and ensuring crop health.

The integration of cattle grazing allows natural mulching and weed control.

4. Low-Cost Farming

Farmers who follow this system reduce dependence on chemical fertilizers and pesticides, significantly lowering input costs.

Income from selling cattle after their productive phase provides financial sustainability.

5. Animal Welfare

Calves are kept with their mothers, ensuring natural feeding and growth.

Early conception of calves (16–20 months) accelerates herd growth, contributing to farm profitability.

6. Ecological Benefits

Promotes biodiversity by creating a balanced environment for plants, animals, and microbes.

Reduces the carbon footprint by minimizing reliance on industrial agriculture practices.

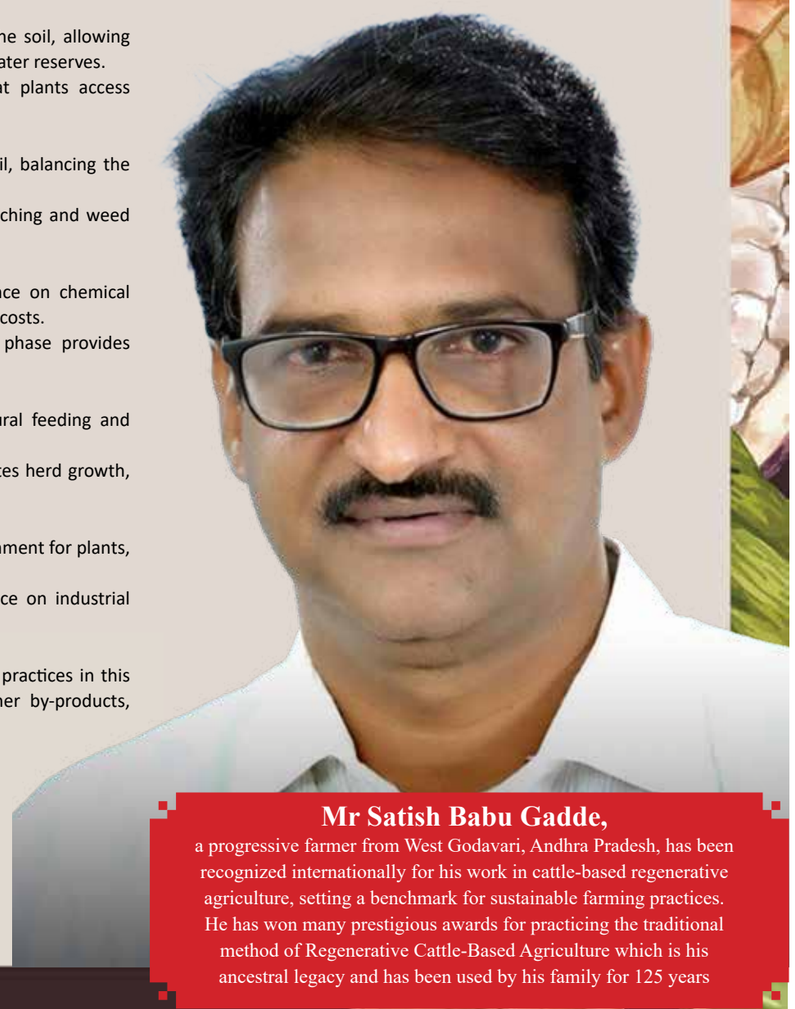
7. Impact on Human Health

Human health is directly tied to cattle. The natural practices in this system produce nutrient-rich crops, milk, and other by-products, supporting healthier food systems.

Scalability

This model is particularly effective in areas with limited water resources, like parts of Andhra Pradesh. It offers a sustainable solution for small and marginal farmers to prosper without depleting natural resources.

"The global narrative suggests that healthy soil inherently retains water, but this oversimplifies the process. True water retention is not just a property of healthy soil—it depends on how the soil is enriched and structured. In India's traditional agriculture, cattle play a critical role. Their dung, when decomposed, creates organic channels within the soil, allowing rainwater to percolate deep into the ground, up to 15 feet below. This stored water resurfaces as vapor, feeding plants naturally during dry periods. This synchronization of cattle, soil, and water cycles is a cornerstone of India's time-tested farming practices and offers a sustainable model for agriculture in water-scarce regions."



Mr Satish Babu Gadde,

a progressive farmer from West Godavari, Andhra Pradesh, has been recognized internationally for his work in cattle-based regenerative agriculture, setting a benchmark for sustainable farming practices. He has won many prestigious awards for practicing the traditional method of Regenerative Cattle-Based Agriculture which is his ancestral legacy and has been used by his family for 125 years

Impact of Technology on Indian Agriculture

Agriculture has been the backbone of the Indian economy for centuries, supporting nearly half of the country's population. With the rapid advancement of technology, Indian agriculture has witnessed significant transformations that have improved productivity, efficiency, and sustainability. The adoption of innovative tools, machinery, and scientific techniques has played a crucial role in enhancing crop yields, reducing labor dependency, and addressing climate change challenges. This article explores the various technological advancements that have impacted Indian agriculture, their benefits, and the challenges associated with their adoption.

1. Historical Context of Indian Agriculture

Traditionally, Indian agriculture was characterized by manual labor, primitive tools, and unpredictable outcomes. Farmers relied heavily on monsoons, and crop yields were limited due to outdated practices. The Green Revolution in the 1960s marked the first major technological breakthrough, introducing high-yielding variety (HYV) seeds, chemical fertilizers, and improved irrigation systems. This period laid the foundation for future technological advancements in agriculture.

2. Modern Technological Advancements in Indian Agriculture

In recent decades, Indian agriculture has embraced various modern technologies that have revolutionized the sector. Key advancements include:

a. Mechanization of Agriculture

Tractors, combine harvesters, seed drills, and threshers have significantly improved efficiency by reducing manual labor and increasing productivity. Mechanization has helped reduce post-harvest losses, especially in large-scale farming operations.

b. Precision Farming

Precision agriculture leverages GPS technology, sensors, and drones to provide farmers with real-time data on soil conditions, moisture levels, and crop health. This data-driven approach enables precise application of fertilizers, pesticides, and water, optimizing resource use and enhancing yields.

c. Biotechnology and Genetic Engineering

Genetically Modified (GM) crops such as Bt cotton have been widely adopted in India to improve resistance to pests, reduce chemical usage, and boost yields.

Tissue culture techniques have enabled the mass production of disease-free planting materials for crops like bananas and orchids.

d. Irrigation Technologies

Drip irrigation, sprinkler systems, and automated irrigation methods have revolutionized water management, reducing water wastage and improving crop growth. Technologies like IoT (Internet of Things) sensors now allow farmers to remotely monitor soil moisture and control irrigation.

e. Information and Communication Technology (ICT)

Digital platforms like e-NAM (National Agriculture Market), Kisan Suvidha, and AgriBazaar have connected farmers with better markets, ensuring fair prices for their produce. Mobile apps provide farmers with real-time weather updates, pest control advice, and market prices, improving decision-making.

f. Artificial Intelligence (AI) and Big Data

AI-driven solutions help predict weather patterns, detect crop diseases, and optimize planting schedules. Big data analytics enables better forecasting, risk assessment, and resource allocation.

g. Drones and Robotics

Drones are increasingly used for crop monitoring, pesticide spraying, and field mapping, reducing labor dependency and improving precision. Robotics in agriculture assists in automated harvesting, planting, and weed control.

h. Blockchain Technology

Blockchain helps improve traceability in the agricultural supply chain, ensuring farmers receive fair payments and reducing fraud.

3. Positive Impacts of Technology on Indian Agriculture

The adoption of technology has brought several significant benefits to Indian agriculture:

a. Enhanced Productivity

High-yield seeds, fertilizers, and mechanization have significantly increased crop yields, ensuring food security for a growing population.

b. Improved Resource Management

Precision farming and IoT-based solutions have reduced water, fertilizer, and pesticide wastage, promoting sustainable practices.

c. Climate Resilience

Weather prediction models, drought-resistant crops, and advanced irrigation systems have helped farmers mitigate climate-related risks.

d. Reduced Labor Dependency

With rural-to-urban migration increasing, technological innovations have addressed labor shortages in agriculture.

e. Enhanced Market Access

Digital platforms and e-commerce solutions have improved farmers' access to markets, reducing dependency on middlemen.

f. Increased Farmer Incomes

Better resource utilization, improved yields, and fair market prices have contributed to higher incomes for Indian farmers.

4. Challenges in Technology Adoption

Despite the numerous benefits, several challenges hinder the widespread adoption of technology in Indian agriculture:

a. High Costs

Advanced machinery, sensors, and precision tools require substantial investment, which many small and marginal farmers cannot afford.

b. Lack of Awareness and Training

Many farmers lack the technical knowledge required to operate modern equipment and use digital tools effectively.

c. Infrastructure Gaps

Limited access to electricity, internet connectivity, and transportation facilities restricts the implementation of modern technology in remote areas.

d. Fragmented Land Holdings

Small and scattered land holdings in India make it challenging to implement large-scale mechanization and precision agriculture.

e. Data Privacy and Security

With the increasing use of digital platforms, concerns about data privacy and misuse have emerged.

5. Government Initiatives to Promote Agri-Tech

The Indian government has introduced several initiatives to promote the use of technology in agriculture:

a. Digital India Campaign: Launched to improve digital infrastructure in rural areas, enabling better connectivity and access to agricultural resources.

b. Pradhan Mantri Krishi Sinchayee Yojana (PMKSY): Aimed at promoting efficient irrigation methods to conserve water.

c. National e-Governance Plan for Agriculture (NeGPA): Focuses on delivering agricultural services electronically to farmers.

d. Soil Health Card Scheme: Provides farmers with detailed soil analysis reports, enabling informed fertilizer application.

e. Agri-Startup Support: The Indian government actively encourages agri-tech startups to develop innovative solutions for farming challenges.

6. Future Prospects for Technology in Indian Agriculture

The future of Indian agriculture lies in the integration of emerging technologies with traditional practices. Some promising developments include: Vertical Farming: Growing crops in controlled indoor environments to optimize space and resources.

Hydroponics and Aeroponics: Soil-free cultivation methods that improve efficiency and reduce water usage.

Climate-Smart Agriculture: Integrating sustainable practices with data-driven insights to enhance resilience against climate change. Additionally, collaborations between technology firms, research institutions, and farmer cooperatives will play a vital role in driving innovation in Indian agriculture.

7. Conclusion

The impact of technology on Indian agriculture has been profound, transforming the sector from subsistence farming to a more productive, efficient, and sustainable industry. While technology has significantly enhanced crop yields, improved resource management, and boosted farmer incomes, challenges such as affordability, awareness, and infrastructure gaps remain. Bridging these gaps through targeted policies, education, and investment will ensure that Indian farmers can fully harness the potential of technology for a prosperous and secure agricultural future.

Dr. Prafull Gadge
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Farm Mechanization for Smallholder Farmers in India

Prospects and Challenges

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Farm mechanization plays a crucial role in enhancing agricultural productivity, reducing labor dependency, and improving rural livelihoods, especially for smallholder farmers. However, its adoption is hindered by economic constraints, inadequate infrastructure, limited technical knowledge, and policy gaps.

While developed regions in India have embraced mechanization, smallholder farmers still rely on traditional tools due to high machinery costs and limited access to credit. Successful models such as Crop Residue Management (CRM) and NICRA's farm implement banks demonstrate that innovative approaches, including custom hiring centers (CHCs), cooperative ownership, and digital rental platforms, can significantly improve mechanization access.

Additionally, promoting women-friendly and climate-smart technologies, such as solar-powered irrigation and conservation agriculture, ensures sustainability and inclusivity. Strengthening government subsidies, public-private partnerships, and farmer training programs is essential for expanding mechanization. Collaborative efforts among governments, private enterprises, and farming communities can create an enabling environment for smallholder farmers, ultimately boosting productivity and ensuring food security. By addressing key barriers and leveraging emerging opportunities, mechanization can transform small-scale farming, making it more efficient, sustainable, and resilient to climate challenges.

Farm mechanization

Farm mechanization refers to the use of machinery, tools, and equipment in agricultural operations to enhance productivity and efficiency. It encompasses a wide range of technologies, from simple hand tools and animal-drawn implements to advanced machines such as tractors, harvesters, and irrigation systems. The adoption of mechanization in agriculture plays a crucial role in reducing human labour, improving efficiency, and enhancing the overall productivity of farming systems. It contributes significantly to increasing crop yields, reducing post-harvest losses, and minimizing drudgery for farmers. Mechanization allows for timely planting, harvesting, and irrigation, which are essential for maximizing output, particularly in regions vulnerable to climate variability. Moreover, mechanization could improve the quality of produce and lower production costs, ultimately enhancing the profitability of farming enterprises.

