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A Resonance in Agriculture

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REMOTE SENSING IN AGRICULTURE

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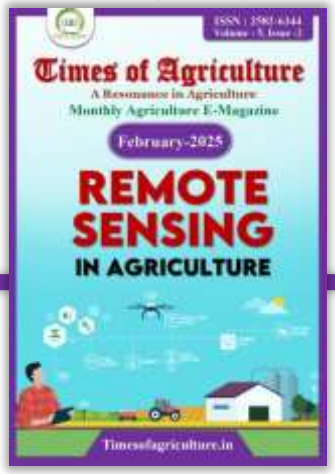

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From the Editor's Desk

Dear Readers,

Hope you are doing well. We are pleased to release the February issue of **Times of Agriculture magazine**. With the presentation of the **Union Budget 2025**, the Indian agriculture sector has received a significant boost through increased allocations and innovative initiatives. This budget focuses on strengthening the rural economy, empowering farmers, and integrating advanced technologies to enhance agricultural productivity.

In this edition, we explore the role and importance of remote sensing in agriculture. This technology provides farmers with precise and timely information on crop health, soil moisture, and weather patterns, enabling them to make informed decisions. By utilizing remote sensing, farmers can reduce crop losses, optimize resource use, and ultimately improve yields. Promoting such innovations can bridge the gap between traditional farming methods and modern agricultural advancements.

Additionally, we highlight key aspects of the Agriculture Budget 2025. The increase in the Kisan Credit Card (KCC) limit from ₹3 lakh to ₹5 lakh marks a major step in supporting farmers financially. Furthermore, 30 lakh more farmers have been added as beneficiaries under the PM-KISAN scheme. The newly introduced PM Dhan Dhanya Krishi Yojana aims to identify 100 districts for agricultural development, fostering innovation and sustainability in farming. We hope this edition of Times of Agriculture magazine provides valuable insights and keeps you informed about the latest advancements in the sector.

Thank you very much, and enjoy reading!

Editor-In-Chief

CONTENT

Times of Agriculture
A Resonance in Agriculture

AGRICULTURE UPDATES

Government Announces Union Budget 2025-26 with a Strong Focus on Agriculture

The **Union Budget 2025-26**, presented by Finance Minister Nirmala Sitharaman, introduced major reforms to enhance agricultural productivity, self-reliance, and rural prosperity. A **Makhana Board** in **Bihar** will improve production, processing, and marketing, while a **National Mission on High Yielding Seeds** will develop over **100 climate-resilient seed varieties**. A **second Gene Bank** with **10 lakh germplasm lines** will also be established.

To boost cotton farming, a five-year **'Mission for Cotton Productivity'** will focus on extra-long staple cotton and sustainable practices. A new **12.7 lakh metric ton urea plant** in **Assam** will enhance domestic fertilizer supply. A six-year **'Mission for Aatmanirbharta in Pulses'** will focus on tur, urad, and masoor, ensuring climate-resilient seeds, better post-harvest management, and remunerative prices.

The **Prime Minister Dhan-Dhaanya Krishi Yojana** will cover **100 low-productivity districts**, improving irrigation, post-harvest storage, and credit access. A **Rural Prosperity and Resilience Programme** will focus on investment, skilling, and employment opportunities for women, small farmers, and rural youth.

A **vegetables and fruits programme** will enhance production, supply chains, and processing, ensuring better farmer incomes. With India being the second-largest global fish producer, a sustainable fisheries framework will be introduced in **Exclusive Economic Zones, Andaman & Nicobar, and Lakshadweep Islands**. These initiatives aim to strengthen India's agricultural and rural economy, driving growth and self-reliance.

NABARD Conducted "Export Pathshala" Workshop in Bhubaneswar to Boost Agri-Exports from Odisha

The National Bank for Agriculture and Rural Development (NABARD), in collaboration with Palladium Consulting India Private Limited (PCIPL), conducted the "Export Pathshala," a three-day workshop from 07-09 February 2025, in Bhubaneswar, focusing on enhancing exports of fresh fruits and vegetables from Odisha.

The first-of-its-kind workshop aimed to equip Farmer Producer Organizations (FPOs) and agri-entrepreneurs with essential knowledge and skills for tapping into global markets. Resource persons from the Agricultural and Processed Food Products Export Development Authority (APEDA), World Trade Centre, Bhubaneswar, Spices Board, and exporters' associations from West Bengal and Odisha guided the FPOs in undertaking exports of fresh fruits, vegetables, and spices from Odisha. Representatives from the Bank of Baroda, NCDC, and NABARD-supported FPOs from 15 districts also participated in the Pathshala.

The workshop focused on presentations on the agriculture sector in Odisha by APEDA and export facilities available in the state by the World Trade Centre, Bhubaneswar, followed by a virtual orientation session by Sahyadri Farms, Nashik. A field visit was also conducted to expose FPO members to good packaging practices.

The event included panel discussions that brought together leading exporters from Odisha and West Bengal, who shared insights into the current export scenario and growth potential in agri-trade. Case studies from successful FPOs and agri-entrepreneurs, including export experiences of mango and vegetable-producing FPOs from Dhenkanal and Bolangir, were also presented.

Government Expands e-NAM by Adding 10 New Commodities for Improved Market Access

The Indian government has expanded the scope of the National Agriculture Market (e-NAM) by adding 10 new agricultural commodities for trading. With this inclusion, the total number of commodities on the e-NAM platform has reached 231. The move is aimed at improving price realization for farmers and ensuring a more transparent and efficient trade system.

The newly introduced commodities include both raw and value-added agricultural products:

- Dried Tulsi Leaves
- Besan (Chickpea Flour)
- Wheat Flour
- Chana Sattu (Roasted Chickpea Flour)
- Water Chestnut Flour
- Asafoetida
- Dried Fenugreek Leaves
- Water Chestnut
- Baby Corn
- Dragon Fruit

Among these, items like Chana Sattu, Water Chestnut Flour, Asafoetida, and Dried Fenugreek Leaves are categorized under secondary trade. Their inclusion is expected to help Farmer Producer Organizations (FPOs) gain better market access for processed and value-added products.

How Will These New Commodities Benefit Farmers

- Provide greater market reach by enabling farmers to sell beyond local mandis.
- Ensure better income generation through transparent price discovery.
- Promote agriculture diversification by encouraging the production and trade of high-value crops like baby corn and dragon fruit.

Anantapur gears up to become country's Major horticulture hub

Andhra Pradesh's city of Anantapur is gearing up to become a major horticulture hub in the country. The district has successfully exported over one lakh tonnes of bananas to Iran. Encouraged by this achievement, the state government has planned to promote five more horticulture crops in a similar manner.

The minister stated that, given the positive response, the horticulture conclave will now be held annually. He emphasized the need to address all issues in the horticulture sector, from nurseries to marketing. He further added that setting up large-scale cold chains is crucial to supporting farmers and increasing their income.

To promote agriculture, the government has decided to expand the Handri-Neeva canal this season. With this development, 12 pump sets will operate to provide irrigation to farmlands. The project is expected to be completed within a year. Special Chief Secretary for Horticulture and Agriculture, Budithi Rajasekhar, assured that the government is committed to addressing all challenges in the sector.

He explained that per hectare banana production in Anantapur stands at 65 million tonnes (MTs), close to Turkey's 70.2 MTs, which is the highest yield in the world. Special focus will be given to maintaining supply chains to improve quality and packaging. Efforts are also being made to reduce post-harvest losses from 15-20% to just 9%.

Six crops—banana, dry chili, sweet orange, tomato, mango, and dragon fruit—have been identified by both the central and state governments for optimal production. The ultimate goal is to establish Anantapur as a leading brand in horticulture.

Government Launches 'Mission for Aatmanirbharta in Pulses' with ₹1,000 Crore Allocation in Budget 2025-26

The Union Finance Minister, in the Budget 2025-26, announced the launch of a six-year-long **"Mission for Aatmanirbharta in Pulses"**, aimed at achieving self-reliance in pulse production. The government allocated ₹1,000 crore for the initiative, with a special focus on tur/arhar (pigeon pea), urad (black gram), and masoor (red lentil).

