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A Resonance in Agriculture
Monthly Agriculture E-Magazine

September-2025



IMPACT OF
GST
REFORM ON



AGRICULTURAL
SECTOR



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From the Editor's Desk

Dear Readers of Times of Agriculture Magazine,

This edition of **Times of Agriculture** is dedicated to the recent reforms in India's **Goods and Services Tax (GST)** and their potential implications for both agriculture and the farming community.

Agriculture, regarded as the backbone of India's economy, has long been subject to numerous policy changes. However, it is now imperative to align GST with the ground realities of the sector. The existing GST framework, with its tax rates on seeds, fertilizers, pesticides, farm machinery, and other essential inputs, not only escalates production costs for farmers but also hinders the competitiveness of Indian agriculture.

There is, therefore, an urgent need for a simplified and transparent system that either exempts agricultural inputs from GST or brings them under minimal tax slabs. Such reforms would significantly improve the viability of farming and uplift the economic condition of farmers.

In the context of **Atmanirbhar Bharat** (Self-Reliant India) and sustainable agriculture, it is crucial that our tax policies serve as enablers — enhancing farm productivity and supporting income growth for farmers.

We are optimistic that the forthcoming GST reforms will inject renewed momentum and resilience into the agricultural sector.

We trust you will find this issue of **Times of Agriculture** as insightful and engaging as ever.

Thank you, Enjoy Reading....

Editor-In-Chief



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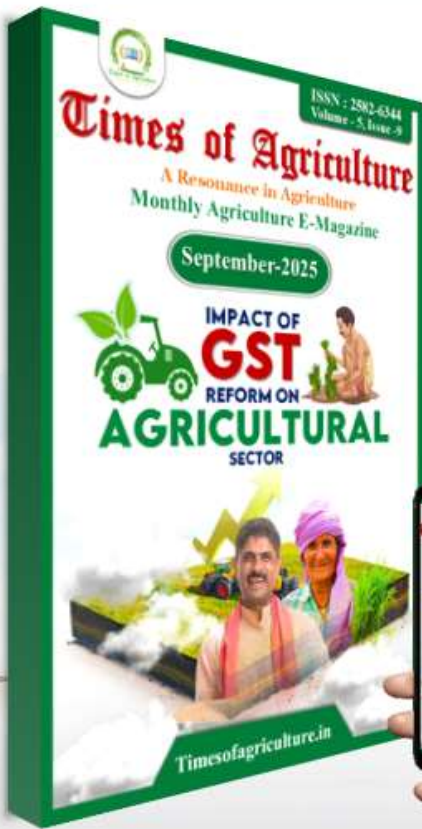
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IMPACT OF GST REFORM ON AGRICULTURAL SECTOR



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AGRICULTURE UPDATES



AI-Powered Monsoon Forecasting Reaches 38 Million Indian Farmers, Revolutionising Agriculture

The Ministry of Agriculture and Farmers' Welfare (MoAFW) has pioneered the use of artificial intelligence (AI) to provide early and precise monsoon forecasts to farmers across India. Nearly 3.8 crore farmers in 13 states received AI-based monsoon predictions via SMS through the m-Kisan platform. These forecasts, delivered up to four weeks in advance, allow farmers to plan crop selection, sowing schedules, irrigation, and input usage more effectively. This initiative is considered a global first in delivering targeted AI weather predictions directly to farmers for actionable decision-making.

During the 2025 monsoon season, the MoAFW sent weekly updates, including alerts about a 20-day mid-season pause in rainfall. Early and continuous communication allowed farmers to mitigate risk, manage resources efficiently, and adapt their agricultural practices to changing weather conditions. Messages were crafted in simple language and tested with farmer groups to ensure clarity and usability, making the technology accessible even to small and marginal farmers.

The AI models underpinning the forecasts combine Google's Neural GCM and the European Centre for Medium-Range Weather Forecasts' Artificial Intelligence Forecasting Systems (AIFS). These models outperform traditional forecasting techniques in predicting monsoon onset, rainfall intensity, and localized weather patterns. The system can identify variations at district and sub-district levels, providing granular guidance to farmers that was previously unavailable.

The initiative has already shown measurable impact. Farmers have reported improved crop yields and reduced losses during unexpected dry spells or heavy rainfall events. The early warning system also helps in planning storage, transportation, and market timing, reducing post-harvest losses and improving profitability. In addition, government extension officers use AI data to guide farmer training programs and resource allocation, enhancing overall agricultural planning. Looking ahead, the MoAFW plans to expand the program to cover all states and union territories, integrate AI-based pest and disease alerts, and deliver forecasts via additional digital channels including apps, WhatsApp, and IVR systems.



National Agriculture Conference – Rabi Abhiyan 2025

India's agricultural roadmap for the upcoming Rabi season 2025–26 is being charted at the National Agricultural Conference – Rabi Abhiyan 2025, which began on 15 September 2025. Chaired by Union Agriculture Minister Shivraj Singh Chouhan, the two-day event is part of the second phase of the Viksit Krishi Sankalp Abhiyan, a mission to modernise Indian agriculture through technology, policy reforms, and farmer-centric strategies. For the first time, the Rabi Conference is being held as a two-day event under this initiative, reflecting the government's focus on in-depth discussions and strategic planning. The conference is being conducted under the theme “One Nation – One Agriculture – One Team,” aiming to foster stronger coordination and partnerships across India's agricultural sector.

The primary objective of the conference is to deliberate on preparations, production targets, and strategies for the upcoming Rabi season, ensuring comprehensive planning and efficient use of resources. Discussions focus on strengthening agricultural extension work and building joint programs between the central government, state agriculture departments, agricultural universities, Krishi Vigyan Kendras, and other institutions. The conference also emphasises ensuring timely availability of quality seeds, fertilisers, and pesticides, while addressing the challenge of spurious products in the market. These steps are expected to improve productivity, safeguard farmer interests, and ensure a smooth cropping cycle.