Smallholder farmers, who typically cultivate less than two hectares of land, represent the backbone of global food security. They produce a significant proportion of the world's food supply, particularly in developing regions such as Africa, Asia, and Latin America. Despite their critical role, smallholder farmers often face numerous challenges, including low productivity, limited access to resources, and vulnerability to climate change. Addressing these challenges through farm mechanization can play a pivotal role in transforming their livelihoods and boosting food security.

Need for farm mechanization in smallholder farming

Smallholder farmers face numerous challenges that hinder their productivity and economic well-being. One of the most pressing issues is low agricultural productivity due to reliance on traditional farming methods, which are labor-intensive and time-consuming. Many smallholders still use basic hand tools such as hoes and sickles, limiting their capacity to cultivate larger areas and achieve optimal yields. Additionally, labor shortages have become a growing concern, especially as younger generations migrate to urban areas in search of better opportunities. Post-harvest losses further exacerbate the problem, as inadequate processing and storage methods lead to significant wastage of agricultural produce, reducing farmer's overall earnings.

Farm mechanization presents a viable solution to these challenges by enhancing efficiency and reducing the physical burden on farmers. The use of mechanized tools, such as small tractors, seeders, and threshers, allows for quicker and more precise farming operations. This results in increased crop yields and improved farm productivity. Mechanization also minimizes drudgery, particularly for women, who make up a significant portion of the agricultural workforce. By streamlining activities such as plowing, planting, and harvesting, mechanization enables farmers to optimize their time and resources, leading to greater economic stability. Furthermore, improved post-harvest technologies, such as mechanized drying and storage facilities, help reduce losses and ensure higher-quality produce reaches the market. Beyond individual farm benefits, mechanization has a broader impact on food security and rural development. By increasing agricultural output, mechanization contributes to a more stable and sufficient food supply, which is essential for feeding growing populations. It also stimulates rural economies by creating new opportunities for agribusiness, including machinery manufacturing, repair services, and equipment rental businesses.

Status of farm mechanization among smallholder farmers in India

Farm mechanization in India has progressed significantly over the years, yet its adoption among smallholder farmers remains uneven across different regions. States like Punjab, Haryana, and western Uttar Pradesh have achieved high levels of mechanization due to

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> MANY FARMERS ARE UNFAMILIAR WITH OPERATING, MAINTAINING, AND TROUBLESHOOTING AGRICULTURAL EQUIPMENT, LEADING TO INEFFICIENCIES AND INCREASED BREAKDOWNS

large landholdings, better infrastructure, and government support. In contrast, states in eastern and central India, such as Bihar, Odisha, Chhattisgarh, and Madhya Pradesh, still rely heavily on traditional farming methods due to fragmented landholdings and financial constraints. The southern states, including Tamil Nadu and Karnataka, have seen moderate mechanization growth, particularly in irrigation and harvesting technologies. Overall, while India's mechanization rate is increasing, smallholder farmers often struggle to afford and access modern equipment, limiting their ability to compete with large-scale farmers.

Smallholder farmers in India primarily use a mix of traditional tools and modern machinery based on their economic capacity and regional requirements. Hand tools such as sickles, plows, and spades continue to be widely used, particularly in rainfed and hilly areas where mechanized solutions are less feasible. Small tractors (ranging from 15 to 35 HP) have gained popularity among small-scale farmers, as they are more affordable and suitable for small landholdings. Additionally, power tillers, seed drills, and planters are increasingly being adopted, particularly in states promoting conservation agriculture. Threshers and combine harvesters have also become more common, especially in wheat and rice-producing states, reducing labor dependency and improving post-harvest efficiency. Irrigation systems, including drip and sprinkler irrigation, are being gradually adopted, supported by government subsidies and initiatives such as the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY). However, the high costs of advanced machinery and limited access to financing remain key barriers for many small farmers.

Challenges hindering farm mechanization for smallholder farmers

Despite the potential benefits of farm mechanization, smallholder farmers face several challenges that hinder its widespread adoption. Addressing these obstacles is crucial to ensuring that mechanization becomes accessible and beneficial to small farmers, ultimately improving agricultural productivity and rural livelihoods.

- **Economic constraints:** Significant barriers for smallholder farmers is the high cost of machinery. Additionally, the cost of fuel, spare parts, and maintenance adds to the overall expense, making it an unsustainable option for many. Limited access to credit and lack of collateral to secure bank loans, results in smallholders for unable to afford modern equipment and continue relying on traditional farming methods.
- **Infrastructure issues:** In many rural areas, inadequate road networks make it difficult to transport machinery to farms, increasing the cost of mechanization services. Additionally, the lack of repair and maintenance facilities in remote regions discourages farmers from investing in machines, as they struggle to find spare parts or skilled technicians for repairs.
- **Technical barriers:** Many farmers are unfamiliar with operating, maintaining, and troubleshooting agricultural equipment, leading to inefficiencies and increased breakdowns. Also, absence of adequate training programs and agricultural extension services prevents farmers from fully benefiting from mechanization.
- **Policy and institutional gaps:** In India, government subsidies for farm machinery are insufficient, preventing smallholder farmers from accessing affordable equipment. Import regulations and high taxation on agricultural machinery further inflate costs, making it difficult for farmers to purchase modern tools.
- **Social and cultural factors:** Many farmers are hesitant to adopt mechanization due to a fear of failure, skepticism about new technology, or lack of awareness about its benefits. Land fragmentation, as small and irregularly shaped plots make it difficult to use large machinery effectively. This problem is particularly prevalent where land is divided among multiple generations, leading to smaller farm sizes over time.

Prospects and opportunities for smallholder farm mechanization

Contempt the numerous challenges hindering farm mechanization among smallholder farmers, there are several promising opportunities that can drive its adoption. These emerging prospects can help bridge the gap between traditional farming methods and modern agricultural practices, ultimately enhancing productivity and livelihoods.

i. Affordable and locally adapted machinery: Many agricultural equipment manufacturers are now designing compact and cost-effective tools tailored to the needs of smallholder farmers. Mini tractors, power tillers, small-scale threshers, and precision seeders are being developed to suit smaller landholdings and diverse crop types. Additionally, innovations in drone technology, automated irrigation systems, and low-cost mechanized harvesting tools are making mechanization more accessible.

ii. Subsidies and Public-Private Partnerships (PPPs): Many governments have introduced subsidy programs to make agricultural machinery more affordable, such as direct financial assistance for purchasing equipment or tax exemptions on farm implements. PPPs are also emerging as effective mechanisms to expand mechanization. Private agribusiness companies are collaborating with governments to establish mechanization hubs, provide financing solutions, and train farmers in machinery operation and maintenance.

iii. Custom Hiring Centers (CHCs): A growing trend in farm mechanization is the establishment of CHCs, where farmers can rent agricultural equipment at affordable rates. These centers, often supported by government schemes or private enterprises, provide access to tractors, planters, harvesters, and irrigation systems on a need-based basis.

iv. The Uberization of farm implements: the Uberization of farm machinery—where farmers can book equipment through mobile apps/digital platforms—is revolutionizing access to mechanization. Platforms like Trringo in India and Hello Tractor in Africa are enabling smallholders to rent farm equipment on-demand, improving efficiency while reducing costs. The expansion of digital mechanization services can further enhance accessibility for remote and small-scale farmers.

v. Women-friendly technology and Ergonomics: Traditional mechanization tools are often designed with male farmers in mind, making them difficult for women to operate. To address this, ergonomic designs, lightweight machinery, and mechanized tools that require less physical strength are being developed. Small-scale harvesters, power weeders, and pedal-operated irrigation pumps are examples of technologies tailored to women farmers. Ensuring gender-inclusive mechanization solutions can empower women in agriculture, increasing productivity and improving their economic standing.

vi. Sustainable mechanization approaches: Sustainable technologies such as solar-powered irrigation pumps are providing smallholder farmers with cost-effective and eco-friendly water management solutions. Conservation agriculture techniques, including zero-tillage seeders and precision planters, are helping farmers improve soil health and reduce water usage. Additionally, mechanization solutions that integrate organic farming practices—such as compost turners and biofertilizer applicators—are promoting environmentally sustainable agriculture. By prioritizing sustainability in mechanization, smallholder farmers can increase yields while preserving natural resources for future generations.

Case Studies and Success Stories

The adoption of farm mechanization among smallholder farmers has yielded significant benefits in various regions through well-structured programs and initiatives. Crop Residue Management (CRM) for mechanization for climate-smart agriculture is an initiative in Punjab and Haryana, India, that has effectively tackled the problem of crop residue burning. Through government support, smallholder farmers were provided with access to mechanized solutions such as the Happy Seeder, Super Straw Management System (Super SMS), and mulchers, which enable in-field residue management without burning. The introduction of these machines, along with financial incentives and awareness programs, helped farmers adopt sustainable mechanization practices. This initiative highlights the importance of custom hiring centers (CHCs), where smallholders can rent machinery at affordable rates. The CHC model ensures that even farmers with limited financial resources can access modern equipment. Key lessons from the CRM initiative include the need for strong policy support, financial subsidies, and extensive farmer training programs to ensure large-scale adoption.

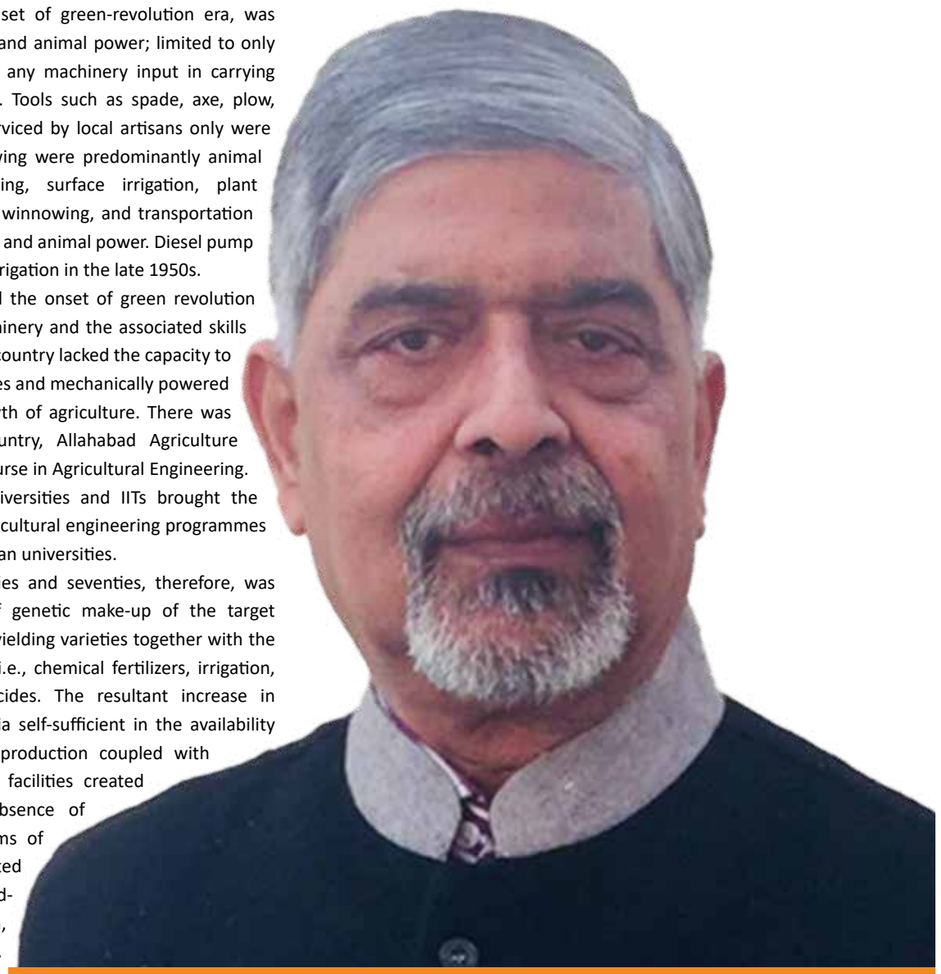
The National Innovations in Climate Resilient Agriculture (NICRA) program, launched by the Indian Council of Agricultural Research (ICAR), focuses on developing climate-smart farming practices. As part of the initiative, farm implement banks were established in villages, providing smallholders with access to essential mechanized tools such as direct-seeded rice planters, laser land levelers, and zero-till seed drills. These technologies have improved water-use efficiency, reduced input costs, and enhanced productivity in drought-prone and rainfed areas. The NICRA initiative underscores the importance of community-based approaches to mechanization. By creating shared resource centers, the program has successfully addressed the issue of high machinery costs, making mechanization accessible to smallholders. A key takeaway from NICRA is that group-based ownership and cooperative farming models can significantly enhance mechanization adoption among resource-poor farmers.