The mission will emphasize the development and commercial availability of climate-resilient seeds, enhancing protein content, increasing productivity, improving post-harvest storage and management, and ensuring remunerative prices for farmers. To support this, NAFED (National Agricultural Cooperative Marketing Federation of India) and NCCF (National Cooperative Consumers' Federation of India) have been directed to procure these three pulses from farmers registered with these agencies over the next four years.

The initiative comes as a crucial step toward self-sufficiency, considering that India's pulse imports during April-November 2024 were valued at $3.28 billion, reflecting a 56.6% increase compared to $2.09 billion in the corresponding period of 2023.

To achieve this goal, the agriculture ministry has planned to establish model pulses villages from the current kharif (summer-sown) season to promote targeted pulse production. Additionally, the government is working with states to utilize fallow land for lentil cultivation and expand pulse production. The plan also includes the creation of 150 hubs to distribute high-yielding seeds across pulse-growing regions.

Finance Minister Unveils 'PM Dhan Dhanya Krishi Yojana' to Boost Agricultural Development

In her historic **8th Union Budget address on February 1, 2025**, Finance Minister **Nirmala Sitharaman** announced the launch of the **Pradhan Mantri Dhan Dhanya Krishi Yojana**, also known as the **Developing Agri-Districts Initiative**. Inspired by the **Aspirational Districts Program** launched in 2018, this initiative aims to transform **100 districts** with **below-average characteristics, moderate crop intensity, and low productivity** into agriculturally developed regions.

The PM Dhan Dhanya Krishi Yojana is an ambitious central government program focused on enhancing irrigation, improving soil fertility, and providing quality seeds and fertilizers to farmers. It will cover infertile, barren, and underdeveloped agricultural land, aiming to increase cultivation and support farmers in these regions. The initiative is expected to benefit 1.7 crore farmers across the country.

Additionally, the Finance Minister announced the launch of a comprehensive multi-sectoral 'Rural Prosperity and Resilience' program in partnership with states. This initiative aims to address under-employment in agriculture through skilling, investment, technology adoption, and strengthening the rural economy. The objective is to generate ample opportunities in rural areas, ensuring that migration remains an option rather than a necessity. The program will focus on rural women, young farmers, rural youth, marginal and small farmers, and landless families.

Budget 2025-26 Slashes Customs Duty on Frozen Fish Paste and Fish Hydrolysate to Boost Seafood Industry

The **Union Budget 2025-26** announced a significant reduction in **basic customs duty (BCD)** on **frozen fish paste (surimi) and fish hydrolysate**, aiming to boost **exports, domestic manufacturing, and value addition** in India's seafood sector.

The BCD on frozen fish paste (surimi) was reduced from 30% to 5%. Surimi is a key ingredient in producing frozen and processed seafood products, including imitation crab meat sticks, shrimp analogues, and lobster analogues. This move is expected to enhance India's competitiveness in the global seafood market.

Similarly, the BCD on fish hydrolysate was reduced from 15% to 5%. Fish hydrolysate is a vital additive in the feed of harvested fish and shrimp, supporting aquaculture growth and sustainability.

In addition to these measures, the Kisan Credit Card (KCC) scheme has been expanded to provide short-term loans to 7.7 crore farmers, fishermen, and dairy farmers. The loan limit under the Modified Interest Subvention Scheme has been increased from ₹3 lakh to ₹5 lakh for loans availed through the KCC. This initiative aims to improve access to credit and strengthen the financial stability of India's agricultural and fisheries sector.

COVER STORY

REMOTE SENSING IN AGRICULTURE

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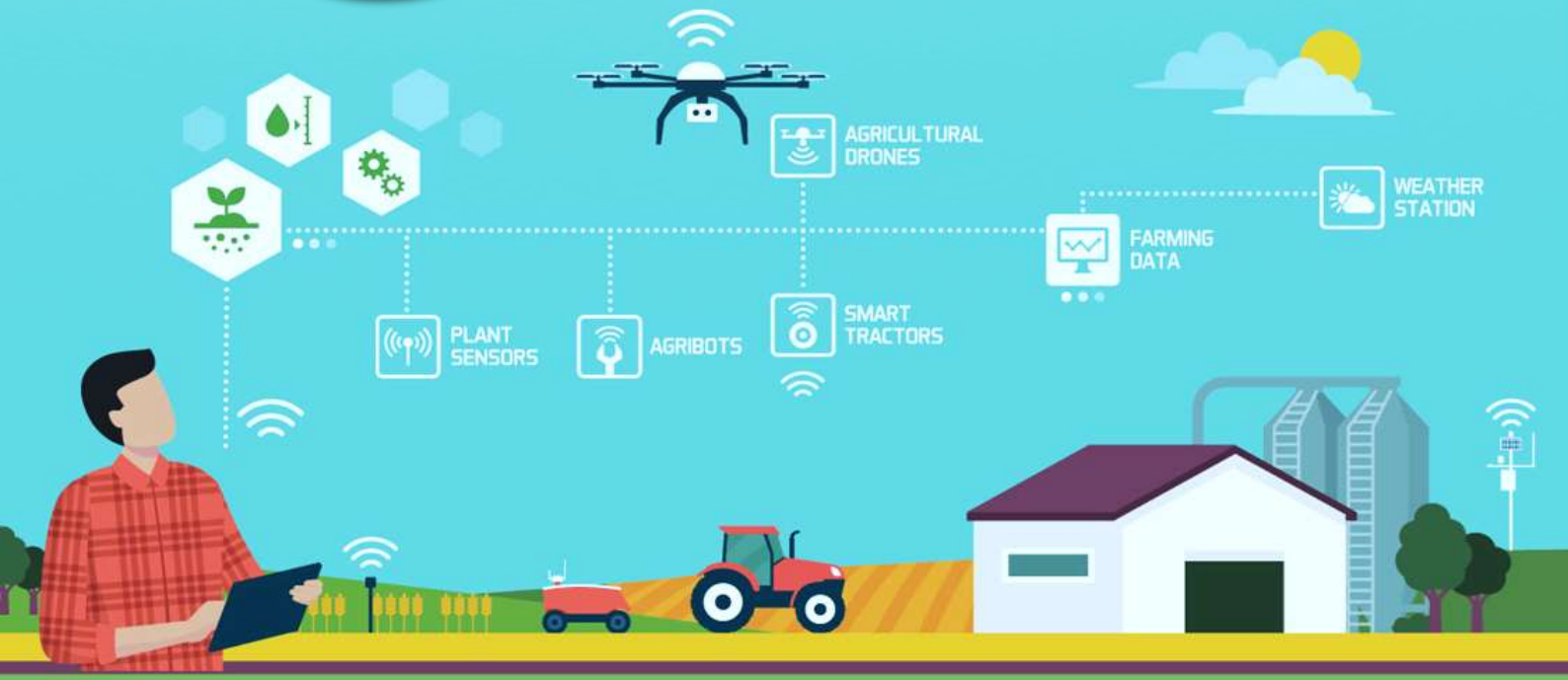


International society for precision Agriculture ISPA states that Remote sensing is a key technology for precision Agriculture, enabling farmers to collect data on crop health, growth and development and make informed decisions about irrigation, fertilization, crop monitoring and pest management.