Union Agriculture Minister Shivraj Singh Chouhan highlighted that India's agriculture sector has recorded a 3.7% growth rate, currently the highest globally, representing a strong recovery compared to last year's performance. He attributed this growth to the combined efforts of farmers, scientists, and farmer-friendly government policies. Chouhan also stressed the importance of strict enforcement against fake agricultural inputs and the need for effective implementation of schemes such as the Pradhan Mantri Fasal Bima Yojana. By focusing on modernisation, collaboration, and innovation, the Rabi Conference aims to prepare India's agricultural sector for a productive season while maintaining its growth momentum and supporting farmer prosperity.



APEDA Launches BHARATI to Empower 100 Agri-Food and Agri-Tech Startups

BHARATI (Bharat's Hub for Agritech, Resilience, Advancement and Incubation for Export Enablement) has been launched by APEDA to empower 100 agri-food and agri-tech startups and drive India's agri-food exports to an ambitious target of **\$50 billion** by 2030. The initiative was announced during a Food & Beverages Sector Stakeholders Meeting, with national and international leadership present. It is conceived to strengthen innovation, export readiness and global market linkages for young entrepreneurs across India. It seeks to support high-value producers, technology-driven service providers, and innovators in categories such as organic foods, GI-tagged products, superfoods, AYUSH, livestock items and novel processed foods.

Starting in September 2025, the pilot cohort will feature 100 selected startups. These will go through a **three-month acceleration programme** covering key areas including product development, regulatory compliance, export readiness, and market access. The initiative also addresses longstanding export-related challenges: value addition, quality assurance, perishability, wastage, and logistics. Technology adoption is central, with a strong focus on AI-based quality control, blockchain traceability, IoT-enabled cold-chain systems, agri-fintech platforms, and innovative packaging. Sea transport protocols and sustainability measures are also being built into the export framework to reduce losses and improve competitiveness.

To build a robust ecosystem, BHARATI will be implemented in cooperation with state agricultural boards, agricultural universities, premier institutes such as IITs and NITs, industry associations, and existing accelerators. A nationwide awareness campaign has been launched to attract startups from across India. Selected startups will be vetted through an application and selection process via the APEDA portal. The pilot programme is expected to serve as a model for an annual, scalable incubation framework that continues beyond the initial cohort. By aligning with national priorities like Atmanirbhar Bharat, Vocal for Local, Digital India, and Start-Up India, BHARATI aims to make Indian agri-products globally competitive and strengthen backward linkages in food innovation.



Revised National Action Plan on Glanders 2025

A revised National Action Plan on Glanders has been introduced by the Department of Animal Husbandry & Dairying (DAHD) to strengthen India's prevention, control, surveillance and eventual eradication of glanders, a dangerous and contagious disease affecting equines. The update reflects a sharper One Health approach, aiming to protect animals, humans and communities linked to equine health. The disease is caused by *Burkholderia mallei*, primarily targets horses, mules and donkeys, but is zoonotic—able to infect humans. It has high mortality if untreated, and is notifiable under the Prevention and Control of Infectious and Contagious Diseases in Animals (PCICDA) Act, 2009. Sporadic outbreaks persist in parts of Asia, Africa and the Middle East.

Key changes under the revised plan include major adjustments to the zoning for control measures. The radius of the infected zone has been reduced from 5 km to 2 km, while the surveillance zone has been redefined to lie between 2 and 10 km, instead of the earlier 5–25 km. Movement restrictions, quarantines, and activity limitations will now apply only within 10 km of infected areas. These modifications are intended to allow more precise containment of the disease while avoiding wider disruptions to animal movement and economic activity. Enhanced surveillance is now mandatory in endemic and high-risk regions, with more frequent field inspections and better laboratory diagnostics to ensure early detection and timely reporting of cases.

The plan also mandates stricter quarantine and certification protocols for equine fairs, yatras, and interstate transport. Standard Operating Procedures (SOPs) have been laid out to ensure swift containment and humane treatment of infected animals. The revised programme includes expanded capacity building through training of veterinarians, para-veterinarians and field staff in recognition, reporting, biosafety and response. Public awareness campaigns will engage breeders, horse owners and communities for cooperation in early detection and containment. Research support is being strengthened through collaboration with institutions like ICAR–National Research Centre on Equines (NRCE), Hisar, to improve diagnostic methods and epidemiological research. This enhanced plan aims to safeguard livelihoods dependent on equines, tighten animal health security, and reinforce India's preparedness under the One Health framework.



Kapas Kisan App Digitises Cotton MSP Procurement to Benefit Farmers

The Union Textiles Minister, Giriraj Singh, launched the Kapas Kisan app, developed by the Cotton Corporation of India (CCI), to modernise cotton procurement under the Minimum Support Price (MSP) scheme. Designed as a farmer-centric digital tool, the app allows self-registration, slot booking, and payment tracking through a multilingual user interface. The new platform aims to reduce dependency on manual paperwork, middlemen and delays, ensuring farmers receive timely support and fair treatment under MSP operations. The move aligns with the broader Digital India vision and is intended to protect farmers from distress sales.

Starting this Kharif season (2025-26), all cotton farmers will be required to register via the Kapas Kisan app; procurement is set to begin in phases by region, with Northern states starting procurement operations from 1 October, Central states following, and Southern ones beginning later in the month. Farmers will be able to choose their preferred slots at procurement centres via the app, easing wait times and congestion. Payment to farmers is to be made directly to their bank accounts, linked with Aadhaar, via a faceless, paperless process. An SMS-based notification system will also alert farmers about payment status.

However, concerns have already emerged among farmers and stakeholders, especially in regions with limited digital access. Issues cited include lack of smartphones in rural areas, poor internet connectivity, and difficulty in uploading land or crop details. In some cotton-growing districts, the app has seen lower adoption levels. Critics warn that unless there is sufficient on-ground support and awareness, many eligible farmers might be excluded. To address this, the Ministry and CCI plan awareness programmes, local support at procurement centres, and training for staff to assist farmers with app usage.