Immense Potential

Farm mechanization holds immense potential to transform smallholder agriculture by enhancing productivity, reducing labor dependency, and improving rural livelihoods. However, challenges such as high costs, inadequate infrastructure, limited technical knowledge, and policy gaps continue to hinder widespread adoption. Successful models like CRM and NICRA's farm implement banks demonstrate that targeted interventions, financial support, and cooperative approaches can significantly improve mechanization accessibility. To accelerate mechanization adoption, governments has strengthened subsidy programs, improved rural infrastructure, and expanded farmer training initiatives. Encouraging CHCs, public-private partnerships, and digital mechanization platforms which further enhance access to affordable equipment. Additionally, promoting women-friendly technology and climate-smart mechanization would ensure inclusivity and sustainability. A collaborative effort between governments, private enterprises, financial institutions, and farming communities is essential to drive smallholder mechanization forward.

Engineering interventions in agriculture for prosperity and sustainability

> AGRICULTURAL MECHANIZATION PRESENTS HUGE POSSIBILITIES IN REDUCING THE COST OF CULTIVATION, INCREASING THE PROFITABILITY, REDUCING THE HUMAN DRUDGERY IN AGRICULTURAL OPERATIONS, AND IMPROVING THE RURAL AND URBAN LIFE LEADING TO SUSTAINABILITY



DR PITAM CHANDRA

FORMER DIRECTOR, ICAR-CIAE, BHOPAL, MADHYA PRADESH

Indian agriculture, until the onset of green-revolution era, was powered essentially by human and animal power; limited to only 0.30 kW/ha. There was hardly any machinery input in carrying out field and off-field operations. Tools such as spade, axe, plow, and trowel manufactured and serviced by local artisans only were available for use. Tillage and sowing were predominantly animal power-based operations, Weeding, surface irrigation, plant protection, harvesting, threshing, winnowing, and transportation were also carried out using human and animal power. Diesel pump sets began to be available for lift irrigation in the late 1950s.

The absence of mechanization till the onset of green revolution was due to the lack of farm machinery and the associated skills for application in agriculture. The country lacked the capacity to mass produce agricultural machines and mechanically powered prime movers to propel the growth of agriculture. There was only one institution in the country, Allahabad Agriculture Institute, that offered a degree course in Agricultural Engineering. Subsequent establishment of universities and IITs brought the discipline in focus by initiating agricultural engineering programmes in collaboration with a few American universities.

The green revolution of the sixties and seventies, therefore, was centred around improvement of genetic make-up of the target crops by way of introducing high-yielding varieties together with the intensified application of inputs, i.e., chemical fertilizers, irrigation, synthetic pesticides and insecticides. The resultant increase in agricultural production made India self-sufficient in the availability of food. However, higher food production coupled with poor transportation and storage facilities created the problem of plenty. The absence of engineering interventions in terms of appropriate machinery accentuated the problems leading to the second-generation issues of soil health, contamination of water resources, pollution, and intolerable pesticide residue levels in the produce.

Looking back, if agricultural mechanization inputs were available together with the improved genetic material, the synergistic impact of the green revolution would have been multi-fold in terms of productivity, profitability and sustainability. Realising the importance of agricultural machinery, a considerable time was lost in deciding the level of mechanization that should be pursued. It was only some three decades ago that agricultural mechanization in India was realized to be not acceptable as long as cheap human labour was available. Moreover, since majority of land holdings were less than 2 ha, individual ownership of farm machines was considered too expensive and hence not feasible.

Two major developments

Two important developments two decades ago brought the inevitability of agricultural mechanization in sharp focus. The cheap labour syndrome melted away with the promulgation of Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA). Almost overnight, the migrant labour vanished and the need for machines was found essential. It was around the same time that an alternative to individual ownership of farm machines was found in the form of custom-hiring.

In view of the essentiality of farm mechanization, Ministry of Agriculture and Farmers Welfare, Government of India launched for the first time a Sub Mission on Agricultural Mechanization (SMAM) in the year 2014-15 for nation-wide promotion of farm mechanization with a view to enhance crop productivities, reduce inputs, reduce postharvest losses, and add value to the agricultural produce leading to higher farmers' income.

The most important impact of SMAM has been the saving in time to complete farm operations in a season to use the spare time for increasing the area under cultivation if available. Custom hiring centres have been observed to benefit the client farmers by way of 10-20% saving in inputs, 25-30% reduction in the cost of production, 15-25% increase in production, and 25-40% increase in gross income of farmers. The application of machines has reduced the human drudgery significantly, an important step in attracting youth to agriculture.

The significance of SMAM

It is estimated that the SMAM has impacted about 5 M ha of cultivated area so far. However, the SMAM needs to be strengthened and expanded considerably to the level of a National Mission on Agricultural Mechanization (IMAM) for benefitting the whole of 140 M ha of net cultivated area in the country. Progress in case of Agro-processing centres has been dismal. Processing and value addition of farm produce needs to be accorded high priority to facilitate reduction in post-harvest losses and better price realization for farmers' produce and increase in their income.

The most commonly known mechanization interventions have been farm-machinery, energy and power management, irrigation pumps, soil and water conservation structures, food storage structures, material handling machinery, value addition to agricultural produce in production catchments, and byproducts utilization. Controlled environment agriculture systems, biosensors and digital systems for measurement, monitoring, and control applications, unmanned ground and aerial vehicles, and AI based autonomous machines are recent technological interventions that have the power of transforming the agriculture from a vocation full of drudgery to blue- and white-collar occupations. The decade starting from now must focus on facilitating a quantum jump in our efforts for harnessing the potential of engineering interventions in agriculture in terms of enhancing agricultural productivity, production, profitability, and sustainability.

Huge possibilities

In 2023, the agricultural machinery market in India was valued at USD 13 billion and is expected to reach USD 19,5 billion by FY 2029, growing at about 6 % (CAGR) over the 2024 - 2029 period. Interestingly, the annual investment in agricultural machinery in India is close to 25% of the total farm subsidies of USD 50 billion given by the Government. Fertilizer and power absorb 45.6% and 30% of all input subsidies, respectively, while irrigation, credit, and crop insurance get 16.4%, 5.07%, and 2.69%, respectively. The growth is attributed to factors such as education, research, infrastructure development, industrialization of agriculture, advancements in crop science, and rural labour scarcity.

In conclusion, agricultural mechanization presents huge possibilities in reducing the cost of cultivation, increasing the profitability, reducing the human drudgery in agricultural operations, and improving the rural and urban life leading to sustainability.

Biofloc Technology

Revolutionizing Aquaculture Practices

Biofloc technology (BFT) has emerged as a transformative approach in sustainable aquaculture, revolutionizing traditional practices by promoting efficient waste recycling, improving water quality, and enhancing productivity. This innovative system relies on the cultivation of microorganisms, primarily bacteria, algae, and protozoa, which form bioflocs in aquaculture ponds. These bioflocs serve as a natural food source for cultured species, reducing the need for external feed inputs and minimizing the environmental impact of aquaculture operations. By maintaining a balanced microbial community, BFT helps in the bioremediation of organic waste, particularly nitrogen compounds, thereby improving water quality and reducing the need for water exchange. This technology offers numerous benefits, including improved growth rates, enhanced disease resistance, and increased survival rates of aquaculture species, especially in intensive farming conditions. Furthermore, BFT supports a more sustainable model of aquaculture by decreasing reliance on traditional feed, lowering operating costs, and contributing to the circular economy. This review explores the fundamental principles of biofloc technology, its applications across different aquaculture systems, and its potential for global adoption as a means to address the challenges of food security, resource sustainability, and environmental protection in aquaculture.

Rapidly Growing Sector

Aquaculture has become one of the fastest-growing sectors in global food production, driven by the increasing demand for fish and seafood. However, traditional aquaculture practices face numerous challenges, including environmental pollution, high feed costs, and limited water resources. In response to these challenges, Biofloc Technology (BFT) has emerged as a groundbreaking approach that not only addresses the sustainability issues but also enhances the productivity of aquaculture systems. BFT utilizes the concept of recycling organic waste within aquaculture ponds, where microorganisms-such as bacteria, algae, and protozoa—form aggregates known as bioflocs.

These bioflocs act as both a natural feed source and a mechanism for improving water quality by reducing nitrogen levels and other waste products. As a result, BFT reduces the need for external feed inputs, minimizes water exchange, and lowers the environmental footprint of aquaculture operations. This introduction provides an overview of the principles of biofloc technology, its advantages over traditional aquaculture practices, and its growing application in diverse aquaculture systems worldwide. With its potential to enhance food security, promote sustainable farming practices, and mitigate environmental impacts, BFT stands at the forefront of revolutionizing the aquaculture industry.

What is biofloc technology?

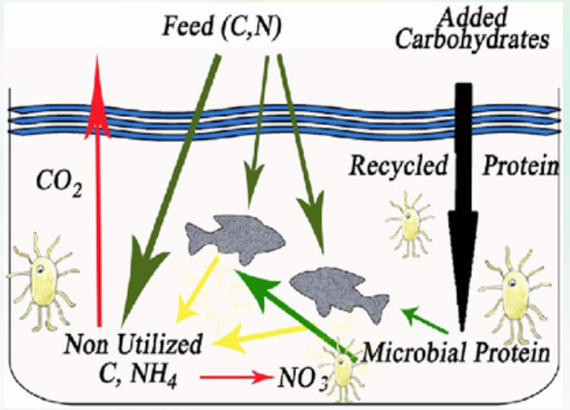
Biofloc Technology is an innovative method for aquaculture that involves the cultivation of microbial communities within the water system. These microbial aggregates, known as "bioflocs," consist of bacteria, algae, protozoa, and other microorganisms. By maintaining a controlled environment, these microbes metabolize waste products such as ammonia, converting them into protein-rich biomass that serves as a natural feed source for aquatic organisms.

This technology eliminates the need for regular water exchange, reduces feed costs, and minimizes environmental pollution. With global seafood demand increasing, BFT offers an efficient alternative to traditional aquaculture methods, ensuring sustainable and profitable production.

Principles of biofloc technology

The core principle of BFT revolves around managing the carbon-to-nitrogen (C:N) ratio in the water. By adding a carbon source (e.g., molasses or rice bran) to the system, heterotrophic bacteria are encouraged to grow and assimilate nitrogenous waste. This process occurs as follows:

- ✓ **Addition of carbon source:** When a carbon source is added to the aquaculture water, it stimulates the growth of heterotrophic bacteria. These bacteria utilize the added carbon along with nitrogen present in the water (mainly from fish excreta and uneaten feed) for their metabolism and reproduction.
- ✓ **Assimilation of nitrogenous waste:** Heterotrophic bacteria assimilate ammonia, a toxic byproduct of fish metabolism, into their cellular structure. This not only reduces ammonia toxicity but also prevents its accumulation in the water, thereby maintaining water quality.
- ✓ **Formation of bioflocs:** The bacterial growth results in the aggregation of microbial communities into flocs. These bioflocs are rich in proteins, fats, and other essential nutrients.
- ✓ **Natural feed supplementation:** The bioflocs, being nutrient-dense, serve as a natural feed source for aquatic organisms. Fish and shrimp consume these flocs, reducing their dependency on expensive commercial feeds and improving their growth and health.



- ✓ **Maintenance of water quality:** The continuous activity of microbial communities ensures the recycling of waste materials, stabilizing water parameters such as pH, dissolved oxygen, and nitrogen levels. This creates a balanced ecosystem within the aquaculture system.

Applications of biofloc technology

BFT has proven successful across various aquaculture sectors, such as:

- ✓ **Fish farming:** Species like tilapia, carp, and catfish benefit significantly from biofloc systems. These species effectively consume bioflocs, reducing their reliance on expensive commercial feeds and improving growth rates.
- ✓ **Shrimp farming:** Biofloc systems have revolutionized shrimp farming by improving water quality and reducing the risk of diseases like white spot syndrome. Shrimp grow faster in biofloc systems, yielding higher production.
- ✓ **Marine species cultivation:** In marine aquaculture, bioflocs are used for species like seabass and groupers, enabling high-density farming without the need for frequent water exchange.
- ✓ **Ornamental fish production:** Biofloc systems are employed for ornamental fish to ensure vibrant coloration and robust health, which are critical for market demand.
- ✓ **Integrated systems:** BFT can be integrated with aquaponics, combining fish farming with plant production. The biofloc-enriched water provides essential nutrients to plants, creating a self-sustaining system.