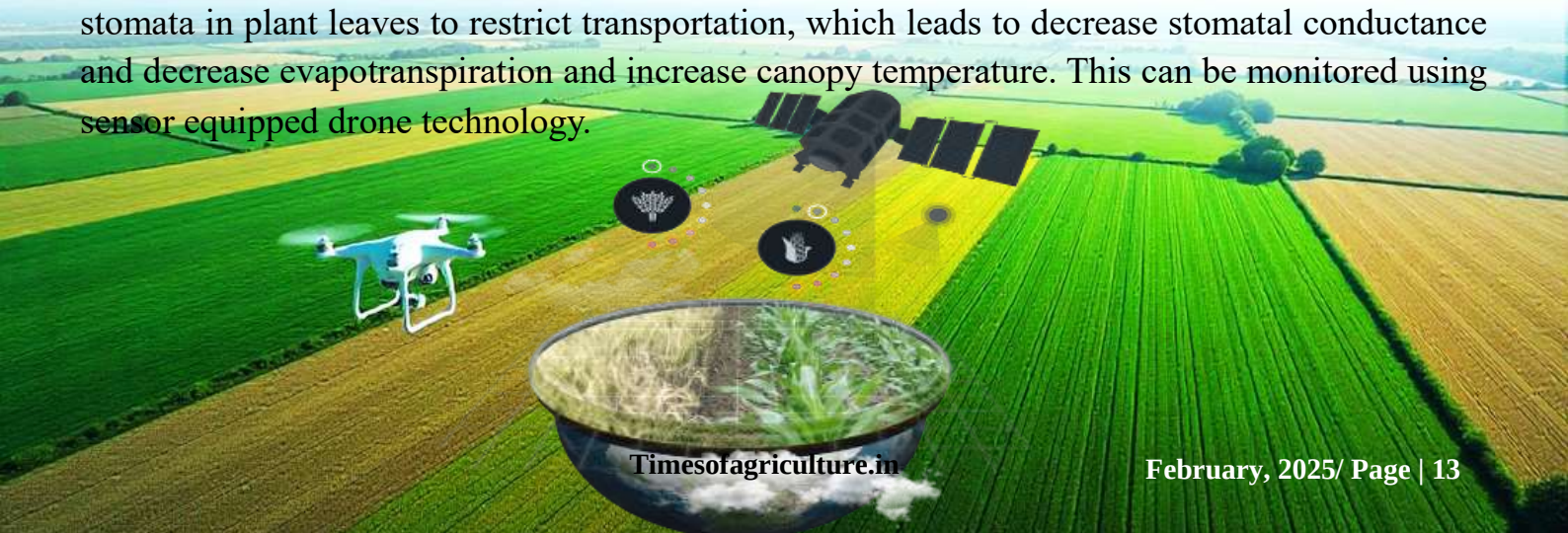
Remote sensing is capturing of image over the crop fields that can be used for mapping soil type, properties, classification of crop species, assessing crop stress over water, monitoring unwanted weeds and crop diseases, pest attacks and mapping of crop yield. The data collected is influenced by type of platform (satellite, airborne, ground based) and spatial resolution (high, medium, low), temporal (hourly, daily, weekly) and radiometric resolution data, which was collected by sensors.

Remote sensing applications in agriculture:

1. Crop yield prediction using multi sensors remote sensing: Crop yield highly depends on the pre harvest conditions of crop, where prediction and assessment of tactical strategies will help farmers prevent crop failure or early strategies in safeguarding producing inputs and harvesting outputs. Spatial resolution is the minimum ground area that can be identified through remote sensing. Smallest area can be monitored is 10m by Sentinel-2 ,20m by Spot and 30m by Landsat sensor. Revisiting time of satellite platforms like IKONOS is 1 to 3 days, Landsat 16 days and Spot 26 days provides farmers with scheduling of data monitoring based on crop growth stages. The electromagnetic spectrum radiation from sun is expressed in wavelengths which responds differently for different colors and features in the field helps detecting stress, damage and plant disease quickly. This is a non- destructive, cost effectively, low labor intensive and timely operative application which can be addressed from anywhere over the globe.

2. Crop Stress Detection Using Drone Remote Sensing: Crop water stress indicates deficit water based on leaf area and crop temperature, which impacts implementation on precision irrigation. Traditional water stress detection is low effective and affected by many field conditions. The experimental set-up required is expensive and time consuming for data interpretation and processing output.

Using drone based remote sensing benefits farmers as it is of low cost, compact equipment, reasonable data evaluation time and acquiring high resolution image data. This drone technology can also be used for monitoring seedling germination rate, leaf area index, plant biomass, chlorophyll content and nitrogen content. The drought conditions can cause stomata in plant leaves to restrict transportation, which leads to decrease stomatal conductance and decrease evapotranspiration and increase canopy temperature. This can be monitored using sensor equipped drone technology.



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3. Remote Sensing in Water Quality Monitoring: Water resources are vital for survival of human beings, plants, and animals. Water quality also effects the soil condition which leads to land degradation, pollution and effects health and yield of crop. Water quality parameters indicate quality level, water environment and describes ecological environment. Water quality monitoring is essential for detection, tracking and contamination of water pollution for timely precautionary measures and management practices.

4. Remote Sensing For Crop Disease And Pest Detection: Remote sensing is a prominent technology for identifying, perfecting and controlling crop diseases and collects large quantity of data for model making, decision taking in insect and pest control with limiting the use of chemical pesticides which effects environment if used excessively and indiscriminately. Pest infestation should be detected at early stage to undertake preventive and management steps to safeguard crop growth and ultimately crop yield. The remote sensing technologies are coupled with image processing and spectroscopy-based equipment's.

5. Irrigation Management With Remote Sensing: The irrigation water management tool for farmers at farm scale will start with utilizing and merging a few available soil moisture sensors and L- band satellite data of surface soil moisture and interpretation using machine learning. The sensing sensors with integrated model with simulations create framework to minimize water use while not allowing soil moisture to drop below threshold level. With remote sensing, we can save 20- 30 % of water without compromising crop yield. With remote sensing and combining weather forecasting we can have 7 days lead for application decisions and 3 weeks lead for arrangement of ready to go irrigation systems.

6. Remote sensing in mobile agricultyral machinery:

a) Precision tractors: It consists of Auto-Steer mechanism and Auto- Guidance by using GPS and sensors to guide along the pre-determined path, reducing overlap and saves fuel, labor cost and other valuable inputs. It is used for application of fertilizers, pesticides and seeds at variable rates of requirement. It sprays precisely saving inputs, reducing environmental impact and reduces interaction and effect of chemicals on humans.

b) Laser guided harvester: uses laser technology for guiding harvester, with improved accuracy and efficiency. It detects the crop and guide the harvester and adjust the harvester reel height to optimize cutting height and reduce wastage. It detects the crop density and moisture which is crucial in preventing pre harvesting losses. Example- John deere's AutoTrac, New holland's precision farming harvester.

Remote sensing-based start-up insights

1- YieldX

YieldX is a Israel start up offers bio security solutions that provide real time bio security insights for poultry farming. It considers factors like vision, sound and smell to monitor farm environment continuously. YieldX developed Redmite sense, a smart sensor to detect red mites in layer poultry house. Trolley Mate Tag is attached to an egg / chick trolley for transport and monitor eggs and chicks in motion. It helps farmers to address and eradicate poultry farming problems and increase income.

2- Agristry

AGRISTRY is an Australia startup makes precision Agriculture platform that helps in crop mapping through drone imagery analysis and plant indices. It creates crop health maps and monitor crop development over the season. It provides insights on Plant population, crop readiness for harvesting, stress detection and weed maps.

3- Harpe Bio Pesticides

Harpe Bio Pesticides Is a is USA based startup that formulates natural herbicides from Plant extraction. The natural herbicides act as an alternative to synthetic chemical herbicides.

4- Trabotyx

Trabotyx is a Dutch startup develops an advanced weed control system featuring a single row autonomous wedding Robot with modular wheelbase. It reduces labor cost and helps farmers in indulging other essential farm works.

5- Farmo

Farmo makes remote sensors for farm monitoring. It is an Australian startup which provides IoT solution for farm monitoring leveraging LoRaWaN and NB IoT technology, which monitor tank water level. Electrical fence sensor sends alert notification to farmers when there is need to monitor over theft.

Remote sensing has revolutionized agriculture yet there are some limitations to be considered:

Technical limitations: Spatial resolution data is limited and has effect on small scale features. Atmospheric conditions like clouds, haze and aerosols can interfere with remote sensing data and reduce its accuracy. Remote sensing sensors require regular calibration to attain accurate data which is the time consuming and costly.

Practical limitations: Remote sensing technology and data can be expensive and require technical prerequisites making it inaccessible to small scale farmers. Remote sensing requires reliable internet connection, specialized expertise hardware and software are the limitations in rural areas with poor infrastructure.