The Kapas Kisan initiative is also expected to generate valuable data on cotton production, procurement trends, and farmer participation across states. This information can be used by policymakers to design better schemes, forecast production more accurately, and stabilise cotton prices in domestic and export markets. Over time, the app could evolve into an integrated platform linking farmers to ginning mills, textile units, and international buyers, boosting value addition and creating new market opportunities for India's cotton sector.



APEDA's Patna Office to Amplify Bihar's Agri-Export Growth

Union Commerce & Industry Minister Piyush Goyal inaugurated APEDA's first regional office in Patna during the Bihar Idea Festival, providing farmers, exporters, and entrepreneurs in Bihar direct access to export-facilitating services. Until now, many stakeholders in Bihar depended on APEDA's regional office in Varanasi, which often resulted in delays in documentation, certifications, and market guidance. With the new office, stakeholders in eastern and central Bihar will no longer face that logistical hurdle.

At the inauguration, a 7-metric-ton consignment of GI-tagged Mithila Makhana was flagged off to New Zealand, Canada, and the USA. The shipment was led by Neha Arya of Nehashi, a woman entrepreneur from Darbhanga, underlining APEDA's emphasis on inclusive export growth and supporting women in agribusiness. Key state leaders including the Deputy Chief Minister and the Industries Minister of Bihar were present, showing strong government backing for expanding Bihar's role in India's agricultural exports. Bihar's range of GI products—such as Mithila Makhana, Shahi Litchi, Jardalu Mango, Magahi Pan—already have strong appeal internationally, and this local presence of APEDA is expected to help scale that appeal.

The Patna office is expected to facilitate exporter registration, documentation, compliance, and market intelligence more efficiently. Technical and capacity-building support will become more accessible, especially for Farmer Producer Organisations (FPOs), startups, and small exporters. The new office will also aid in improving packaging, quality standards, logistics, and adherence to global export protocols. By decentralising these services, Bihar can better leverage its strengths in horticulture, pulses, cereals, organic products, and value-added foods. The move is seen as a step toward boosting farmers' incomes, promoting sustainable agricultural practices, and integrating Bihar more effectively into global food supply chains while nurturing local economies and enterprise.



Bibi Fatima SHG from Karnataka Wins UNDP Equator Prize 2025 for Sustainable Farming and Women-Led Innovation

The Bibi Fatima Women's Self-Help Group (SHG) from Teertha village in Karnataka's Dharwad district has been awarded the prestigious UNDP Equator Prize 2025, often referred to as the "Nobel Prize for Biodiversity Conservation." This recognition celebrates their pioneering work in eco-friendly farming, community seed banking, millet promotion, and women-led rural entrepreneurship.

Established in 2018 with just 15 members, the Bibi Fatima SHG has grown to support over 5,000 farmers across 30 villages. Their initiatives include reviving millet-based mixed cropping systems on rainfed lands, establishing a community seed bank with over 300 indigenous seed varieties, and setting up a solar-powered millet processing unit. These efforts have enhanced food security, biodiversity conservation, and women's economic empowerment.

The Equator Prize 2025, awarded by the United Nations Development Programme (UNDP), recognizes outstanding community-led, nature-based solutions for sustainable development and climate resilience. Selected from over 700 nominations across 103 countries, the Bibi Fatima SHG was honored for their innovative approach to sustainable agriculture and women's leadership in rural development. With the prize money, the Bibi Fatima SHG plans to further invest in their seed bank, upgrade processing units, and train more marginalized women and youth in sustainable farming practices. Their model serves as an inspiration for similar communities aiming to integrate sustainability with economic development. Beyond these immediate initiatives, the SHG aims to create a replication framework for other villages in Karnataka and neighboring states.





IMPACT OF
GST
REFORM ON



**AGRICULTURAL
SECTOR**



About the Author

Saroj Kumar Mahapatra

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PRADAN



The Government of India's recent GST reforms, especially the rationalisation of tax slabs and reduction in rates on essential goods and services, are a significant and progressive step towards building a more inclusive and growth-driven rural economy. For the agriculture sector, which remains the backbone of rural India, these changes could bring much-needed relief and momentum.

The reduction in GST on critical agri-inputs such as fertilizers, agrochemicals, farm machinery, and food processing equipment will help lower operational costs for farmers, especially smallholder and marginal farmers and agri-entrepreneurs. This directly translates to better profit margins for smallholder and marginal farmers who are often burdened by high input costs. They will be able to invest more in farm mechanization. Moreover, by easing the compliance process, the reforms will empower Farmer Producer Organisations (FPOs) and rural agri-startups to scale operations, access markets more efficiently, and formalise their businesses