Implementation of biofloc systems

> SPECIES LIKE TILAPIA, CARP, AND CATFISH BENEFIT SIGNIFICANTLY FROM BIOFLOC SYSTEMS

Establishing a biofloc system requires careful planning and monitoring to ensure success. Below are the essential steps:

- ✓ **Selection of aquatic species:** The species selected must be adaptable to biofloc environments. Common species include tilapia, catfish, and shrimp, as they can utilize bioflocs efficiently for nutrition and thrive in a controlled environment.
- ✓ **Tank design and aeration:** Proper tank design with a robust aeration system is critical. Aeration facilitates oxygen supply, ensures the continuous movement of bioflocs, and prevents sedimentation. Aerators or diffused air systems are commonly employed.
- ✓ **Carbon source addition:** Maintaining the optimal C:N ratio (generally 10:1) is achieved by adding carbon sources like molasses or wheat bran. The type and quantity of carbon depend on the species and system size.
- ✓ **Water quality monitoring:** Consistent monitoring of key parameters is vital. Measurements of dissolved oxygen, ammonia, nitrite, and pH levels help maintain system stability and prevent harmful buildups. Automated monitoring systems can improve efficiency.
- ✓ **Light and temperature control:** For optimal microbial and aquatic growth, ensure the tank receives sufficient light (for algae and microbes) and maintain a stable temperature suitable for the species being cultured.

Challenges and limitations

While BFT offers numerous advantages, there are challenges:

- ✓ **Initial investment:** Setting up a biofloc system requires capital for tanks, aeration equipment, and monitoring systems. Small-scale farmers may find this cost-prohibitive.
- ✓ **Skill requirements:** Proper management of C:N ratios, water quality, and aeration demands skilled operators. Training programs are essential to bridge this gap.
- ✓ **Energy consumption:** Continuous aeration and monitoring consume significant energy, increasing operational costs.
- ✓ **Species-specific needs:** Not all aquatic species can adapt to biofloc systems. Careful selection and trial-based implementation are necessary.

Future prospects of biofloc technology

The future of BFT lies in its integration with smart technologies and renewable energy. Automation in monitoring and management, combined with solar or wind-powered aeration systems, can significantly reduce operational costs. Additionally, combining BFT with aquaponics and biogas production can enhance resource efficiency.

Moreover, research is being conducted to expand the applicability of BFT to new species and environments, including freshwater and saline systems. By addressing current limitations, biofloc technology has the potential to transform global aquaculture into a more sustainable and resilient industry.

Conclusion

Biofloc Technology represents a paradigm shift in aquaculture practices. By transforming waste into a valuable resource, this innovative approach enhances productivity and sustainability. As the global demand for seafood rises, adopting BFT can help meet this demand while reducing environmental impacts. For aquaculture practitioners, biofloc technology is not merely a tool but a pathway to a sustainable and profitable future.

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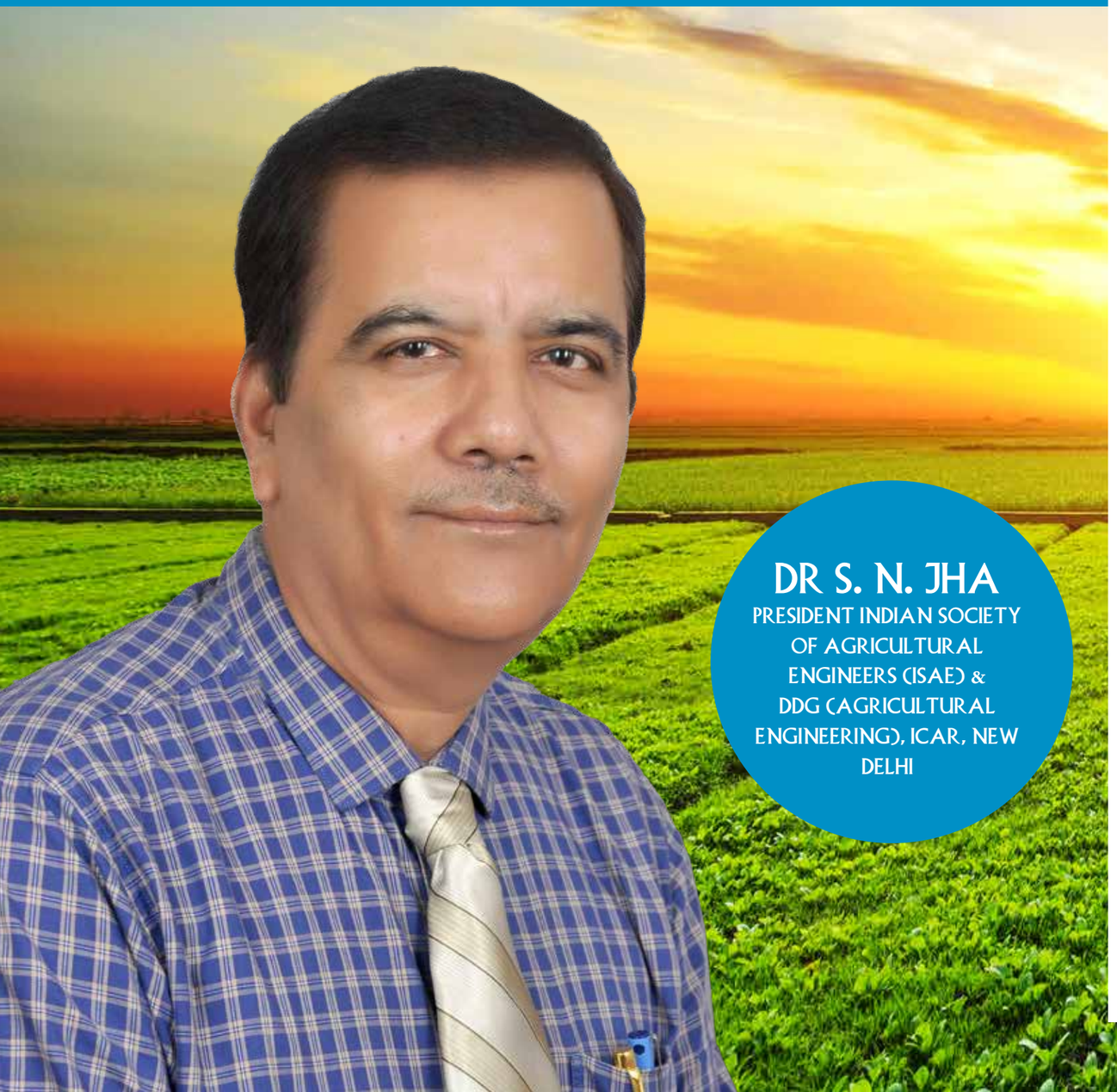
IMPACT OF AGRICULTURAL ENGINEERING RESEARCH ON INDIAN AGRICULTURE AND BEYOND



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Agricultural Engineering is providing the speed and scale to the Indian Agriculture as the luxury of putting more area under cultivation is drying up. Increasing the per unit land and labour productivity in the realm of over 69% of marginal farmers with less than one-hectare land and continuously declining land holdings pushed more than 86% farmers to small and marginal farmers' categories. According to a third-party report submitted to Department of Agriculture and Farmers' Welfare, Government of India, mechanization saves 15% – 20% seeds, fertilizers and 20%-30% time, increases germination by about 25 %, reduces weeds and labour about 20%-40% and enhances cropping intensity by 5%-10% and yield 13% -23%. This means mechanization is a sure shot way to mitigate the challenges being faced by the Indian Agriculture.

Recognizing these facts and essentiality, the 58th Parliament Standing committee on Agriculture, Animal Husbandry, fishery and Food processing has given targets of increasing the average mechanization level of the Indian Agriculture from current 47% to 75% by 2047 and recommended to open Directorate/department of Agricultural Engineering in each states employing Agricultural Engineers in district, block and Panchayat levels in sufficient numbers.

Agricultural Engineering technologies have played a pivotal role in Indian Agriculture. Imagine if a wheat threshers and proper irrigation pumps would not have been available during the green evolution period and combine harvester during COVID-19 period for harvesting of wheat. Irrigation without pump, harvesting without combine harvester when all labour forces are off the farm, and threshing of wheat without threshers could have been impacted badly in production and post-production operations of Indian Agriculture. India is now the highest producer of quality tractors and net exporters of farm machinery (Fig. 1) including tractors and ginning machinery to the tune of about Rs 12000 and Rs. 300 crores, respectively, per year. Impact study of only a few machineries, tools and gadgets indicates economic gains of about Rs. 7210 crores annually besides social intangible gains like easing of operations, improving comfort, health benefits, and allied income of stakeholders.

To minimize the wastage of water in agriculture sector, the scientific methods of water application systems such as micro-irrigation is the game changer for better on-farm water management practices. Standardized irrigation and fertigation schedules using drip irrigation have showed promising outcomes with 9-80% higher yield, 11%-71% irrigation water saving, 18%-25% fertilizer saving and 10-200% higher income from various crops grown under varying soil textural classes across the country. The average penetration rate of micro-irrigation in India is about 19%. As of 2023, the area under micro-irrigation in India is approximately 83.46 lakh hectares, covered under the Per Drop More Crop (PDMC) scheme.

During the last five years, about 70,000 ha waterlogged saline soils have been reclaimed in different states of India through subsurface drainage technology. This has resulted in 25%-100% improvement in cropping intensity and significant enhancement in crop yields (upto 45% in paddy, 111% in wheat and 215% in cotton). Recent development of check dams using rubber and fibre reinforced plastic (FRP) are in deploying stage and may change the scenario of water conservation and land degradation in plains and hilly regions respectively.

ICAR flexible check dam (rubber dam), an inflatable structure build across a stream, has the ability for better water conservation, flood control and regulating flow of water in the stream and has been successful in watersheds in different parts of the country. Participatory integrated watershed management approaches covering biophysical and socio-economic interventions have shown rich dividends for ensuring resilience to climate change.

A well-managed watershed supports human wellbeing by providing direct economic benefits (e.g., provisioning services such as food and fruits), as well as a host of indirect benefits, including regulatory, cultural, and supporting services. To have production of high value crops in harsh conditions, agricultural engineering research has contributed in the field of greenhouse/protected cultivation and it has covered 127000 hectares till 2018 and has given several standardised design of structure for all parts of the country.

Renewable And Bio-Energy

On renewable and bio-energy front, contributions of Agricultural Engineers are visible at national level and Government of India therefore has made target to fulfil around 33% and 75% of India's and rural areas' energy needs respectively through solar, wind, geo-thermal, bio-mass energy. According to the Central Electricity Authority of India, about 50% of the country's power supply will be generated by renewable energy sources by 2030. Wider adaptation of biogas technologies has made biomass-based electricity generation systems and bio-CNG plants operational in the country. Thermo-chemical and bio-chemical conversion based electrical power routes are available and there is a need to promote these with better incentives.

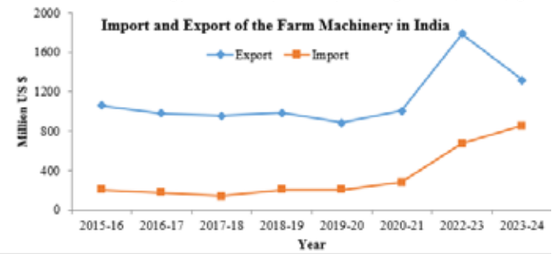

Fig. 1. Overall approximate import/export of farm machinery (including tractors) of India

Agricultural Engineers pioneered the concept of Agro-Processing Centers (APC) since 1980 in production catchments by providing technical guidance and monitoring. These APCs have an impact in terms of reduction of storage and processing losses, higher recovery,

cost saving, energy saving, timeliness of operation, premium price for better quality, maintaining hygienic conditions and improved comforts and social and economic wellbeing of different stakeholders. More than 300 such APCs have been established through explicit intervention of ICAR, each of which generates direct employment to 4-6 persons and average annual profit of about Rs. five lakhs. Successes of these APCs have played a key role in formulating several Government schemes.