Support and training limitations: Farmers may not have access to adequate technical support and access to training and education on how to use effectively. Farmers may not have access to experts who can help them interpret remote sensing data and make informed decisions.

Future directions:

1. Integrating remote sensing with other technologies like IoT, AI and robotics can enhance its capabilities and applications.
2. Advancements in sensor technology and data processing can improve accuracy and resolution.
3. Development cost effective and user-friendly remote sensing solutions can increase accessibility and acceptability for small scale farmers.

Conclusion:

Remote sensing assesses over all crop condition and provide insights into crop production by considering climate, soil characteristics, soil nutrients, crop canopy, water content, disease, weed infestation and variety etc.

Farmers should explore partnerships with startups in the agricultural technology space. These companies often offer innovative solutions, financial assistance, infra-structure and guidance that enhance farm productivity and sustainability. The growing use of remote sensing and related technologies spurs job creation in the tech and agritech industries for youth. This includes roles in data analysis, machine learning, drone operation, sensor manufacturing, and software development. Additionally, farmers may need skilled technicians for sensor calibration, maintenance, and system integration, which further support employment.

In conclusion, the economic effects of remote sensing in agriculture extend beyond the farming sector, benefiting national economies through increased productivity, cost savings, job creation, environmental sustainability, and improved trade opportunities. By fostering a more efficient, sustainable, and resilient agricultural system, nations can enhance their economic growth and achieve long-term agricultural stability.

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AGRI-BUDGET 2025

AGRICULTURE AS THE FIRST ENGINE OF DEVELOPMENT

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The Agri-Budget 2025, delivered by Finance Minister Nirmala Sitharaman, reaffirms agriculture as the "First Engine of Development." Priorities include productivity, farmers' welfare, and rural development, acknowledging the important position that agriculture holds in the Indian economy. Major emphasis areas are modernization, credit facility, quality seeds, effective supply chains, and value addition. Climate resilience, infrastructure upgradation, and adoption of technology align with the "Aatmanirbhar Bharat" vision for self-reliance and sustainability. Through a multi-sectoral strategy, the budget seeks long-term rural development, enhanced farmer incomes, and a strong agriculture economy, putting agriculture at the center of India's economic future.

Major budgetary expenditures

A. Overall budgetary allocation for agriculture:

Agri-Budget 2025 gives top priority to agriculture as the prime growth driver, with ₹1.37 lakh crore provided to the Ministry of Agriculture and Farmers' Welfare. The Department of Agriculture and Farmers' Welfare is given ₹1.27 lakh crore, while Agricultural Research and Education is given ₹10,466 crore. Notwithstanding a fall of 2.5% over ₹1.41 lakh crore in the last year, fisheries, animal husbandry, and dairying experience a 37% growth to ₹7,544 crore, and financing for food processing increases by 56% to ₹4,364 crore.

B. Comparison with previous budgets & key initiatives:

Strong funding is given to key projects. The PM Dhan-Dhaanya Krishi Yojana focuses on 100 backward areas, with 1.7 crore farmers to benefit. The Mission for Aatmanirbharta in Pulses increases production of pulses with NAFED and NCCF providing price stability. The National Mission on High Yielding Seeds formulates 100 weather-resistant seed varieties, while the Kisan Credit Card now offers credit up to ₹5 lakh. A 12.7 LMT plant in Assam also reduces dependence on fertilizers.

Major policy announcements

Agri-Budget 2025 announces major policies for transforming agriculture, financial inclusion, and sustainability. A rural prosperity program covering several sectors will enhance infrastructure, skill development, and agribusiness investment with priority areas being cold storage, farm-to-market road connectivity, and digital financial services. The main schemes are:

a. Dhan-Dhaanya Krishi Yojana: Targets 100 low-productivity districts

through enhanced irrigation, automation, and financial inclusion via government-provided solutions.

b. Aatmanirbharta Mission in Pulses: A six-year mission for raising the production of Tur, Urad, and Masoor, with assured procurement prices being offered by NAFED and NCCF.

c. National Mission on High Yielding Seeds: Produces over 100 varieties of climate-resistant seeds in association with agricultural universities and private industry companies.

d. Mission for Cotton Productivity: Five-year scheme to enhance extra-long staple (ELS) cotton production with improved irrigation and pest management.

e. Integrated Programme for Vegetables & Fruits: Horticulture is promoted with investment in cold storage, logistics, and processing to curb post-harvest losses.

f. Makhana Board in Bihar: Enhances Makhana production, processing, and branding to boost exports.

g. Enhanced Credit Through Kisan Credit Card (KCC): Raises the loan limit from ₹3 lakh to ₹5 lakh, which will benefit 7.7 crore farmers.

h. Urea Plant at Assam: A 12.7 LMT per year plant at Namrup ensures a consistent supply of fertilizer.

These measures consolidate agricultural modernization, financial empowerment, and sustainability, which will usher in long-term rural prosperity.

Bridging challenges and gaps in Indian agriculture

a. Issues in fund implementation and use: In spite of huge budgetary expenditures, fund use is inefficient. It was seen, as a CAG audit revealed, that only 30.3% of the intended agricultural projects were implemented. Inadequate record-keeping at gram panchayat levels limits monitoring and evaluation of fund use.

b. Bending bureaucratic red tape: Delayed policy implementation keeps subsidies and loans away from farmers. Administrative inefficiencies and government departments' coordination gaps keep approvals slowed up, introducing fiscal pressure onto waiting farmers.

c. Reaching marginal and small farmers with benefits: Small farmers are not well-informed, have difficulty accessing credit, and are exploited by middlemen. Increasing coverage under Kisan Credit Card, making application processes simpler, and raising financial literacy levels can improve financial inclusion and ensure benefits reach the intended beneficiaries.

Resolution of these concerns will make fund utilisation more efficient, decrease bureaucratic delay, and ensure the support reaches vulnerable farmers, optimising the value of Agri-Budget 2025 for inclusive agricultural growth.

Agri-Budget 2025 advantages

Agri-Budget 2025 emphasizes financial inclusion, self-reliance, and sustainability. The Kisan Credit Card (KCC) loan limit is increased to ₹5 lakh, enhancing credit access. High-yielding seed investments under the National Mission on High Yielding Seeds will increase productivity with more than 100 durable crop varieties. Self-reliance in pulses and cotton is also encouraged through special missions, minimizing import dependence.

Sustainability programs comprise climate-resilient agriculture, organic farming, and solar water pumping. Online platforms such as e-NAM and AgriStack will enhance market access and reduce middlemen participation. Rural employment is also promoted through agri-business promotion and skill development.

Improvement opportunities

There are still gaps in cold storage, warehousing, and transportation infrastructure, making post-harvest losses higher. Small farmers require easier access to loans, and adoption of agri-tech needs improved subsidies and training. Improved MSP systems and transparent fund allocation will yield the best results and promote inclusive agricultural development.

Conclusion

The Agri-Budget 2025 represents a transformational turn in Indian agriculture, prioritizing self-reliance, rural wealth, and sustainability. Through major investments in financial support, infrastructure, and advanced technology, this budget promises long-term gains for the agricultural sector.

a. Augmenting farmers' incomes: More credit support, subsidies, and MSP mechanisms to ensure financial security.

b. Rural employment boost: Multi-sectoral skill development schemes and employment schemes** to improve the rural labor force.

c. Agricultural productivity: Investment in research, high-yielding seeds, and agri-tech innovations** to optimize production.

d. Ensuring sustainability: Encouragement of climate-resilient agriculture, renewable energy use, and organic farming to ensure long-term farm growth.

e. Strengthening market access: Scaling up e-NAM and direct-to-consumer models to remove intermediaries and provide remunerative prices to farmers.

While the budget is a solid foundation, efficient implementation, transparency, and focus reforms will be required to ensure maximum impact. Emphasis on small and marginal farmers, infrastructure development, and market price stability will make Indian agriculture the key engine of economic growth in the years ahead.