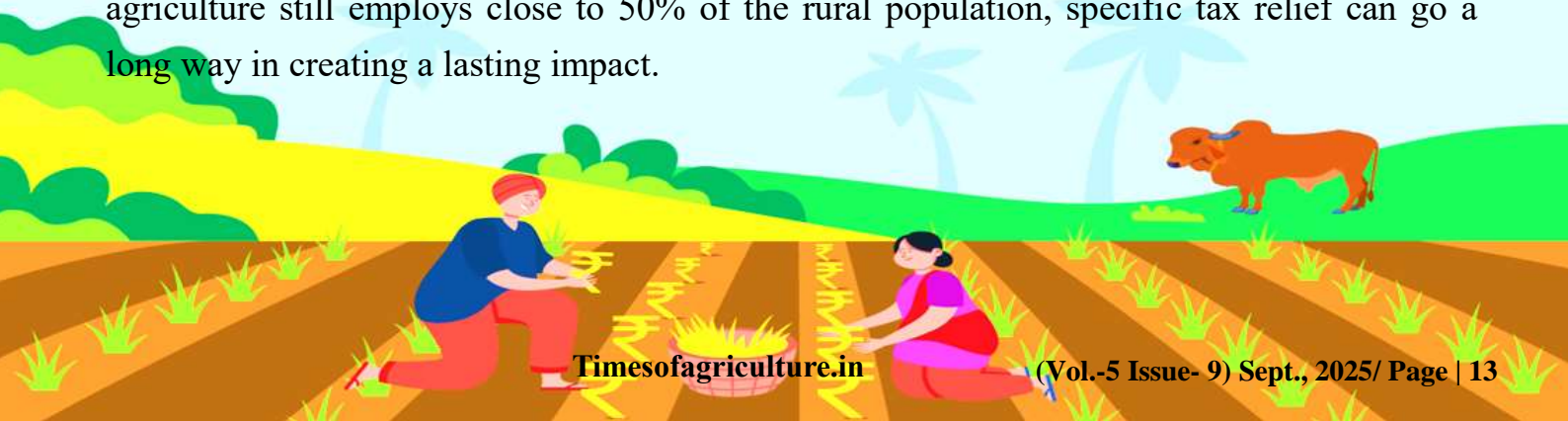
Why GST Reforms Matter for Agriculture

Ever since its July 2017 implementation, GST has sought to integrate India's patchwork tax system and simplify the indirect taxation regime. But for industries like agriculture, which are highly input, machinery, and service intensive, challenges have varied from cost escalation to complicated compliance.

The recent reforms with a focus on lowering GST rates on critical agricultural inputs and ease of procedures have been universally appreciated. These reforms recognize the pivotal position occupied by agriculture in the Indian economy and reflect a serious effort to eliminate structural inefficiencies, decrease costs of production, and improve the competitiveness of rural producers.

Simplified Taxation, Strengthened Economy

The lowering of GST rates on basic goods and services marks a thoughtful shift towards establishing an inclusive and growth-centred rural economy. It lightens the burden of cost for consumers and producers, spurring demand and supply. In a nation where agriculture still employs close to 50% of the rural population, specific tax relief can go a long way in creating a lasting impact.



Boost to Smallholder Farmers and Agri-Enterprises

With the GST rates now rationalised, smallholder farmers and agri-entrepreneurs would be able to have lower operational costs. It directly leads to improved profitability and more liquidity, which they can re-invest back in their farms, particularly in mechanisation and technology adoption. Mechanisation is the way forward to enhance productivity and facilitate timely farm operations. Affordability has been a major hindrance for smallholder farmers; the new tax system can assist in lifting that hurdle, allowing farmers to get easier access to equipment such as tractors, threshers, and irrigation systems.

Further, the GST reforms will positively impact Farmer Producer Organisations (FPOs). They are key to bringing produce together, bargaining for better prices, and providing market access and agri-services. By easing compliance and lessening the tax burden, the reforms will enable FPOs and rural agri-startups to grow faster and expand the outreach of farmers' produce.

Better profit margins for farmers

India has over 100 million small and marginal farmers who have less than two hectares of land. They usually work on thin margins and are beset by systemic challenges like high input prices, restricted market access, and weak bargaining power. Among the most direct and concrete effects of the new GST reforms is the lowering of input costs.

By lowering GST rates on seeds, pesticides, fertilizers, and farm equipment, the government has eased the economic burden on farmers. For instance:

- ❖ Fertilizers, previously taxed at 12%, are now taxed at 5%, thus making them quite cheaper
- ❖ Farm equipment and tractors, which are essential in mechanization, have also experienced a decrease in taxation, making them more accessible to smallholder farmers

Reduced input costs will directly make the profit margin better. With more fiscal space, farmers would be more willing to invest in their farms using superior technology, enhancing irrigation facilities, or increasing cultivation all of which make the productivity as well as the income more stable.



Tractors



Tractor Tyre and Parts



Bio-Pesticides Micro-Nutrients



Agricultural Machines



Boost to Mechanisation and Technology Adoption

One of the enduring challenges in Indian agriculture is the limited use of mechanisation. Less than 50% of Indian farms use any form of machinery, and this figure is even lower in eastern and central India. Affordability has always been a roadblock.

The reduction in GST on equipment like threshers, harvesters, and solar-powered irrigation systems can be a game-changer for smallholder farmers, especially the women. Mechanisation not only improves farm efficiency and reduces physical hardships, but also helps in timely planting and harvesting, which is critical for yield optimization especially in regions dependent on erratic rainfall.

Technology adoption also gets a boost. For instance, agri-drones and remote sensing devices used for precision farming could become more accessible to small and medium farmers, especially if coupled with government subsidies and incentives. These tools help in resource optimisation, disease monitoring, and yield prediction functions that are increasingly essential in the face of climate change.

A Push for the Food Processing Sector

India's food processing sector, is anticipated to exceed \$600 billion, is vital to reducing post-harvest losses and increasing farmers' income. It has, however, been affected for years by high taxation on processing machinery and packaging materials, deterring rural investment. The recent GST reforms overcome this hurdle by reducing tax rates on a number of essential food processing equipment and machines.

This action is likely to spur the development of rural processing units, especially around farm gate locations, allowing Farmer Producer Organisations (FPOs) and rural entrepreneurs undertake value addition exercises like drying, oil extracting, grading, packing, and branding without the limitation of high initial taxes. The effects of these reforms will be extensive enhancing price realization for farmers, minimizing food wastage via enhanced preservation and storage, and generating rural jobs, especially among women in packaging and quality control-related occupations.

In addition, a robust food processing ecosystem will reinforce the diversification of agriculture production beyond mainstream cereals to products such as pulses, fruits, vegetables, and millets, thus pushing both nutritional impacts and income security among rural families.



Supporting Women Farmers and Rural Livelihoods

Women comprise nearly 50% of the self-employed farmers in India, and in many regions, they are the primary cultivators due to male migration. However, they have higher hurdles to climb in accessing inputs, credit, and markets.

With agri-inputs and food processing machinery decreasing in cost, farm collectives led by women and Self-Help Groups (SHGs) will be able to invest in small-scale ventures. These can range from pickle and papad units, spice grinding, seed banks, nursery activities, and other micro-agri ventures. This will lead to more empowerment amongst women, and their earning capacity can also get some boost.

Enabling Rural Transformation

The impact of these reforms goes beyond individual farms. Lower taxation on agri-inputs and processing equipment will also benefit India's growing food processing industry, an important link in the farm-to-fork value chain. It creates opportunities for rural entrepreneurs, especially women and youth, to engage in value addition, packaging, and distribution of agri-produce.