Contributions of Agricultural Engineering

India is only country after USA to have its own calibration cotton as standard of cotton fibre and several value-added products and machinery for other natural fibres and those are testament contributions of Agricultural Engineering research in India. Quantity of Post-harvest losses of foods have decreased from about 74.11 million tonne in 2012 to 66.48 million tonnes in 2021 (accounting for 54 commodities) and thereby saving of 7.63 million tonnes of foods due to adoption of post-harvest technological interventions and infrastructural development. PH loss study of 2012-13 reported monetary loss of ₹92,651 crores (about 11300 million USD) (for 65.4 million tonnes of 45 commodities only). With the premise that if the extent of losses recorded in 2012-13 would have continued, the value loss estimated would have been ₹1,66,593.72 crores (about 2030 million USD) in 2021-22. However, study by NABCON in 2021-22 estimated the monetary loss of ₹1,46,153.15 crores (about 17820 million USD) for 45 crops covered under 2012-13 study. The difference of monetary losses of 45 commodities resulted in savings of ₹20,440.58 crores (about 2493 USD). In addition, adoption of CAR recommendations for uniform norms for loss calculation in FCI and CWC godowns (One nation one norms) about Rs. 540 crores (about 660 million USD) is being saved annually to FCI and CWC combined.

The contributions of Agricultural Engineering on on-farm and off-farm mechanization have been unparalleled and have added value in food, feed, fodder, fibre, natural resins and gums. Some important contributions which have impacted indelibly include a mass scale adoption of rotavator, laser guided land levellers (Fig. 2), zero till drill, paddy drum-seeder, seed-cum-fertilizer drills, inclined plate planters, micro-irrigation systems, combine harvesters, threshers, mini dal mill, maize sheller, makhana popping machine, accelerated jute retting system, diversified jute products, cotton ginning technology, small and medium lac processing plants, non-destructive diagnostic tools and methods for fruits and vegetables etc. In fact, use of sensors, big data analysis, infrared spectroscopy, artificial intelligence etc. are the pioneering contributions of Agricultural Engineers in in Indian Agriculture, which now are the words of mouth of every researcher. Agricultural Engineering Research has improved the socio-economic status of populations many folds as compared to other fields of research and is driving force of Indian Agriculture and Agriculture based startups. Agricultural Engineering education, research and extension needs need primary focus for giving further speed and scale to Indian Agriculture.

Fig. 2. Laser land leveller

> AGRICULTURAL ENGINEERING RESEARCH HAS IMPROVED THE SOCIO-ECONOMIC STATUS OF POPULATIONS MANY FOLDS AS COMPARED TO OTHER FIELDS OF RESEARCH AND IS DRIVING FORCE OF INDIAN AGRICULTURE AND AGRICULTURE-BASED STARTUPS

Sajeevan Spearheads Organic Certification and Natural Farming in Gujarat

In a significant move towards sustainable agriculture, Sajeevan is collaborating with the Government of Gujarat to certify 13,500 farmers from Dang district as organic farmers. Dang, the first district in Gujarat to be declared fully organic, has seen its farmers adopt natural farming methods under the guidance of Governor Sh. Acharya Devvratji. This initiative aligns with the state's broader vision of promoting natural farming practices.

Key Initiatives by Sajeevan:

Organic Certification in Dang District: Sajeevan is working closely with the government to ensure that farmers in Dang district receive organic certification. This certification not only validates their farming practices but also opens up new market opportunities for their produce.

Collaboration with Banas Dairy and Banaskantha District: In addition to Dang, Sajeevan is partnering with Banas Dairy and the district collector of Banaskantha to certify 6,000 farmers practicing natural farming. This collaboration underscores the organization's commitment to expanding sustainable agriculture across Gujarat.

Formation of Natural Farming FPCs: Under the 10,000 FPO scheme of the Government of India, Sajeevan has established 25 natural farming Farmer Producer Companies (FPCs) in Gujarat. These FPCs are successfully managing their own businesses related to natural farming products, contributing to the local economy and promoting sustainable agriculture practices.

Sajeevan's Impact and Growth Potential

Sajeevan's growth is driven by the increasing demand for organic food, sustainable agriculture, and eco-friendly solutions. The organization offers a diverse range of products, including chemical-free groceries, nutritious snacks, Ayurvedic wellness formulations, biochar for carbon sequestration, and biofertilizers to enhance soil health. By supporting farmers and promoting sustainable practices, Sajeevan is poised to make a significant impact on both the environment and local livelihoods.

Woman Farmer Nituben Patel Crowned as 'Richest Farmer of India' at MFOI Awards 2024

Nituben Patel, a farmer from Gujarat's Rajkot district, has made history by being crowned the 'Richest Farmer of India' at the Millionaire Farmer of India (MFOI) Awards 2024. This monumental achievement celebrates her groundbreaking work in sustainable agriculture and her unwavering commitment to empowering women in a traditionally male-dominated field.

Nituben's success story is a powerful example of how women are shaping the future of Indian agriculture. From her humble beginnings to becoming an icon of innovation and leadership, Nituben's journey is evidence to the transformative power of determination and vision.

Transforming Agriculture with Natural Farming

Nituben's farming philosophy is deeply rooted in natural and sustainable practices. Inspired by her mentor, the late Shri Dipakbhai Sachade, she adopted innovative techniques like Amrut Krushi and Magical Mitti. These methods focus on converting agricultural waste into valuable resources, improving soil health, and enhancing crop productivity. Her commitment to organic farming has not only boosted yields but also set an example for farmers across India to adopt eco-friendly practices.

A Visionary Leader in the Farming Community

As the leader of the Sajeevan Foundation, Nituben has been at the forefront of driving agricultural transformation in Gujarat. In an extraordinary feat, her foundation facilitated the registration of 84 Farmer Producer Organizations (FPOs) within just 45 days, creating new opportunities for farmers to connect with government initiatives and improve their livelihoods.

Nituben also pioneered a Farm-to-Plate model in Rajkot, ensuring that farmers receive fair prices while consumers enjoy fresh, organic produce. Additionally, she introduced an Internal Cluster System (ICS) in collaboration with the Gujarat government, which has significantly reduced production costs and improved traceability for farmers. Government of Gujarat and Sajeevan has transformed 13500 farmers of Dang in Organic certified farmers.

Her efforts have not only elevated Gujarat as a leader in natural farming but have also inspired countless farmers to embrace sustainable practices, earning her recognition on both national and international stages.

A Historic Milestone in Women's Empowerment

Nituben's achievement as the 'Richest Farmer of India' marks a turning point for women in agriculture. Her success serves as a beacon of hope and empowerment, showing women that they too can excel in fields traditionally dominated by men. Her work has become a rallying cry for equality, resilience, and innovation in the agricultural sector.

Recognizing Excellence

The MFOI Awards, organized by the Krishi Jagran Group, aim to honor the unsung heroes of Indian agriculture. By spotlighting extraordinary individuals like Nituben Patel, the awards highlight the pivotal role of farmers in shaping the future of the nation.

Leading a New Era in Agriculture

Nituben Patel's journey is more than an individual success story—it's a movement that is redefining Indian agriculture. Her leadership, dedication, and innovative spirit are paving the way for a brighter, more inclusive future in farming. As she continues to inspire farmers across India, Nituben has firmly established herself as a symbol of progress and hope in the agricultural world.

IoT Based Smart Irrigation Systems for Enhancing Water Use Efficiency

Agriculture consumes more than 60% of the fresh water available for irrigation. With the increasing pressure on available arable land and water resources, plant stress alleviation and avoidance has gained momentum in last decade. Traditional irrigation methods with low application efficiency and higher losses (evaporation, seepage and percolation) are aggravating issue with limited water availability.

To mitigate this, farmers should use the minimum amount of water required to meet their yield goals and ensure adequate water supply for future generations. Different irrigation scheduling techniques, such as evapotranspiration and water balance, soil moisture condition, and plant water condition techniques, have been used through smart irrigation management. The ET-based irrigation techniques rely heavily on assessing local climate data. ET-based irrigation techniques rely on crop coefficients that are individual to each location and can be incorrect.

With computed ET-based scheduling systems, cumulative mistakes might arise, which is why field-based measurements are typically required to rectify error. Soil moisture sensor-based irrigation have limitations of spatial variability, accuracy and precision of sensor based on method of measurement, installation and calibration errors. A combination of irrigation scheduling measures promotes crop irrigation scheduling and reduces water wastage. In a few studies, evapotranspiration (ET), soil moisture sensors, or plant-based smart irrigation technologies have been used to schedule irrigation events by considering the weather, soil moisture conditions, and plant water status. In recent years, agriculture has experienced a fourth evolution (Agriculture 4.0) as information and communication technology (ICT) has been merged with traditional agricultural techniques.

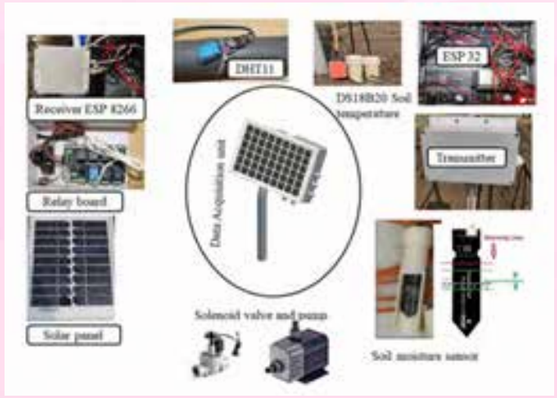

Fig. 1 Components of IoT based irrigation system

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Precision Irrigation

In precision irrigation, water is applied to a crop's root zone at the right time, amount, and place using an effective method. A precision irrigation system increases crop productivity and water use efficiency (WUE) at a lower energy cost per irrigation. Wired and wireless smart drip irrigation systems with soil moisture sensors can apply a precise amount of water to the right place at the right time. This can be done by using smart strategies to improve precision. The smart irrigation monitoring drip systems are very effective techniques to determine how much water needs to be applied based on the amount of water lost by the plant. A precisely planned irrigation system can maximize water use efficiency (WUE). Wireless sensor networks (WSNs) can improve real-time database monitoring. Installing sensors near the top of the active root system is critical for optimizing precision irrigation and irrigation scheduling

IoT-based smart irrigation technology measures soil moisture in the root zone of plants, which is decomposed by plant roots at an evaporation rate until a wilting point is reached. Soil moisture sensors can determine the timing of irrigation and irrigation stops in real-time. The amount and timing of irrigation can be estimated based on available soil moisture. It is a simple method and can be automated with commercially available systems. Earlier, agricultural monitoring systems deployed wired data acquisition systems, in which wires connected the sensor units for monitoring. Due to the limited wiring connection range, such systems had a limited deployment size for monitoring points. Further, strengthening these systems require extensive cabling, which leads to high installation and maintenance costs. Further they had high risk of physical damage due to weather and outdoor conditions.

AI/IoT based irrigation ensures precise water management by monitoring soil moisture, weather, and plant needs in real-time. It enhances resource efficiency by accurately assessing soil moisture and environmental conditions, minimizing wastage. Automated systems adjust watering schedules based on crop growth stages, improving yield and produce quality. Remote monitoring via Smartphone's / computers enables timely adjustments, reducing manual work. Data-driven insights from AI algorithms inform decisions on crop health, soil, and water usage. Climate adaptation features adjust irrigation to changing weather conditions, ensuring adequate water supply. Overall, these systems optimize water usage, reduce labour, and boost crop productivity, yielding significant long-term cost savings.

Intelligent Irrigation Systems

The intelligent irrigation systems consist of a soil moisture sensors and temperature sensor installed at the effective root zone of a specific crop in undisturbed soil. It also consists of a micro sprinkler irrigation system, irrigation pump and electric solenoid valve in farmland fields using WSN, supported by communication technologies. The soil moisture data collected from soil moisture sensor and connected to IoT cloud platform for storage. The soil moisture characteristic curve was prepared threshold values were designed based on field capacity and wilting point. Based on soil moisture threshold and prediction of rainfall, the system shall actuate pump and valve for irrigation.

A developed hardware set up to measure soil moisture consisted soil moisture sensor interfaced with the Wi-Fi module. On Thingspeak cloud, the IoT data transfer protocol was implemented for receiving the weather and soil and soil moisture data. Raspberry Pi was used as a micro controller for IoT based intelligent irrigation system. Micro controller collects real-time weather data from weather website (https://weather.com) and sends it to cloud server.

Micro controller based on weather data and soil moisture data from ThingSpeak platform, actuates relays for pump operation. The developed system was evaluated in wheat, pea and maize crops. In Maize, IoT based irrigation system improved yield by 10-12% with water savings up to 12-24% compared to ET based irrigation. In pea, significantly higher yields were observed under 50% of maximum allowable depletion level irrigation threshold with saving of 10% of irrigation water. Similar results were also recorded for wheat grain yield with 8-20% water savings with IoT compared to ET based irrigation.