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THE ROLE OF FOOD ENGINEERING
IN OPTIMIZING FOOD MANUFACTURING PROCESSES

About Author

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By integrating scientific principles and approaches to enhance food production's sustainability, efficiency, safety, and quality, food engineering plays a critical role in process optimization. It improves the design, functionality, and management of food processing systems by combining knowledge from several fields, such as fluid dynamics, microbiology, heat transfer, mass transfer, and thermodynamics. With an emphasis on innovations, difficulties, and future prospects, this article examines the diverse role that food engineering plays in enhancing food manufacturing processes.

Introduction

With an upsurge in global food consumption, the growing need for sustainability, and the obligation to guarantee food safety and quality, the food sector has seen a significant transition in recent decades. In order to ensure that food items are produced efficiently and satisfy the required criteria of safety, taste, texture, and nutritional content, food engineering is essential to the optimization of food manufacturing processes. In order to tackle issues like industrial scalability, energy consumption, waste management, and product uniformity, food engineering integrates concepts from several engineering disciplines.

Key areas where food engineering contributes to process optimization

1. Heat and mass transfer in food processing

In the production of food, effective heat and mass transfer procedures are essential. The capacity to regulate temperature and moisture levels is crucial for processes like pasteurization, sterilization, drying, and cooking in order to provide the appropriate product qualities while maintaining microbiological safety.

- **Heat transfer:** Improving heat transfer systems can save energy usage and raise the caliber of output. Engineers can anticipate thermal profiles, model heat movement in food systems, and enhance equipment designs using computational techniques like computational fluid dynamics (CFD).
- **Mass transfer:** In procedures like drying, fermentation, and extraction, mass transfer—which involves the movement of water, solutes, or gases inside food systems—is essential. Designing systems that preserve product texture, flavor, and nutritional value is made easier by an understanding of mass transfer principles.

2. Microbial control and food safety

By avoiding contamination from harmful microbes, the food manufacturing process must guarantee the final product's safety. To maximize microbial control, food engineers employ a variety of strategies, including as heat treatment, cold storage, and cutting-edge preservation procedures like pulsed electric fields (PEF) and high-pressure processing (HPP).

- **Heat treatment and sterilization:** To efficiently eliminate dangerous bacteria and maintain food quality, heat exchanger and sterilization unit designs must guarantee uniform temperature distribution.
- **Emerging technologies:** High pressures are used in non-thermal technologies like HPP to inactivate germs and enzymes, extending food's shelf life without sacrificing its nutritional value or sensory appeal.

3. Automation and control in food manufacturing

Process control and automation innovations are essential for streamlining the production of food. Automation boosts throughput, improves uniformity, and lowers labor costs.

- **Systems for process control:** Critical process factors including temperature, pressure, humidity, and pH may be precisely controlled thanks to sophisticated sensors and real-time monitoring systems. These solutions reduce human mistake and preserve product consistency.
- **Artificial intelligence and robotics:** Robotics in food processing allows for efficient handling, packaging, and quality inspection, while artificial intelligence (AI) systems can predict maintenance needs, optimize processing sequences, and reduce energy consumption.

4. Sustainability and waste minimization

In response to environmental concerns, food engineering also focuses on minimizing waste, reducing energy consumption, and improving the sustainability of food manufacturing processes. This includes optimizing resource use, recycling by-products, and reducing water and energy consumption.

- **Energy efficiency:** Optimizing energy use in thermal processing systems, such as using waste heat recovery and advanced insulation materials, can significantly reduce the carbon footprint of food manufacturing.
- **Zero-waste and by-product utilization:** Food engineers are also exploring ways to utilize food by-products, such as fruit peels and vegetable stalks, to create new products or biofuels. This contributes to both sustainability and profitability in the food industry.

Challenges in food engineering

Despite its many contributions, food engineering faces several challenges. These include balancing food safety with quality preservation, dealing with the complexity of natural food materials, and adapting to consumer preferences for healthier and more sustainable food options.

- **Product complexity:** Natural foods vary in composition, which poses a challenge for engineers in designing universal processing systems that work effectively across different raw materials.
- **Consumer preferences:** As consumer preferences shift towards healthier and more natural products, food engineers must develop processes that preserve the nutritional quality of food while reducing the use of preservatives, artificial additives, and excessive processing.
- **Supply chain and globalization:** The global supply chain introduces further complexities, as food manufacturing systems must adapt to regional variations in raw materials, climatic conditions, and transportation constraints.

Future directions

Innovation, sustainability, and the incorporation of new technology are becoming more and more important in the field of food engineering. Among the crucial areas for improvement are:

- **Food 4.0:** To further optimize the manufacturing process, increase traceability, and improve food safety, industry 4.0 technologies—such as blockchain, machine learning, and the Internet of Things (IoT)—are being incorporated into food production systems.
- **Biotechnology:** New fermentation techniques, enzyme technologies, and plant-based substitutes are being developed as a result of biotechnological breakthroughs, and these developments have the potential to completely transform the food sector.
- **Personalized Nutrition:** Food engineering is expected to be essential in creating customized food items that satisfy dietary requirements based on genetic, environmental, and health data as data gathering and processing skills advance.

Conclusion

In order to maximize food manufacturing processes and guarantee product quality, safety, sustainability, and efficiency, food engineering is essential. Food engineers are spearheading industry innovation by utilizing cutting-edge methods in automation, microbiological control, heat and mass transmission, and resource management. Notwithstanding the difficulties encountered, the industry keeps developing, adopting new techniques and technology to satisfy the constantly shifting needs of the world food market.

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Previous Issues

Website Statistics (January 2025)

160K	69K	3.2M
Monthly Pageview	Monthly Visitor	Monthly Impression

Social Stats

6.5K	5.4K	8.5K	1.7K	2K

NATIONAL EDUCATION POLICY AND AGRICULTURAL EDUCATION IN INDIA

A NEW ERA OF LEARNING

About Author

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Education and agriculture are more than just sectors - they are the backbone of India's progress. To strengthen these pillars, the government has introduced two game-changing policies: the National Education Policy (NEP) 2020 and the National Agricultural Education Policy (NAEP). These policies are designed to make learning more hands-on, skill-driven, and tech-savvy, ensuring that students and farmers alike are better prepared for the future.

NEP 2020: Learning that prepares you for life

For decades, our education system remained unchanged, but NEP 2020 brings a fresh, modern approach. It moves beyond rote learning and focuses on real-world skills, creativity, and critical thinking. With an emphasis on multidisciplinary learning, technology, and flexibility, this policy ensures that students don't just earn degrees—they gain the skills needed to thrive in a rapidly changing world.

Key features of NEP 2020

Feature	Description
New Structure (5+3+3+4)	Replaces the 10+2 system with a phased, scientific learning approach.
Multidisciplinary Learning	Allows students to mix subjects from different streams.
Mother Tongue Learning	Encourages early education in regional languages.
Technology Integration	Promotes AI, digital tools, and online education.
Skill-Based Learning	Focus on vocational training and practical skills.
Flexibility in Higher Education	Offers multiple entry-exit options and a credit-based system.

National Agricultural Education Policy (NAEP):

Making Agricultural Education Future-Ready Agriculture isn't just an industry- it's a way of life for over half of India's population. But while the world moves ahead with smart farming, AI-driven techniques, and sustainable practices, agricultural education has remained stuck in the past. That's where the National Agricultural Education Policy (NAEP) steps in.

NAEP is all about bridging the gap between tradition and technology. The policy integrates hands-on learning, cutting-edge research, and entrepreneurial skills into agricultural education, ensuring that young minds don't just learn about farming-they learn how to innovate, adapt, and lead in a rapidly changing world. With the National Agricultural Education Policy (NAEP), the future of farming isn't just about growing crops-it's about growing opportunities.

Key Features of NAEP

Feature	Description
Revised Curriculum	Focuses on precision farming, organic agriculture, and smart farming techniques.
Technology Integration	Uses AI, IoT, and satellite imaging for better crop monitoring.
Entrepreneurship in Agriculture	Encourages agribusiness startups and self-employment.
Internships & Practical Training	Includes mandatory fieldwork and industry exposure.
Sustainability Focus	Promotes zero-budget natural farming (ZBNF) and organic fertilizers.