This, in turn, supports employment generation, better price realisation, and reduced post-harvest losses leading to stronger rural economies. It also aligns with broader national goals such as doubling farmers' incomes, improving food security, and encouraging self-reliance under the Atmanirbhar Bharat initiative.

Promoting Sustainable Farming and Climate Resilience

Equipment such as solar pumps, drip irrigation, and organic input processing units, when made cheaper through tax subsidies, promote environmentally friendly and resource conserving agriculture.

Climate-resilient farming requires subsidies for system-wide affordability of sustainable options. Reducing GST on eco-friendly machines and methods pushes the sector in the desired direction, consistent with India's net-zero and Sustainable Development Goal (SDG) commitments.



12%

5%

Preserved Fruits and Vegetables

12%

5%

Solar Panels, Butter, Ghee, Milk Cans

12%

0%

UHT Milk, Paneer, Chhena

"Introduction of the new GST reforms is a timely and welcome step for the agri-input industry. By reducing the tax burden on critical raw materials for fertilizers and making compliance procedures simpler, the government is encouraging an environment which is more efficient for trade and industry. The steps will not only ease cost pressures along the supply chain but also help speed up modern farming practices and enhance market efficiency. At Tradelink International, we view this as a powerful indication of the government's determination to create a solid agri-value chain and unlock new private investment opportunities in the sector."

- Abhishek Wadekar, Founder Chairman – Tradelink International Private Limited

A Step in the Right Direction

The GST reforms have correctly recognized agriculture as a sector that must be encouraged through facilitatory policy mechanisms. Although this rationalization in itself may not address all the problems confronting Indian farmers, it is a definite and welcome indication of intent. By reducing the cost of crucial agri-inputs and bringing down the burden of tax compliance, the reforms will lead to short-term and long-term gains.

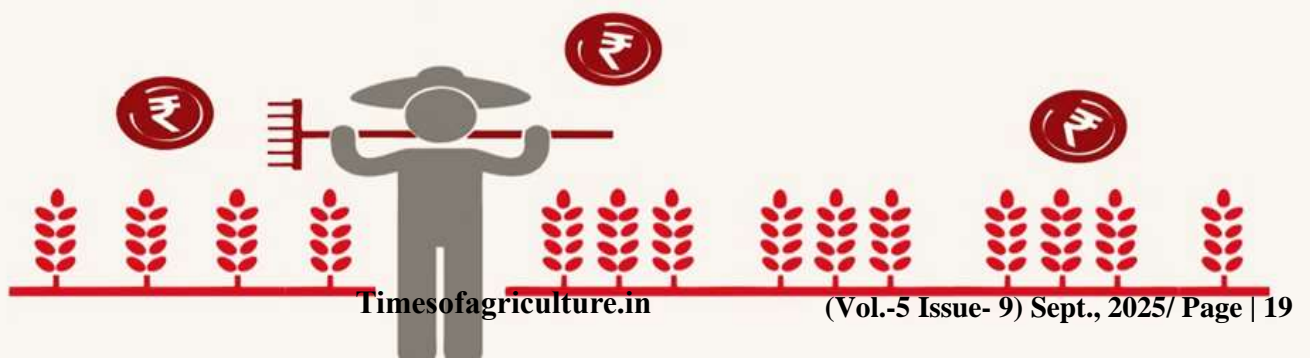
It is now imperative for the implementing agencies, banks, and industry players to ensure that the dividends of these reforms percolate to the last-mile farmer. With a robust on-ground implementation and sustained policy push, this step can be a catalyst in unshackling the next wave of agricultural transformation in India.

Together, these measures will strengthen smallholder and marginal farmers' ability to withstand market and climate shocks. In the long run, this will support rural prosperity, enhance community resilience, and pave the way for more inclusive rural growth.

Recommendations for Strengthening GST Reforms

To make sure that the advantages of GST reforms really pass on to the last mile, some supporting steps are necessary. Firstly, mass awareness campaigns must be initiated so that farmers fully understand the new tax rates and can force dealers to offer reasonable prices. Secondly, a streamlined GST return system designed for Farmer Producer Organisations (FPOs) would simplify compliances and prompt more collectives to formalise. Thirdly, focussed schemes for women-run Self-Help Groups (SHGs) and rural agri-startups can make the reforms inclusive so that women and youth can meaningfully engage in agri-business. Collectively, these measures will enhance the impact of GST rationalisation throughout rural India.

The GST reforms mark more than a tax adjustment as they signal a policy shift that recognises the centrality of agriculture in India's growth story. By reducing input costs, easing compliance, and promoting mechanisation, the reforms create space for farmers, FPOs, rural entrepreneurs, and ensure growth in the farm sector. The direction is clear- a more inclusive and robust rural economy. For India's \$5-trillion ambition, empowering its farmers, Agri-Entrepreneurs, market linked production systems, enhancing the productivity of crops, and Rural Start-ups is the need of the hour.





SEEDS AMONG THE STARS

NOVEL FRONTIER IN AGRICULTURAL STARTUPS

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In a historic move made by India during the Axiom-4 Mission, Group Captain Shubhanshu Shukla, the second Indian to go to the space after Rakesh Sharma conducted various experiments in the International Space Station (ISS) under the micro-gravitational condition. Out of seven different experiments, trials were conducted on cultivation of plants in space under microgravity. Group Captain Shukla shared photos of 'moong' and 'methi' seeds sprouted in the ISS storage refrigerator. Once returned to Earth, the seeds will be cultivated over several generations to examine changes in their genetics, microbial

ecosystems and nutritional profiles. In another experiment, Captain Shukla deployed and stowed microalgae, which are being investigated for their potential to produce food, oxygen and even biofuels. Their resilience and versatility make them ideal for supporting human life on long-duration mission. Back on the Earth, University of Agricultural Sciences, Dharwad will study the effect of microgravity on plant growth for future space exploration.