> **AI/IoT based irrigation ensures precise water management by monitoring soil moisture, weather, and plant needs in real-time**

Fig. 2 IoT based irrigation system

Brown Revolution

Learning from Sri Lanka's Organic Crisis

In 2021, Sri Lanka faced a self-inflicted crisis from its abrupt nationwide transition to organic agriculture. President Gotabaya Rajapaksa's administration banned synthetic fertilisers and pesticides without preparation, leading to declining crop yields, price surges, economic losses, and food insecurity. This event has been misused by the advocates of synthetic fertiliser to side-line the core issues.

Let's examine the failure's root causes, consequences, and lessons for Indian Agriculture.

Reasons for failure:

Inadequate Supply of Organic Inputs: The government failed to boost domestic production of organic inputs. A USDA report highlighted Sri Lanka's inability to meet organic fertiliser demand.

A major controversy occurred when Sri Lanka rejected a shipment of organic fertilizer from China's Qingdao Seawin Biotech Group due to contamination.

Lack of Farmer Knowledge: Only 20% of farmers knew about organic production, and 63% received no guidance. Farmers lacked skills and understanding of organic farming methods.

Increased Costs: 80% of farmers were forced to source conventional pesticides through unofficial channels at inflated prices, introducing substandard chemicals into the agricultural system.

Impact of COVID: Sri Lanka's tourism sector, historically contributing 14% of foreign earnings, generated only $615 million in 2021, recovering to $3.17 billion by December 2024. This collapse depleted foreign exchange reserves, preventing banks from issuing letters of credit for fertiliser imports.

Unrealistic Expectations: Expecting the same production without inputs was unrealistic. In November 2021, the government partially lifted the ban on key export crops.

Impacts:

Decreased Production: Domestic rice production fell by 20% within six months, and by 40% in the main harvest. Sri Lanka imported $450 million worth of rice. Tea exports were devastated, and overall food production decreased 40-50%.

Economic Impact: Tea production losses were estimated at $425 million. The government spent $200 million in direct compensation and $149 million in price subsidies, nearly equal to the fertiliser subsidy savings.

Trade Imbalance: Fertilizer imports decreased by 99%, while exports of fertilizer-dependent produce fell by 33%. Revenue losses outstripped savings from fertiliser import reductions.

Food Security: Reduced yields and increased imports worsened the foreign currency shortage.

India provided approximately $4 billion in financial assistance to Sri Lanka in 2022, helping sustain essential imports and avoid defaults.

Lessons from the disaster:

Hindsight is 20/20; let's learn from the Sri Lankan fiasco and not blame organic cultivation. The problem was implementation, so instead of an abrupt change, a phased approach must be adopted. This includes consultations, research, capacity building, creating value chains of organic farm inputs and produce, and developing market linkages.

Agriculture is fundamentally about plants converting sunlight, minerals, and biological processes into food. The divisions between organic, natural, regenerative, and chemical farming are industry constructs that have disrupted natural nutrient cycles.

These artificial divisions have interfered with natural environmental-soil-plant relationships. The indiscriminate use of chemicals for plant nutrition and protection has disrupted ecological balance. Following World War II, facilities that produced nitrogen for bombs were repurposed for agricultural fertilisers, marking a significant shift in farming practices.

The plant root system absorbs nutrients through complex processes. Organic, natural, and regenerative agricultural approaches focus on increasing soil carbon content to restore microbial populations that facilitate natural nutrient cycling. These methods also aim to improve soil structure for better aeration and water retention capacity. The excessive use of chemical inputs has significantly damaged these natural soil systems.

The carbon content in Indian soil has reached critically low levels, often just 0.3% or below. This diminished carbon has led to poor absorption of chemical nutrients due to depleted microbial populations—a situation that didn't exist decades ago.

Government policy should prioritize increasing soil carbon content rather than subsidizing urea to appease farmers, as this approach damages ecosystems and agricultural systems. Even advocates of chemical fertilizers must acknowledge carbon's crucial role.

> "THE INDISCRIMINATE USE OF CHEMICALS FOR PLANT NUTRITION AND PROTECTION HAS DISRUPTED ECOLOGICAL BALANCE"

The fertiliser industry has created artificial market categories for nutrients (primary, secondary, and micronutrients), yet no one sells the carbon, oxygen, and hydrogen that plants require in greater quantities than all other nutrients combined.

Brown Revolution: Link between Green & White Revolution

Can government subsidies effectively change farmers' behavioural patterns towards adopting sustainable agricultural practices, such as those promoted by schemes like PKVY, MOVCDNAR, CISS, NPOF and NMNF, which aim to enhance soil carbon content? These schemes are the monkey's business.

The Fertiliser (Control) Order of 1985, through Schedule IV, acknowledges industrial waste products as potential organic fertilisers. However, fertiliser regulation falls under the Ministry of Chemicals & Fertilizers, which tends to favour chemical inputs and neglects soil health complexity.

Municipal solid waste, a major Urban Development Ministry challenge, is now being redirected to agricultural lands as fertiliser. Before promoting widespread organic cultivation, we must redefine fertiliser itself. A genuine fertiliser should both supply plant nutrients and enhance the soil ecosystem's overall health and regenerative capacity.

Understanding Soil Carbon Depletion

Soil carbon depletion has become critical, largely resulting from intensive agricultural practices that remove carbon without replacement. Carbon-rich straw, instead of being incorporated back into the soil, is commonly burned, releasing CO_2 into the atmosphere. Simultaneously, the dairy industry generates substantial amounts of cow urine and dung—valuable sources of carbon and plant nutrients—which are often discarded, exacerbating global warming.

Re-linking Agriculture and Dairy

Historically, agriculture and dairy have been intertwined, but this connection has been disrupted. Both government and industry efforts must focus on re-establishing this link.

Impact on the Dairy Industry

In the dairy industry, only dairy cows receive proper nourishment while other cattle are neglected. If farmers could generate income from cow by-products like urine and dung, they would manage their cattle better, reducing stray animal populations. This approach could substantially reduce milk production costs, making Indian dairy more globally competitive.

Consider a cow producing daily outputs of 5 litres of milk, 7 litres of urine, and 10 kg of dung. At conservative estimates of Rs 50/L for milk, Rs 10/L for urine, and Rs 5/kg for dung, this creates significant revenue potential. Importantly, urine and dung production continues throughout the animal's entire lifespan, unlike milk.

Innovative Solutions (Technology Provider)

Companies are pioneering the conversion of cow dung and urine into effective fertilisers and pesticides. Currently, aged cattle typically end up in government-funded gaushalas (or slaughterhouses), with the government providing a daily subsidy of Rs 50 per animal. By utilising these by-products commercially, the government could eliminate these expenditures, making gaushalas self-sustainable.

Market Potential & Value Proposition

India's cattle population stands at approximately 308 million as of the 2023 census, representing enormous commercial potential for value-added urine and dung products.

The National Dairy Development Board (NDDB) has effectively organised the dairy sector through cooperative societies. These cooperatives could form partnerships with technology providers to transform dairy waste into valuable products. For distribution channels, they could collaborate with fertiliser marketing cooperatives like IFFCO and Kribhco. This approach would benefit both dairy and agricultural farmers while highlighting the importance of realigning dairy and farming practices to combat global warming. This will inculcate the habit and preparedness for organic farming.

Double production is not necessary to double a farmer's income. Instead, this can be achieved by reducing the cost of cultivation or developing additional revenue streams from other available rural resources. Decentralising large fertiliser companies into smaller, rural fertilizer-producing units located in Gaushalas (cow shelters) is essential to creating a circular economy.

I appreciate companies like Zydex and Biotricks for their work promoting cow dung manure and value-added urine derivatives as agricultural inputs. These initiatives deserve greater government and scientific community support. Krishi Jagaran's efforts to elevate this discussion nationally and frame it as natural, organic, and profitable agriculture that transcends conventional agricultural categories are commendable.

Mother Earth's health is paramount; its vitality is essential for organic agriculture and our health, prosperity, and ecological harmony.

Mr Ajay Bhartiya
Commercial Head, Oceana Minerals, Brazil

Advancements in Agricultural Engineering

Transforming Indian Agriculture for a Sustainable Future

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Agricultural engineering research in India has become the backbone of a transformative journey that intertwines traditional practices with modern technologies to create a resilient, efficient, and sustainable agrarian ecosystem. The evolution of Indian agriculture has moved beyond simply increasing yields; it now encompasses precision resource management, climate adaptation, and technological integration to ensure long-term sustainability.

With India's population projected to reach 1.5 billion by 2030, food security, resource efficiency, and environmental resilience have become critical concerns.

The advancements in mechanization, precision irrigation, residue management, renewable energy integration, digital transformation, and post-harvest innovations are revolutionizing the industry. These developments not only enhance productivity but also optimize resource utilization, reduce environmental impact, and strengthen rural economies. Agricultural engineering plays a crucial role in modernizing farming practices, reducing labor intensity, improving water conservation, and minimizing post-harvest losses—factors that directly impact the livelihoods of millions of farmers. As India faces increasing challenges such as erratic monsoons, soil degradation, depleting groundwater resources, and labor shortages, agricultural engineering research is providing innovative solutions. Technologies such as AI-driven farm management, satellite-based monitoring, automated irrigation systems, and sustainable mechanization are ensuring that Indian agriculture remains resilient in the face of climate change.

Furthermore, the integration of renewable energy in farming operations, such as solar-powered irrigation and biogas production, is reducing dependence on fossil fuels and promoting sustainable practices. The impact of these advancements extends beyond individual farms to the national and global levels, contributing to India's commitment to sustainable development goals (SDGs) and its role in global food security. Public-private partnerships, government initiatives, and international collaborations are further accelerating research and innovation in agricultural engineering, making it a cornerstone for the future of Indian agriculture.

Role of Agricultural Engineering Research

Enhancing Farm Mechanization

Farm mechanization has significantly improved productivity by reducing labor dependency and enhancing operational efficiency. Advances in self-propelled combine harvesters, multi-crop threshers, and precision seeders have increased crop yields by 15-20% while reducing input costs by 25-30%. Technologies like laser land leveling have improved water application efficiency by 20-30% in states such as Punjab, Haryana, and Bihar.

Despite these advancements, India's mechanization level remains at 47%, lagging behind China (59.5%) and Brazil (75%). Government initiatives like the Sub-Mission on Agricultural Mechanization (SMAM), introduced in 2014-15, aim to bridge this gap. Custom hiring centers (CHCs) and low-cost machinery have democratized access to advanced agricultural equipment, reducing the drudgery of manual labor and enabling smallholder farmers to operate more efficiently.

Efficient Irrigation and Water Management

Agriculture consumes nearly 80% of India's freshwater resources, making efficient water management critical. Drip irrigation has improved water use efficiency by 30-50% in states like Maharashtra, Gujarat, and Karnataka. Similarly, sprinkler irrigation, widely adopted in Rajasthan and Madhya Pradesh, now covers 21-23% of irrigated land.

The Pradhan Mantri Krishi Sinchai Yojana (PMKSY) has helped expand micro-irrigation to 12.91 million hectares, increasing irrigation efficiency to 80-90% compared to 30-35% in conventional surface irrigation. Smart irrigation systems, equipped with IoT sensors and mobile apps, relay real-time data on soil moisture, weather forecasts, and crop water requirements, allowing farmers to schedule irrigation with pinpoint accuracy, conserving water and cutting input costs.

Initiatives like Telangana's Mission Kakatiya have rejuvenated ancient water harvesting techniques, restoring groundwater levels and promoting biodiversity.

Soil and Water Conservation

India faces severe soil erosion and land degradation, impacting over 120 million hectares of land. Conservation agriculture methods, such as zero tillage, contour farming, check dams, and percolation ponds, help mitigate these issues. Integrated watershed management practices have improved soil retention, particularly in rainfed areas of Rajasthan and Madhya Pradesh.

Soil health—a pillar of agricultural sustainability—has benefited from conservation tillage and mulching, which minimize erosion, boost organic matter, and improve nutrient cycling. The adoption of organic and bio-fertilizers has grown by 30% annually, reducing dependence on chemical inputs and improving soil health.

Post-Harvest Technologies and Value Addition

Post-harvest losses in India range between 10-15% (₹92,651 crores annually). Advanced storage solutions like Controlled Atmosphere (CA) storage, hermetic storage, and solar-powered cold storage units have significantly reduced spoilage, especially for perishable items like fruits and vegetables. Controlled Atmosphere storage alone has cut post-harvest losses by 50% in perishables.

Modernization of milling processes has improved efficiency: pulse milling efficiency has increased from 60% to 75%, and rice milling efficiency has risen from 65% to 75%, leading to better grain utilization and reduced waste. Improved transportation and packaging techniques further enhance market access and profitability for farmers.

Automated post-harvest technologies, such as solar-powered cold storage units and AI-powered grading systems, reduce post-harvest losses—estimated to be worth over ₹1.52 lakh crore annually—and ensure that a higher proportion of produce reaches the market in optimal condition, boosting farmer incomes and enhancing food security.