Challenges & Implementation Strategies

Challenge	Possible Solution
Lack of trained educators	Capacity-building programs for teachers.
Digital divide in rural areas	Expanding digital infrastructure and affordable internet access.
Resistance to change	Awareness campaigns and incentives.
Funding & resources	Increased government and private sector investment.
Industry-academia gap	Stronger collaboration between universities and agribusiness industries.

Impact on Various Stakeholders

Stakeholder	Impact
Students	Improved career opportunities and practical learning.
Teachers	More focus on research, digital tools, and skill development.
Agriculture Sector	Increased use of modern technology and sustainable practices.
Startups & Entrepreneurs	Growth in agribusiness and innovation.
Government & Policymakers	Strengthened food security and rural development.

Impact of NEP & NAEP

The National Education Policy (NEP) 2020 and the National Agricultural Education Policy (NAEP) are not just reforms-they are blueprints for India's future. By focusing on practical skills, technology, and innovation, these policies are set to bring transformational changes across various sectors.

Conclusion

The National Education Policy (NEP) 2020 and the National Agricultural Education Policy (NAEP) are more than just policy reforms-they are catalysts for change. By promoting multidisciplinary learning, digital innovation, and entrepreneurial growth, these policies are paving the way for a more skilled, self-reliant, and future-ready India.With education that nurtures creativity and critical thinking and agricultural training that embraces technology and sustainability, NEP and NAEP hold the potential to empower millions of students, educators, and farmers. Together, they are not just reshaping industries-they are reshaping the nation's future.

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[From Tea Stall to Farming Frontiers: The Journey of Gramik's Founder]

CROP CONNECT: IOT AND AGRICULTURE

About Author

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The Internet of Things is revolutionizing the technological landscape, and the agricultural sector is no exception. As the backbone of our nation's economy, agriculture is undergoing a significant transformation, driven by innovative solutions and forward-thinking farmers. This article delves into the application's present day IOT in agriculture, and ardor for progressive farming solutions.

IOT and agriculture

The integration contemporary net ultra-modern (IOT) generation in agriculture is revolutionizing the manner farmers domesticate, manipulate, and harvest their vegetation. By way of leveraging a network state-of-the-art interconnected sensors, gadgets, and facts analytics, farmers can now optimize crop yields, reduce water consumption, and decorate average agricultural productivity. As the sector grapples with the demanding situations modern day feeding a growing population, IoT-pushed agriculture offers a promising solution. This article explores the transformative capability ultra-modern IoT in agriculture and highlights its applications and destiny possibilities."

Innovatives:

Smart farming & edge computing system

This system was advanced by way of CDAC, Thiruvananthapuram. SMART FARM machine equips farmers to exactly plan fertigation and irrigation, guaranteeing top-rated production and resource wireless famed for its talent in Artificial Intelligence (AI) and excessive-performance Computing (HPC). C-DAC designed this gadget to address the main issues that farmers confront today. That is designed Wi-Fi especially for Indian farming conditions which state-of-the-art Wi-Fi wireless sensors to accumulate information. The system sends timely alert to farmers on their cellular devices through messages for the duration of important conditions. The structures cloud-based totally analytics, well suited with 4G and 5G networks, offer treasured insights. Additionally, farmers can remotely manipulate water pumps and valves using their cell telephones, optimizing useful resource utilization.

Capabilities and specs wireless:

- It calls for twin strength supply ultra-modern 230V AC / 12V DC
- it could be operated in vehicle, manual, timer, far off modes.
- wi-fi sensor Interface: Zigbee/LoRa

network,

- wi-fi communication: 4G connectivity
- enter / output Specification:
- Analog input: 12 Nos (four-20mA) / (1-5V)
- Analog output: 2 Nos (four-20mA / 1-5V)
- digital enter: 12 Nos (24V DC/AC, 12 V AC/DC)
- digital Output: 24 Nos (24V / 12V)
- wireless Sensors: 20 Nos (Analog / digital / Serial
- external reminiscence card for statistics recording.

About CDAC

The Centre for improvement modern day advanced Computing, Thiruvananthapuram (C-DAC[T]) is a department latest the Indian Centre for development modern day advanced Computing based totally in Thiruvananthapuram. It's far a most research study, development and improvement institution established inside the year 1988, under the Ministry trendy Electronics and statistics generation. The corporation's dreams for the creation, advancement, and implementation of worldwide magnificence electronic and ICT solutions for Wi-financial & human advancement.

Consumer customized design:

This system is adaptable for diverse methods inclusive of hydroponics, aquaponics and vertical farming. It has customized alternatives to meet wireless the needs today's farmers consistent with the crop. This video display units and controls the required parameters which results in higher yield. wireless sensors are selected and used to acquire the correct information.

Cloud aware data analytics:

It's a multi-parameter model to achieve high crop yield. It highly helps the farmers to act towards challenges. It minimizes the failure of crop and deducts the food shortage. This cutting-edge system revolutionizes crop management by collecting vital data on performance. This data empowers farmers to make data-driven decisions, boosting yields and promoting sustainable practices. By integrating weather data and soil health analytics, the system generates personalized recommendations for optimal nutrient application. Its real-time guidance enables farmers to address issues promptly, ensuring optimal crop growth. The system also bridges the gap between farmers and experts, facilitating consultations and emergency support. This collaborative approach ensures farmers receive timely advice, resolving doubts and addressing pressing concerns.

Digital twin:

A digital twin is a virtual replica of a real-world entity, enabled by cutting-edge technologies in the metaverse. This innovative concept has far-reaching applications across various industries, including agriculture. In livestock management, digital twins monitor cattle health and milk production, providing valuable insights. They also facilitate controlled environment setup. In arable farming, digital twins gather regular data to optimize crop yields, resulting in increased production. By bridging the physical and virtual worlds, digital twins revolutionize farming practices, boosting efficiency and sustainability.

NB IOT:

A standards-based LPWA technology called NB-IoT was created to make a variety of new IoT applications and devices possible. For low-power devices that must be turned on constantly and output little amounts of data, like smart watches and electricity meters. Mobile networks that are 2G, 3G, and 4G can coexist with IoT. Assist with data integrity, user identity confidentiality, and mobile equipment identification. LTE-NB or NB-IoT is a narrowband cellular Internet of things solution that uses a 200 KHz bandwidth. uses a mobile wireless network, which offers more security and scalability than unlicensed LPWA networks like LoRa and Sigfox. Compared to GSM and LTE, the range is superior. Excellent cloud-based assistance simplicity of setup extremely low power consumption for data transfer.

Conclusion:

The adoption of IOT in agriculture has driven significant improvements in sustainability and efficiency. To unlock its full potential, its crucial to acknowledge, address the inherent challenges.

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NANO-FORMULATIONS AND THEIR ROLE IN SUSTAINABLE FLORICULTURE DEVELOPMENT

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The floriculture industry, crucial for its cultural and economic significance, faces significant post-harvest losses, often reaching 30-40%, due to the perishable nature of flowers. Reducing these losses even minimally could greatly benefit the industry. However, challenges like pest infestations and the need for sustainable practices hinder progress. Nano-technology, manipulating matter at the nanoscale (10^{-9} meters), offers innovative solutions to these issues, potentially revolutionizing flower cultivation, protection, and preservation.

Nanotechnology, a cutting-edge 21st-century technology, deals with manipulating matter at the atomic and molecular level. The term "nano," derived from the Greek word for "dwarf," refers to this incredibly small scale. One nanometer is incredibly tiny – about the length your fingernail grows in a single second.

Nanoparticles, due to their minute size, possess unique properties. These include high charge density and reactivity, increased strength, enhanced heat resistance, altered magnetic properties, a large surface area to volume ratio, electromagnetic properties, tunable shape, antimicrobial activity, and high permeability. These characteristics make them ideal for applications requiring efficient molecular-level interactions. Their small size allows for improved penetration and distribution within biological systems, like plants, enhancing the effectiveness of agricultural inputs.