Current status of space agriculture startups:

Global space agencies like NASA (USA), CNSA (China), ESA (Europe) and India's ISRO are taking strides in conducting research experiments on space agriculture. The new frontier in the field of agriculture and space science has opened great opportunities for the innovative startups at home in India and across the globe.

Several startups like UK-based Vertical Future has been awarded 1.5 million pounds by the

UK Space Agency, United Kingdom to set up an autonomous farm in the orbit by 2026. The high-tech vegetable garden will be installed on the world's first commercial space station. The idea opens opportunity for astronauts to cultivate their food in space on their own against the present method of receiving freeze-dried meals to cover their dietary requirements.

In January 2025, India's ISRO launched CROPS-1 Mission to test the cultivation of plants in space under the influence of microgravity. The experiment was all indigenous to demonstrate germination of a seed and sustenance up to two leaves stage in space for 5 to 7 days. Cowpea (Scientific name: *Vigna Unguiculata*) was chosen based on ground trials on a variety of seeds due to its shorter germination time. On the fourth day, seeds sprouting out from the enclosed tissue strips was observed. On the fifth day, two leaves were visible on spouted seeds indicating successful accomplishment of the objectives.



India's potential for space agriculture startups:

India's ISRO is a pioneer in conducting space farming experiments. Its strides in CROPS-1 and Axiom-4 Mission evidently proves it. ISRO's IN-SPACE is dedicated to commercialize the space-based technology to the aspiring innovators and entrepreneurs to expand the scope of India is the space related research and development at a global stage.

At present, India accounts for 2% share in the global space market. It is expected to grow upto 10% by 2030. Various startups like Skyroot Aerospace, DHRUVA are pioneering in rocket launches and satellite related developments. India's young minds are talented enough to grab the opportunity for space farming.

India has largest population of students in STEM (Science and Technology, Engineering and Mathematics) courses with significant number of youth engaged in agricultural research. India has the world's largest National Agricultural Research System (NARS). By leveraging the combined benefits of both the science areas, India can become a global tech power in space agriculture. Recently established

National Research Foundation by the Government of India is a way forward in the direction of research and development.

India has third largest startup ecosystem in the world. The steps in the direction can generate highly remunerative employment opportunities. It will help India's talented minds to stay back at home and contribute to the nation's technology and science led development. By developing technology for ease of cultivation in space, India can rule the Intellectual Property market currently being ruled by USA and China.

By 2035, India will operationalise its own space station called Bharat Antariksh Station which will be our laboratory in the space. Developing technology indigenously will enable our astronauts to survive better in the space with healthy, tasty and fresh food. Before that in 2028, India will send its first human crew to space as Mission Gaganyaan. The astronauts will conduct various experiments in space.

Developing such forward looking technology will make India a trust-worthy nation which will handhold other nations in taking strides at space-led research. Global South consider India as an elder

brother (Voice of Global South) to which we can be a helping hand in providing space education and research led education to the global student community. This way India can gain an edge in the diplomatic policy in the multipolar world.

Underlying challenges and potential solutions:

Though there lies challenges like high cost of education in apex research institutes, inadequate infrastructural facilities, high initial investment required to carry out the experiments, these challenges are not insurmountable.

Multiple solutions like technology-enabled innovations, zeal to explore the possibility for space agriculture among young minds, extensive research and development support by the academia and institutions like IITs, IISc, NITs, Agricultural universities and pioneering research institutions like ICAR and IARI along with the financial support by the government and technological aid by ISRO can play an instrumental role in the exploration of the hidden potential of space farming. Collaborative partnerships and research exchange programmes with the internationally active startups and global space agencies can prove to be fruitful.

■ ■ ■





AI MEETS AGRICULTURE

A TEEN'S MISSION TO REIMAGINE IRRIGATION

About Author



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In villages of North Gujarat, farming has always depended on water. For decades, groundwater kept crops alive, but today wells are running dry. With limited infrastructure and unreliable electricity, many farmers still rely on flood irrigation, watching precious water seep away. Among them is Ayan Patel, a 16-year-old student from Mehsana, who chose not to inherit this challenge but to solve it.

Ayan's roots run deep in farming advocacy. His great-grandfather, Shaheed Vir Tribhuvandas Patel, pioneered North Gujarat's first borewell and sacrificed his life championing farmers' rights. His grandfather, Ajit



Patel, expanded access to water and stood alongside farming communities. Carrying this legacy, Ayan founded Krishi Mitra — a grassroots movement to co-create solutions with farmers.

What began as Khedut Sabhas under neem trees grew into a structured platform of nine interconnected modules - from soil health awareness and composting to collective marketing and women's microenterprises. With support from Ganpat University students and

Krishi Vigyan Kendra (KVK) experts, Krishi Mitra has reached 3,300+ farmers across five villages, empowered 240 women entrepreneurs, and mobilized 120 youth.

At its heart lies Ayan's flagship innovation: SaurSinchAI. Designed when he was just 16, it is a solar-powered, AI-enabled irrigation rover equipped with a mobile soil probe that reads real-time data on moisture, pH, and nutrients. The rover delivers water, fertilizer, and pesticides only where needed.



Running entirely on solar power and without Wi-Fi, it is tailored for smallholder farmers in arid regions. Piloted on 15 farms, SaurSinchAI saved nearly 20 lakh liters of water, cut pesticide use by 35%, and increased yields by up to 30%.



Krishi Mitra's other efforts include conducting 1,800 soil tests across 3,200 acres, shifting farmers from water-hungry crops like wheat to resilient alternatives such as cumin, castor, and millet. Mulching and composting have restored soil fertility while reducing residue burning. Ergonomic weeders have

reduced labor strain by 70%, saving 15,000 hours of work per month. Farmer collectives have improved bargaining power, generating an additional ₹34.8 lakh in income, while women-led Gruh Udyog units have quadrupled household earnings.