Digital Farming and Precision Agriculture

Digital transformation is expected to play a pivotal role in this revolution, as agricultural engineers deploy drones equipped with multispectral cameras to survey fields, monitor crop health, and identify pest infestations. IoT sensors integrated with mobile applications gather real-time data on soil moisture, nutrient levels, and weather conditions. AI-driven platforms analyze this data to provide tailored recommendations on irrigation scheduling, fertilizer application, and pest management.

The Government of India launched the Digital Agriculture Mission (2021–25) to integrate AI, blockchain, and big data analytics into farming practices. GPS-enabled tractors, drone-based crop monitoring, and soil health mapping help optimize resource use and improve decision-making, contributing to higher yields, lower input costs, and better sustainability.

Renewable Energy in Agriculture

India is advancing towards renewable energy adoption in agriculture through initiatives like the Kisan Urja Suraksha evam Utthaan Mahabhiyan (KUSUM) scheme, which aims to install 2 million solar pumps by 2025. Solar-powered irrigation, biomass energy, and wind energy help reduce dependence on fossil fuels, lowering carbon emissions and promoting sustainable agricultural practices.

Solar-powered irrigation systems are replacing diesel/electrical pumps in rural areas, reducing operational costs and carbon footprints. Biogas plants that process crop residues generate clean energy and reduce dependence on fossil fuels.

Climate-Resilient Agricultural Technologies

With climate change posing significant challenges to agricultural productivity, developing climate-resilient technologies is crucial. Conservation agriculture practices, such as zero tillage and the use of the Happy Seeder for paddy residue management, have reduced air pollution by 35-40% in northern India.

Future research should focus on AI-driven automation for smallholder farmers, scaling up IoT-based smart irrigation systems, developing bioengineered climate-resilient crops, and enhancing rural mechanization infrastructure.

Future Outlook and Challenges

Despite remarkable progress, challenges persist, including the high cost of implementing advanced technologies, fragmented land holdings, labor shortages, and the ongoing impact of climate change. The successful implementation of these solutions requires not only technological innovation but also robust support systems in the form of policy incentives, training programs, and financial assistance. The future holds exciting prospects, including the potential for green hydrogen production through renewable energy integration, AI-powered chatbots in regional languages to democratize access to expert advice, and climate-smart villages integrating solar microgrids and digital connectivity.

Agricultural Engineering Research

The impact of agricultural engineering research on Indian agriculture is a story of transformation—a journey from the Green Revolution to a future where technology, tradition, and sustainability converge to create a robust, equitable, and prosperous agrarian landscape. By leveraging technology and scientific advancements, India is poised for continued agricultural growth in the coming decades.

Agricultural engineering research will continue to play a pivotal role in reimagining farming practices, ensuring that the sector remains robust, adaptable, and capable of driving socio-economic growth across rural India. Sustained innovation and policy support will be essential to ensuring food security, reducing post-harvest losses, and achieving environmental sustainability.

Rethinking Biostimulant Regulations in India for making India profitable

Based on lessons from Sri Lanka and China

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BIOTRICKS BIOTECH,
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India stands at a crossroads in its agricultural journey, where the need for sustainable farming practices has never been more critical. With agriculture being a cornerstone of the nation's economy, supporting millions of livelihoods, the shift towards organic farming presents a significant opportunity to enhance food security, protect natural resources, and boost farmers' incomes. While chemical-intensive farming has boosted productivity, it has also led to soil degradation, water pollution, and declining nutrient efficiency. The push for organic and natural farming has gained momentum, but challenges remain. By drawing lessons from Sri Lanka's failed organic farming transition and China's fertilizer policies and integrating modern advancements such as Green Intelligent Fertilizers (GIFs) and rethinking Biostimulant reguations in India can carve a sustainable and profitable path forward.

Learning from Sri Lanka's Organic Farming Experience

India's shift towards organic farming must be guided by global experiences, particularly Sri Lanka's transition. Examining both the challenges and takeaways from Sri Lanka can help India craft a more pragmatic and structured approach to sustainable agriculture.

In 2021, Sri Lanka banned chemical fertilizers in a rapid transition to 100% organic farming. The abrupt shift led to significant declines in crop yields, food shortages, and economic distress. The key takeaways from Sri Lanka's experience include:

Gradual Transition: A sudden ban without adequate preparation disrupted production cycles.

Infrastructure and Inputs: Organic farming requires robust supply chains for natural fertilizers and biostimulants.

Scientific Integration: Traditional organic methods must be supported with scientific advancements for sustained productivity.

Economic Viability: Organic farming should be introduced in a manner that ensures profitability for farmers.

Lessons from China's Fertilizer Industry Transformation

China's success in implementing sustainable fertilizer policies provides valuable insights for India's agricultural sector. By adapting China's policy-driven approach to India's diverse agro-climatic conditions, policymakers can establish region-specific strategies that encourage efficient fertilizer use while maintaining soil fertility. India can also leverage China's model of integrating advanced technologies with traditional agricultural practices to ensure a smooth transition toward sustainable farming.

Since 2014, China has implemented policies for fertilizer efficiency and sustainability. In 2015, the Ministry of Agriculture and Rural Affairs introduced the "Action Plan for Zero Growth in Fertilizer Use by 2020", and the Ministry of Industry and Information Technology launched the "Guiding Opinions on Promoting the Transformation and Development of the Fertilizer Industry."

Green intelligent fertilizers are new types of high-quality fertilizers produced based on the principles of optimized plant nutrition that matches crops, soils and the environment, using the big-data intelligent algorithms for targeted supply-demand matching, activating root-fertilizer synergy or feedback by intensifying crop biological potential, developing advanced green manufacturing technology to stimulate crop rhizosphere effects and fully exploiting mineral resources contained in raw materials (e.g., phosphate rock). Such fertilizers have the characteristics of high nutrient efficiency, low-carbon production and use footprint, and maximized utilization of nutrient resources in the whole industry chain. Green intelligent fertilizers not only increase yield and improve quality of food, but also serve as an important entry point for integrating the fertilizer industry and agricultural chain via green transformation of the fertilizer production.

Green Intelligent Fertilizers (GIFs) are an innovative solution for sustainable farming, offering precision nutrient management while minimizing environmental harm. These fertilizers integrate:

Root-Nutrient Feedback Mechanisms: Optimizing nutrient absorption based on plant needs.

Eco-Friendly Formulations: Utilizing natural minerals and microbial interactions to enhance efficiency.

Slow-Release Technologies: Ensuring a steady supply of nutrients, reducing runoff and leaching.

Data-Driven Applications: Leveraging AI and precision farming to match fertilizers to soil and crop conditions.

By adopting GIFs, India can improve nutrient use efficiency, enhance soil health, and reduce dependency on synthetic inputs, aligning with the goal of profitable organic farming.

Biostimulants: Enhancing Crop Resilience and Productivity

Biostimulants, which include microbial consortia, humic acids, protein hydrolysates, and seaweed extracts, play a critical role in bridging the gap between organic and conventional farming. Their benefits include:

Improved Nutrient Uptake: Enhancing the efficiency of applied fertilizers.

Increased Stress Tolerance: Helping crops withstand drought, salinity, and temperature fluctuations.

Better Soil Microbiology: Encouraging beneficial microbial activity for healthier soils.

Higher Yields and Quality: Supporting robust plant growth while

minimizing reliance on synthetic chemicals.

However, India's current regulatory framework under the Fertilizer Control Order (FCO) limits biostimulant adoption. A dedicated regulatory framework, similar to those in the EU and USA, would accelerate research, investment, and adoption.

Here are few suggestions in the Biostimulant Act that could be considered to transform Indian Agriculture.

Current Limitations of Biostimulant Regulation Under FCO

1. Narrow Definition:

The FCO definition of biostimulants focuses on specific product categories, often excluding innovative products like natural chelates, microbial consortia, or combined formulations with NPK and micronutrients (Hybrid Biostimulants).

Products like humic acids, protein hydrolysates, or microbial extracts that may require additives but face restrictions on additive levels, potentially leading to less effective products.

2. Regulatory Overlap:

Biostimulants that enhance nutrient bioavailability or NUE often overlap with fertilizers, creating confusion in classification and registration.

Hybrid Biostimulants (e.g., fertilizers with biostimulant activity) face fragmented regulatory requirements.

3. Efficacy Validation Challenges:

Current regulations lack clear protocols for efficacy validation, especially for novel formulations or combined products.

Misalignment between scientific advancements and regulatory criteria can discourage innovation and investments.

4. Market and Investment Barriers:

Ambiguities in the regulatory framework create uncertainty for private entities, discouraging investment in R&D and product commercialization.

High registration costs and lengthy approval processes may further deter innovation.

Need for Change in Biostimulant Definition and Regulation

1. Broader Definition:

Redefine biostimulants based on functionality rather than composition, aligning with global standards like the EU Fertilizing Products Regulation (FPR 2019/1009).

This would:

- Include products that enhance NUE, abiotic stress tolerance, or soil health.
- Allow innovative products like natural chelates and microbial consortia while protecting the interest(s) of an industry and to benefit farmers.

2. Separate Law for Biostimulants:

Establish a dedicated biostimulant regulation to avoid overlap with fertilizers and simplify approval processes.

Include a hybrid category for "Nutrient Efficiency Enhancers" that integrates biostimulants with NPK and micronutrients. This would encourage the industry to do more research and attract investors as well.

3. Streamlined Processes:

Introduce transparent, cost-effective, and time-efficient registration protocols.

Focus on efficacy-based validation, emphasizing lab/ field trials and scientific data.

4. Data Requirements:

Require clear data on:

- Efficacy in enhancing NUE or plant health.
- Safety and environmental impact.
- Compatibility with fertilizers and other agricultural inputs.

Global Regulatory Insights

EU Fertilizing Products Regulation (FPR 2019/1009):

- Biostimulants are defined by their functional role in improving NUE, stress tolerance, or soil health.
- Allows combined products (e.g., fertilizers + biostimulants), provided each component's role is validated.
- Requires rigorous efficacy testing and labeling standards.

USA (EPA and USDA):

- Flexible classification of biostimulants under soil amendments or plant amendments.
- Encourages innovation by allowing broad claims, provided safety and efficacy are demonstrated.

China:

- Incentivizes combined products that reduce synthetic inputs while improving NUE.
- Encourages public-private collaborations for product development.

Incorporation of NPK and Micronutrients in Biostimulants

Role of Combined Products:

Products integrating biologicals or natural chelates with NPK and micronutrients improve NUE and sustainability.

Examples include:

- Humic Acids with NPK: Humic acids can enhance nutrient availability and uptake when combined with NPK fertilizers.
- Protein Hydrolysates: These formulations provide amino acids that improve nutrient absorption while enhancing plant resilience to stress.
- Seaweed Extracts with Fertilizers: Seaweed-based biostimulants can improve NUE and root growth when applied with micronutrients.
- Microbial Formulations: Consortia combined with fertilizers to enhance nutrient uptake and soil health.
- Natural Chelates (e.g., amino acids): Replacing synthetic chelates like EDTA with organic acids or amino acids to improve micronutrient bioavailability and environmental sustainability.

Regulatory Positioning:

- Under EU FPR, such products can be classified as fertilizers with biostimulant activity, provided the biostimulant effect is documented.
- India's framework currently lacks this flexibility, restricting innovation and market adoption.

Path Forward:

- Develop a regulatory framework that allows combined products with clear efficacy validation.
- Introduce labeling standards to distinguish nutrient delivery roles from biostimulant effects.

Promoting Private Investment in Biostimulants

Clear and Inclusive Regulations:

- Broaden biostimulant definitions to include natural chelates, microbial consortia, and NUE enhancers.
- Establish a hybrid category for products combining fertilizers and biostimulants.

R&D Incentives:

- Co-fund R&D efforts for sustainable alternatives to synthetic chelates.
- Offer tax benefits or subsidies for companies developing eco-friendly biostimulants.

Public-Private Collaborations:

- Encourage partnerships to share the financial risks of developing and validating innovative products.

Efficacy-Based Validation:

- Require field trials demonstrating NUE improvements or abiotic stress tolerance, tailored to local agricultural conditions.

Key Recommendations for India

Adopt Functional Definitions: Align biostimulant definitions with global frameworks like the EU FPR, focusing on their functional role in enhancing NUE and plant health.

Streamline Approval Processes: Simplify registration for combined products and innovative formulations, ensuring timely market access.

Encourage Sustainability: Promote the use of biostimulants and hybrid biostimulants as sustainable alternatives to synthetic inputs.