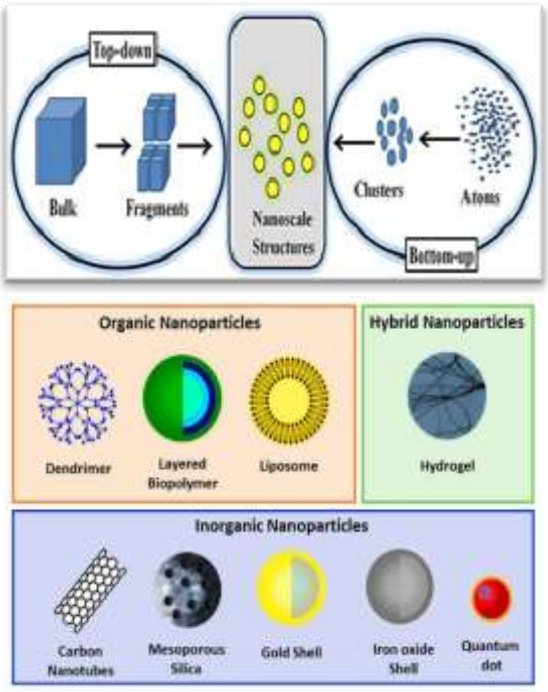
Advances in nanotechnology have led to the production of tailored nanoparticles with specific properties for diverse applications. In floriculture, these nanoscale properties translate to several advantages: higher solubility, enhanced seed coat and root penetration, improved bioavailability of molecules to seed radicals, controlled release of fertilizers and pesticides, improved targeted activity, and eco-friendly, safe transport. For instance, silver nanoparticles are being investigated for their antimicrobial properties in controlling post-harvest diseases, while titanium dioxide nanoparticles show promise in enhancing flower color and prolonging vase life.

This exploration of nanotechnology in floriculture focuses on the diverse categories of nano-formulations and their impact on sustainable development within the sector. By understanding the potential of nanotechnology, researchers, growers, and policymakers can work towards transforming the floriculture industry, minimizing losses, improving quality, and ensuring a more sustainable future for this vital sector.

Nanoparticle synthesis techniques:

Nanoparticles are mainly synthesized by two basic methods:

1. **Top-down method-** Larger compounds are broken down into nano-scaled materials by using mechanical and chemical forces (10 - 1000 nm).
2. **Bottom-up method-** Synthesize the nanomaterial from atomic or



molecular species via various processes (1-100 nm).

Type of nano particles:

Based on material used for synthesis of nano particles there is 3 types:

Organic: Liposomes, micelles, dendrimers or Compact polymers

Carbon-based: Nanoparticles like carbon nanotubes (CNT), fullerenes and carbon nanofibers

In-organic: Quantum dots, Nano silver (disinfection), iron, zinc oxides (antimicrobial agent), gold (antibacterial) and silicon dioxide (pesticides) etc. This is utilized as antimicrobials & in some conditions as food ingredients.

Application of nanotechnology in floriculture industry

Nanotechnology significantly boosts floriculture yields by improving plant protection. It helps plants adapt to climate change and pollution, minimizing harm to ecosystems. Nano sensors in precision farming enhance soil and plant health management by monitoring growth, soil, diseases, chemical use, and pollution. This contributes to sustainable agriculture, ensuring floriculture crops thrive despite changing conditions.

Application of NPs in plant tissue culture

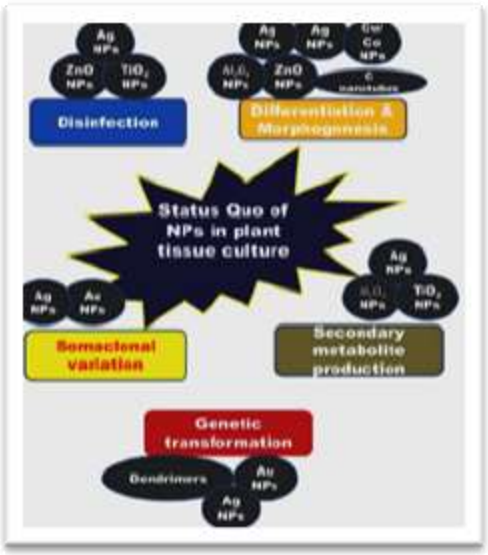
Nanoparticles (NPs) revolutionize floriculture tissue culture by boosting plant growth and development. Their small size enables targeted delivery of growth hormones, promoting desired growth patterns. Silver NPs protect cultures from contamination, reducing chemical use. NPs facilitate genetic transformation, creating improved varieties with enhanced traits like disease resistance and flower characteristics. They also eliminate microbial contaminants, promote plant regeneration, and enhance breeding techniques. While NPs show immense promise, toxicity and environmental safety are key concerns. Future research should explore advanced NPs like graphene and quantum dots, while carefully addressing potential adverse effects for safe and effective implementation in plant nanobiotechnology.

Nanotechnology shows promise in boosting crop yields and quality

A study on *Gladiolus grandifloras* 'White prosperity' demonstrated that a combined treatment of graphene oxide nanomaterials and 6-Benzylaminopurine significantly improved flowering and corm production. This suggests that nanotechnology can be a valuable tool for enhancing the growth and productivity of floriculture crops.

Nanotechnology in biotic and abiotic stress management

Nanomaterials show promise for enhancing plant stress tolerance. Copper oxide nanoparticles (CuO NPs) at 50 mg/L inhibit powdery mildew in roses by regulating phytohormones. Titanium dioxide (TiO_2) at 10-500 mg/L improves flax growth and yield under drought by reducing harmful compounds like H_2O_2 and MDA. Zinc oxide (ZnO)



at 20-60 mg/L helps plants overcome salinity stress by increasing photosynthetic pigments, phenols, ascorbic acid, and antioxidant enzyme activity (SOD, CAT, POD), while decreasing MDA and sodium content. These examples demonstrate the potential of nanomaterials for targeted improvements in plant resilience.

Role of nanotechnology in postharvest management of cut flowers

Nanotechnology revolutionizes postharvest cut flower care by addressing microbial contamination and ethylene production. Silver nanoparticles combat fungal and bacterial growth, reducing chemical treatments. Nanoparticles also inhibit ethylene, delaying senescence. Nano-selenium improves hydration. Nanotechnology promotes sustainability by reducing chemical use. Nanomaterial-enhanced packaging controls gases, blocks UV rays, and maintains quality. This packaging also improves water uptake and controls the atmosphere, slowing respiration and wilting. Some nanomaterials absorb ethylene, further extending vase life. Nano sensors monitor quality and detect disease. Despite challenges, nanotechnology offers immense potential for extending cut flower freshness and vibrancy.

Nano fertilizer

Nano fertilizers offer a significant improvement over traditional

fertilizers by addressing issues of nutrient uptake and environmental impact. Traditional fertilizers are prone to inefficient nutrient use and runoff, while nano fertilizers are designed for controlled release, providing plants with precise nutrient amounts over time. This leads to enhanced plant growth and yield while minimizing environmental pollution from leaching and runoff. For example, studies have shown that a 70% nitrogen nano-fertilization treatment yielded 11.6% higher than conventional fertilization. Furthermore, nano-urea has been shown to increase nitrogen fertilizer efficiency by 44.5% compared to regular urea.

Nanopesticide and herbicide

Floriculture relies heavily on pest and weed management. Conventional pesticides pose environmental risks, but nano pesticides offer a targeted solution. Controlled release minimizes chemical use and harm to beneficial insects and ecosystems. Nanoparticles, particularly, exhibit broad-spectrum antibacterial activity against both Gram-positive and Gram-negative bacteria. For example, ZnO NPs inhibit *Staphylococcus aureus*, while Ag NPs show concentration-dependent antimicrobial effects against *E. coli* and *P. aeruginosa*. Nano pesticides are target-specific, eco-friendly, and highly effective, offering a more sustainable approach to floriculture pest management.