Ayan's work has earned recognition from Ganpat University, which is collaborating with him to refine and scale SaurSinchAI, and from local leaders such as Shri Mukesh Patel, MLA of Mehsana, who encouraged district-level adoption. Ayan has also pitched the rover to the Gujarat Department of Agriculture for subsidization under precision farming schemes - to make it affordable for smallholders while conserving groundwater at scale.



"Farmers don't need charity, they need choices," Ayan reflects - echoing the values of his grandfather. His journey is proof that when youth innovation meets farmer wisdom, farming becomes more than survival: it becomes a legacy carried forward with dignity, resilience, and hope.





REAL-TIME HIVE ANALYTICS

INNOVATIONS IN SENSOR-BASED BEEKEEPING

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Beekeeping is an ancient practice of managing honey bees for the production of honey, beeswax and other valuable hive products. Beyond this, honey bees play a vital role in the pollination of many cultivated crops, significantly contributing to global food security by improving both the quantity and quality of yields. Traditionally, the harvesting of hive products and the assessment of colony status have relied on manual inspections conducted by beekeepers equipped with protective clothing. Such inspections typically evaluate colony weight, brood condition (eggs

and pupae), the presence of a healthy queen and the availability of nectar and pollen reserves essential for colony survival. In recent years, technological innovations particularly the integration of sensor based monitoring systems have transformed apiculture by providing real-time data and actionable insights that support more efficient and sustainable colony management.

Need for Sensors in beekeeping

Conventional hive inspections, which require physically opening the hive, often aggravate colonies, disrupt honeybee behaviour and lead to measurable productivity losses. Manual monitoring of colony parameters such as honey yield, weight, pest incidence, and disease prevalence is labour-intensive, time-consuming and unsuitable for the large-scale management of colonies. Repeated inspections further compromise colony strength, with each inspection estimated to cause the loss of approximately 3% of worker bees. Over time, such losses result in reduced productivity. Seasonal factors also present

challenges; during winter, honeycomb structures may be destroyed by the formation of host organisms within the hive, further diminishing yield. To overcome these limitations, bee hive sensor systems have emerged as an advanced technological solution. These systems provide continuous, non-invasive monitoring of critical parameters including hive temperature, humidity, weight, activity levels, and even the health and behaviour of individual bees. By offering insights into colony biology, seasonal growth patterns and apicultural management practices, sensor-based technologies enable more efficient, sustainable, and productive beekeeping.

Sensors used in beekeeping:

Sensors may be installed both inside and outside beehives, offering real-time data that beekeepers can access remotely. Various sensors used in bee keeping includes

1. Temperature and Humidity Sensors:

Temperature and humidity sensors assist beekeepers in





monitoring the climate conditions within the hive, ensuring the ideal conditions for the bees development and honey production. Fluctuations may indicate stress, illness, or the presence of pests.

2. Weight Sensors:

Sensors are positioned underneath the hive to constantly monitor its weight. A abrupt drop in weight may indicate a nectar scarcity or even a swarm, whereas a consistent increase indicates a good nectar flow and honey production. Weight sensors, on the other hand, aid in determining honey production and nectar flow rate, allowing beekeepers to take decisions.

3. Acoustic Sensors:

Beekeepers may keep monitoring on activity levels by

using acoustic sensors, which measure up the sound and vibrations produced by bee movement. By identifying sound waves, motion, and changes in electric charge, microphones, accelerometers, and piezoelectric sensors continuously detect the hive vibrations, sounds, and motions. Relevant information on colony behavior, communication pattern, stress levels, and general hive health can be gathered from the data obtained.

4. Camera and Image Sensors:

Cameras and image sensors

can capture images of the hive's interior, allowing beekeepers to inspect frames for eggs, pupae and the queen's presence. This technology can also be used to automatically identify pests or signs of disease.

5. Gas and Air Quality Sensing:

Sensors for gases like carbon dioxide (CO₂) can indicate the overall metabolic activity of the hive. High CO₂ levels can suggest a strong, healthy colony, while unusual fluctuations can alert beekeepers to a problem.

Commercial bee hive sensors

Company	Sensor type	Communication/ UI
Solutionbee	Weight, Outside temperature	App, Web
Broodminder	Inhive and outside temperature, Hive weight	Web
Arnia	Inhive temperature, Hive weight	Web
BeeSmart	Inhive Temperature and Humidity, Sound.	Web
3BEE	Sound, Inhive temperature and humidity, weight	App
Apiara	Hive weight and Temperature	Web
ApisProtect	Temperature, humidity, Sound detector	Web
Buzzbox	Temperature, Humidity	Web



Previous Issues



Website Statistics (Aug. 2025)

152K

**Monthly
Pageview**

56K

**Monthly
Visitor**

3.5M

**Monthly
Impression**

Social Stats



6.5K



5.8K



9.5K



1.7K



2.1K



Times of Agriculture
A Resonance in Agriculture



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WATERLESS MILK AND MEAT? THE RISE OF PRECISION FERMENTATION

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Did you realize that tomorrow's coffee might contain milk from a lab rather than a cow and still taste just the same? Or that you could grow your burger patty without killing any animals? Greetings from the precision fermentation universe, where food is not raised like cattle but is produced like beer. Human food production is changing in a way that has never been seen before. Over the last ten years, scientists have been able to use microbes instead of animals to "brew" dairy proteins, meat components, and functional additives. What it means to grow, cook, and eat is being redefined by this method, which is called precision fermentation. With precise fermentation, bioidentical proteins can be produced using a

fraction of the resources used in traditional livestock systems, which use enormous amounts of feed, water, and land. In addition to highlighting prominent figures in the worldwide business and up-and-coming startups, this article delves into the science underlying precision fermentation and considers the social, environmental, and economic ramifications of this game-changing technology.

Precision Fermentation:

Precision fermentation makes use of microorganisms like Yeast, fungi, or bacteria that have been genetically engineered to produce particular animal proteins like collagen, whey, or casein are used in precision fermentation. Microbes are put in fermentation tanks and "fed" sugar or other carbon sources, just like when making beer. They produce proteins that are molecularly identical to those found in meat, eggs, and cow's milk rather than alcohol.