Create a Hybrid Category: Introduce a "Nutrient Efficiency Enhancer" category within FCO to regulate combined products effectively.

Collaborate for Innovation: Foster partnerships between government, academia, and industry to drive research and adoption of advanced biostimulants.

Changing The Way We Look At Fertilizers

Fertilizers	Characteristics	Breakthroughs
Common fertilizers (e.g., coated fertilizers, nanofertilizers, biofertilizers and stable fertilizers)	Adding exogenous substances to enhance fertilizer efficiency; slowing or controlling nutrient release; and reducing nutrient loss in agricultural applications	Regulating nutrient release solely by mechanical addition or production methods; high cost of external materials; and high environmental impact
Alternative fertilizers	Full use of mineral resources; fully mobilize the biological potential of crops themselves; matching crops, soil, and environment; nutrient release conforms to the pattern of crop nutrient requirements; and low consumption, emissions and losses	Use of Microbial Technology for manufacturing alternative fertilizers using organic (cattle urine, seaweed, humic); and inorganic (simple or complex fertilizer) sources

The Road Ahead

India has a unique opportunity to lead in biostimulant innovation by learning from global regulatory frameworks and tailoring its policies to local needs. By expanding definitions, streamlining processes, and fostering public-private collaboration, India can unlock the full potential of biostimulants in sustainable agriculture and can create a sustainable, productive, and profitable agricultural ecosystem. A robust and inclusive regulatory environment will encourage private investment, drive technological advancements, and benefit farmers and the environment alike. The key to success lies in a balanced, research-backed approach that prioritizes both environmental sustainability and farmer prosperity.

FOOD SUPPLY CHAIN – IMPACT OF DISRUPTIONS IN 2025

With changing global scenario especially post Covid era that caused disruptions across value chain in supply lines of all the industry including – technology role has been appreciated by all the stakeholders that not only enhanced the transparency in entire production process , traceability from farm to fork , improved quality , better CRM , better customer experience , better OTIF and fill rates that are backbone of robust food supply chain. Effective use of tech including GPS/AI/BLOCKCHAIN to name a few has helped the supply chain professionals to release the bandwidth which can now be utilized in more productive avenues .

Food supply chain has been the flag bearers of How to reduce the Carbon footprints by blending tech with skillsets and experience – the key mantra was RRR (Reduce , Reuse and Recycle) , reduction of plastic packaging (especially single plastic use), minimizing food waste, usage of sustainable products , usage of renewable energy source in production areas . Even basic thoughts of shifting the physical factory floor meetings to virtual meet also support the said social cause.

INFRA GAPS IMPACTING COLD CHAIN IN FOOD LOGISTICS

Although a lot has been achieved in past one decade in bridging the gap between current Infra and what actually is needed in the food supply chain – we still have miles to travel . The first few years has been devoted to accept the fact that THERE IS GAP , next period got consumed in understanding and de-coding the problem statement . minimum usage of cold storages , unplanned construction of packhouses/ temp controlled warehouses , obsolete tech that adding to pollution, are some of the main culprits in the infra creation that eroded the resources rather than adding value . Now with help of assessment studies , involvement of SMEs and implementing global best practices there is some light on the other side of the tunnel , The blue print is ready ….. it now need to be implemented WITH GOOD INTENT and execution NEED TO BE FLAWLESS.

SUGGESTIONS :

Creating a conducive ecosystem wherein professionals and organizations from all walks of their respective industry come on same platform and take a pledge to address the common goal – CREATING Commercially sustainable and Eco friendly cold chain infra for the food industry . Each stakeholder should voluntarily assumes responsibility for the efficient cold chain system that will add more life to the food industry mainly the fresh produce which has high hopes from Infra Giants and Govt especially on account of climate changes that have shown their ferocious colours in recent time in shape of floods , extreme summers , long droughts …

ROLE OF COLLABORATIVE APPROACH TO STRENGTHEN THE FOOD SUPPLY CHAIN

We at ISSGF , looking at the above mentioned disruptions across globe – activated our customer interactions more – sharing with them (on most of the occasion on real time basis) inputs , options and curating customized solutions to mitigate the impact . ISSGF with its strong presence in APAC regions and own/network offices in more than 35+ countries – has access to vital information in shipping and airlines industry that was beneficial to the trade at large . Such vital information was assimilated and then shared with our customers across location to help them decide wisely – the best options for their business.

At ISSGF , lot of emphasis is given to long term collaborative approach with network partners that include shipping lines , airlines , transporters and our customers . Though the approach has always been to have regular interaction with all stake holders across all levels which has been a building block of ISSGF and reasons for more than 90% customer retention in past 6 years .

In current times wherein visibility on long term freight levels , geo-political instability in Middle east due to growing tension among nations , USA policy changes etc – it becomes all the more imperative to strengthen the bonds of partnership on basis of trust , strong MIS sharing , review mechanism and sustainable resilient supply chain

The period gone by taught us a lot on value of being pro-active and role of information Technology in various avatars like AI , MIS , GPS , Block chain to name a few . For organizations and individuals to sustain in the coming times – it is important to embrace the technology and upgrade the supply chain skills with systematic approach by investing in processes , to remain relevant and add social value to the world at large.

MR PRANAV MALIK
VICE PRESIDENT FMCG SALES ISS GLOBAL

Ensuring Supply of Plant Nutrients for Organic Cultivation

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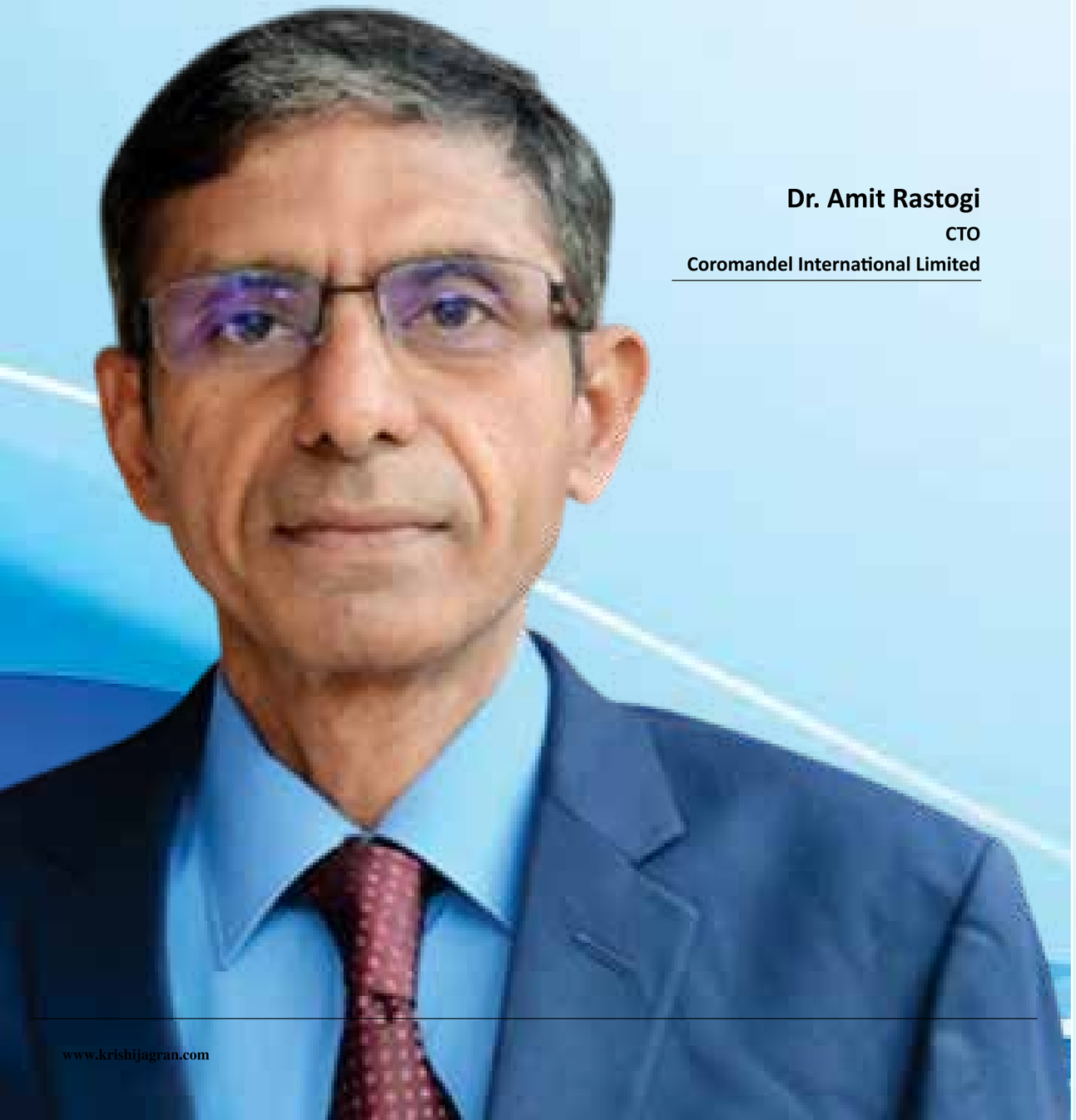

Crops grown under organic method of cultivation need to be supplied by nutrients such as Nitrogen, Phosphorus, and Potassium (N, P, and K) from organic or biological sources. In modern agriculture, most of the nutrients are supplied by mineral fertilizers which contain inorganic compounds that are produced through chemical processing. To move towards the goal of making Indian agriculture completely organic, we need to replace nutrients supplied by chemical fertilizers with nutrients from organic or biological sources.

Currently in India around 35 million tonnes/year of NPK nutrients are applied in the form of chemical fertilizers. Organic fertilizers are primarily applied as Farm Yard Manure (FYM) and compost; according to FAO data they contribute to around 7 million tonnes/year of NPK nutrients. However, for replacing chemical fertilizers completely and making Indian agriculture fully organic, we must find new organic sources of plant nutrients as there is limited quantity of FYM available. Some of the potential sources of nutrients which can be used for producing fertilizers for organic cultivation are described below:

1. Agricultural residues

India generates huge quantities of agricultural residues in the form of straw, stover, husks, shells etc. These are commonly disposed off by burning. As now microbial technology is available for quick composting of biomass, compost from agri-waste can become an import source of nutrients.

2. Municipal Solid Waste

The municipal waste generated in Indian cities contains about 30-40% organic matter. By implementing proper segregation methods, this organic matter can be collected and converted into compost. This is already happening on a limited scale.

3. Organic Manure from Compressed Biogas plants

There are plans to set-up large number of biogas plants based on agricultural residues, pressmud from distilleries, cattle dung, and municipal waste. The vast quantities of Fermented Organic Manure that will be generated in these plants will play a key role in meeting the demand for organic fertilizers.

4. Waste from food processing industries

Food processing industries which process fish, shrimps, fruits, vegetables etc. generate substantial amounts of organic waste which can be converted into organic fertilizer.

5. Sewage sludge

The sludge from Waste Treatment Plants upon incineration generates ash which can be used to produce phosphorus fertilizer. Recovery of nutrients from sewage sludge is now being widely adopted in Europe as part of circular economy.

6. Potash from Molasses

Distilleries convert molasses into ethanol and generate spent wash as effluent. The incineration of spent wash produces ash which contains significant percentage of potassium. As the use of ethanol as bio-fuel is increasing in India, there will be higher generation of potash from distilleries in future.

7. Potash from Banana pseudo stem

India is major producer of bananas and therefore generates substantial volume of banana waste in the form of pseudo stems which contain high levels of potassium. Like spent wash from distilleries, this waste can also become an important source of potassium.

8. Poultry Manure

Poultry litter which has phosphorus and potassium can be processed to produce PK fertilizers. As poultry consumption is growing in India, the generation of poultry litter will continue to increase.

9. Biological Nitrogen Fixation

Biological Nitrogen Fixation which involves the conversion of atmospheric nitrogen into ammoniacal nitrogen by roots of plants is typically found in leguminous crops. However, now new forms of bacteria have been developed which can fix nitrogen in cereal crops. This revolutionary microbial technology can be an alternative to nitrogen from urea.

10. Direct application of Phosphate Rock

Phosphate rock, while not an organic fertilizer, is permitted to be used for organic cultivation as it does not undergo any chemical processing. Now microbial solutions are available to quickly solubilise the insoluble phosphorus in phosphate rock. Therefore, direct application of phosphate rock along with microbial culture can become an alternative to phosphorus from chemical fertilizers.

In summary, there is a large potential to generate nutrients from organic and biological sources in India and meet the requirements of Indian agriculture as it moves towards becoming completely organic.

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