The end product is a true bioequivalent rather than a plant-based substitute: collagen without slaughter, egg whites without hens, and dairy proteins without cows.

Emerging Start Ups:

- **Perfect Day (USA):** Produces cow-free whey proteins already used in ice cream and cream cheese sold in supermarkets.
- **Remilk (Israel):** Developing large-scale fermentation plants, addressing water scarcity and climate pressures.
- **Formo (Germany):** Crafting authentic cheeses for the European market using precision-fermented proteins.
- **Future Cow (Brazil):** Raised nearly R\$4.85 million in 2025 to advance fermentation-based milk for local markets.
- **Brown Foods (USA):** Developing Unreal Milk, the world's first whole cell-cultured milk, projected to use 90% less water and 95% less land.
- **Better Dairy (UK):** Producing human osteopontin for infant nutrition—improving calcium absorption and gut health in formula-fed babies.
- **Eden Brew (Australia):** A co-op venture integrating traditional dairy farmers into the precision fermentation value chain.



Economic and Environmental Effects:

- **Water savings:** About 1,000 Liters of water are needed to produce one litre of cow's milk. Milk that is fermented uses more than 90% less (Forbes, 2024).
- **Climate:** According to the FAO, livestock contributes around 14.5% of global greenhouse gas emissions. Emissions can be lowered to less than 5% of animal equivalents with precision fermentation (Green Queen, 2025).
- **Land use:** Compared to dairy herds, fermented proteins require 95% less land, which might free up millions of hectares for replanting or food crops.
- **Market expansion:** By 2030, analysts estimate the precision fermentation ingredients market would be worth USD 36 billion (Boston Consulting Group, 2023).

Implications for farmers:

- Traditional dairy farming is undoubtedly being disrupted, but new models are appearing, Government transition plans and private investment will play a major role in the future of rural livelihoods.
- **Risk:** Without assistance programs, the widespread adoption of cow-free proteins could cause rural economies in India, where 80 million households rely on dairy products, to become unstable.
 - **Opportunity:** Farmers can provide fermentation facilities

using feedstock crops including corn, sugarcane, and sorghum.

- **Adaptation:** By co-owning fermenting businesses, farmer cooperatives can participate in the value chain, as demonstrated by Australia's Eden Brew. Government transition plans and private investment will play a major role in the future of rural livelihoods.

Applications beyond Meat and Milk:

While dairy and meat replacements dominate headlines, precision fermentation's scope extends further:

- **Lactoferrin and osteopontin** are functional proteins that support immunity and the development of infants.
- **Nutraceuticals:** High-value supplements with enhanced bioavailability.
- **Natural food colours:** Companies like Phytolon produce stable pigments via yeast fermentation.
- **Space applications:** Microbes have been tested aboard SpaceX missions to evaluate fermentation under microgravity, demonstrating potential for closed-loop food systems in space exploration.

Safety and Regulation:

The FAO confirmed in a report published in 2024 that there are no essentially new concerns to food safety associated with precise fermentation. It is possible to modify established standards such as

HACCP and Codex Alimentarius. But regulation is still disjointed:

- **Singapore:** In 2020, it became the first nation to authorize grown meat.
- **Australia:** According to The Guardian, approved lab-grown quail goods will be available in 2025.
- The European Union is creating a channel for "novel foods," while companies are complaining about delays.
- **UK:** To expedite approvals, a regulatory "sandbox" was introduced in 2025.

Conclusion:

One of the most significant food breakthroughs of the twenty-first century is precision fermentation. It has the potential to significantly lessen negative effects on the environment, increase food security, and diversify the world's protein supply chain. However, public trust, supportive regulatory frameworks, and careful integration with farming communities are necessary for its success. Precision fermentation has the potential to completely alter the fundamentals of food production, much like tractors replaced oxen ploughs and drip irrigation transformed desert agriculture. Whether this technology will scale is no longer the question; rather, it is how society will make sure it benefits farmers, consumers, and the environment.

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India's Most Visited Agri-Websites

A quick comparison of the top-performing agriculture websites based on monthly organic search traffic.

Tractor Junction

Domain Overview: tractorjunction.com			
Worldwide	US	UK	VN
Desktop	Apr 18, 2025	USD	
Overview	Compare domains	Growth report	Compare by countries
Authority Score	Organic Search Traffic	Paid Search Traffic	
57	2.8M	192	-84%

Tractor Guru

Domain Overview: tractorguru.in			
Worldwide	US	UK	VN
Desktop	Apr 18, 2025	USD	
Overview	Compare domains	Growth report	Compare by countries
Authority Score	Organic Search Traffic	Paid Search Traffic	
40	578.9K		

ICAR

Domain Overview: icar.org.in			
Worldwide	US	UK	IN
Desktop	Apr 18, 2025	USD	
Overview	Compare domains	Growth report	Compare by countries
Authority Score	Organic Search Traffic	Paid Search Traffic	
57	367.4K		

Times of Agriculture

Domain Overview: timesofagriculture.in			
Worldwide	US	UK	VN
Desktop	Apr 18, 2025	USD	
Overview	Compare domains	Growth report	Compare by countries
Authority Score	Organic Search Traffic	Paid Search Traffic	
34	202.1K		

Tractor Gyan

Domain Overview: tractorgyan.com			
Worldwide	US	UK	VN
Desktop	Apr 18, 2025	USD	
Overview	Compare domains	Growth report	Compare by countries
Authority Score	Organic Search Traffic	Paid Search Traffic	
40	154.2K		

Apni Kheti

Domain Overview: apnikheti.com			
Worldwide	US	UK	IN
Desktop	Apr 18, 2025	USD	
Overview	Compare domains	Growth report	Compare by countries
Authority Score	Organic Search Traffic	Paid Search Traffic	
40	159.9K		

Krishi Jagran

Domain Overview: krishijagran.com			
Worldwide	US	UK	IN
Desktop	Apr 18, 2025	USD	
Overview	Compare domains	Growth report	Compare by countries
Authority Score	Organic Search Traffic	Paid Search Traffic	
47	88.8K		



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