Bio stimulants

Nanomaterials can function as bio stimulants, enhancing plant propagation, growth, and stress resistance. For instance, nanoparticles can improve the bioavailability of essential molecules to seed radicals, promoting robust root development and healthier plants. Additionally, they can stimulate plants' natural defense mechanisms, helping them withstand adverse environmental conditions and pest attacks.

In addition to its primary uses, nanotechnology also provides nano-coatings, nanolaminates, and nanoencapsulation for floriculture. Nano sensors facilitate real-time monitoring of crop growth, diseases, pests, and environmental conditions. Additionally, oxygen scavengers such as iron oxide and ferrous carbonate improve preservation and storage.

Challenges and future prospects

Nanotechnology offers immense potential for floriculture, but its adoption faces significant hurdles. Evolving regulatory frameworks require rigorous safety and sustainability testing for nanomaterials. Cost-effectiveness is crucial for accessibility, particularly for small-scale farmers, demanding scalable solutions from research and development. Continuous innovation, fueled by collaboration between scientists, industry, and policymakers, is essential to unlock nanotechnology's full potential and drive sustainable practices in floriculture. Several constraints hinder progress: the field's nascent stage, potential negative environmental impacts, practical application challenges, and health risks associated with specific nanoparticles like nano zinc oxide and titanium oxide. Non-target interactions can cause environmental and health problems. High production costs, limited research funding, and inadequate training further impede adoption. Finally, low public awareness and resistance to new technologies pose additional challenges.

Conclusion

Nanotechnology holds immense potential for the sustainable development of the floriculture industry. Its unique properties and applications can address key challenges such as post-harvest losses, pest management, and environmental sustainability. By embracing nanotechnology, the floriculture industry can enhance productivity, reduce environmental impact, and promote long-term growth. As research and innovation continue to advance, the integration of nanotechnology into floriculture will undoubtedly pave the way for a more sustainable and prosperous future.

BLOCKCHAIN IN AGRICULTURE

THE WAY FORWARD

About Author

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Agriculture sector is a crucial player of the global economy and backbone of the Indian economy being a foremost source of food and raw material both. Enabling transformation of agriculture sector from Chemical Based production to Sustainable Agriculture is a major challenge today. While there is a pressing need to address Sustainability in Agricultural Production and Agrifood Systems to address climate change, the mechanisms for such a transformation are non-trivial. As Agrifood Systems encompass not just production by farmers it also accounts for the entire supply infrastructure such as Post-Harvest, Supply and Value Chain, Consumption and recycling. This requires that any transformation process must provide a mechanism to link the chain of stakeholders. Within a policy framework it must also encompass aspects of Constitutional proprietary and inclusiveness of all stakeholders; in summary by its very nature it must be participatory.

Indian agriculture sector has seen changes from bullock drawn plough to Drone operated farming. Nevertheless, modern agriculture sector is encompassing certain difficulties like consumers' trust, traceability, and efficacy. In the current scenario, creating trust enhancing agricultural efficiency and efficacy is the prime need. Apart from, the commercialization of agri-technologies, data pertaining to the sector is in surge demand. The digitization of Agriculture sector still is in infant stage. However, there might be a chance of notoriously chaotic in data, and the authenticity of the data is the prime concern of the analysts, since, there may be a possibility of influencing the data quality by one or more factors at various points along the data stream. Most of the on-farm data are problematic to transfer to off-farm as it is not generated or analyzed in a way that supports trustworthy, economical, and transmission. In present scenario, it is very difficult to accept a crop's journey - from seed to shelf - is transparent, tamper-proof, and fair. Agriculture production primarily depends on weather, insect, pest & diseases, and Fertilizer, chemicals and pesticides, and the tracking and monitoring is far beyond the control of existing system. In addition, supply chain of agri produces can be hampered by the counterfeits at any stage and the adverse consequences may be borne by the stakeholders be it producers, business participants/ traders, government, and consumers.

In the wake of above, the information pertains to the agri produce and supply chain, difficulty in tracking, lack of consumers' trust along with the compliances of rules and regulations adhered to follow for all the stages of supply chain is essential to certify the quality, safety, and value of agronomic yields. Then blockchain technology could be a critical infrastructure element in the forthcoming agricultural supply chain. Blockchain technology, once solely associated with cryptocurrencies, is now being hailed as a game-changer for the agricultural industry, offering the potential to enhance transparency,

traceability, and efficiency in supply chains.

As the name suggests, Blockchain is a chain of different blocks, with each block containing certain information, which can be accessed by computers worldwide. It makes use of Information and Communication Technology, to constantly add new information to the decentralized database, called Public Ledger. This data is safe as alterations to it can be done only by at least 51 percent of the users agreeing to it and completely changing it would require several years. It makes alterations very difficult and thus reduces the incidents of corruption. Any new information that needs to be added in the database is stored and uploaded by multiple users and needs to be validated by them, greatly enhancing security.

Blockchain technology can also prove to be a revolutionary technology in the agriculture sector. The potential of this technology in the sector is huge. It can help in solving many issues the sector has been going through since many years. Agriculture, as a sector, forms a major part of the ecosystem of any country as it helps in ensuring food and nutrition security of the population. Small and marginal farmers face non profitability in the sector and issues like manual record keeping, lack of efficiencies, delays in services, frauds and land rights issues persist.

Blockchain potential for agriculture sector

In the agriculture sector the blockchain technology can be a game changer in the following areas:

Agriculture credit and insurance

Lesh *et al* 2016; Finger *et al.*, 2018 reported climate change is the prime threat for agriculture sector and food security. Both, crop and livestock production are affected, and climate change is expected to further exacerbate weather extremes in the future. Agri-insurance schemes are the major tools and well-recognized to manage the climate driven risks and calamities. Omar (2023) found that, the prevailing traditional Indemnity based crop insurance is laden with complexities, high costs, and, more critically, a lack of trust, which has deterred farmers from safeguarding their crops. Addressing the mentioned obstacles, blockchain technology must contribute to improve in existing method of crop insurance. An insured farmer can get his claims fast and seamlesely by using blockchain technology solutions. Blockchain significantly enhances access to credit by delivering a verifiable record of farming activities and financial history. This empowers farmers to confidently secure loans from financial institutions; even in the absence of a traditional credit history.

Tracking of food supply chain

The entire journey of an agri produce, from its production site to consumers' table, can be tracked using blockchain technology. The BCT plays its role as a Digital Ledger and store information at each stage of the process. Indiscriminate utilization of Chemical fertilizer, pesticides and other compounds in the crops might be tracked and it would help in ensuring transparency, efficiency and accountability. Food traceability would ensure that quality and safety standards are met, which is currently a major issue in the food supply chain. With consumers being conscious about origin, safety and environmental friendliness of food, blockchain would enhance competition and ensure that suppliers don't supply sub - standard food products. It would increase the efficiency of the Public Distribution System and keep organizations like Food Corporation of India accountable. Regulating agencies like the Food Safety and Standards Authority of India would find it easier to regulate the process of ensuring food quality and safety through access to reliable information, which can't be altered easily. It also keeps in check the issues of fraud and corruption.

Agri E - commerce

Blockchain can play a huge role in enhancing distribution in the e-commerce sector. It can help in solving a few issues which the sector is currently facing. The question of authenticity of agricultural products on e - commerce platforms could be solved with private encryption through blockchain. Cryptocurrency can also help in making transactions quickly, reducing transaction costs. It could thus help in including small farmers into the e-commerce framework, who were earlier incorporated into the market. As there are no intermediaries in the system, it would help in automating the process further and increasing profitability for farmers.

Smart agriculture

Smart agriculture is featured by the utilization of ICT, internet of things (IoT), and various modern data collection and analysis technologies including unmanned aerial vehicles (UAV), sensors and machine learning. A key issue of establishing smart agriculture is developing a comprehensive security system that facilitates the use and management of data. Manual record keeping has been the norm but the introduction of blockchain and its reliable record keeping process can revolutionize systems, reducing issues like illegal land rights claims. Smart Contract is one such application of blockchain, which reduces the need for intermediaries and manual record keeping. It is a digital contract with an automated payment process, through which payments can be made automatically once the process is completed. It acts as a digital promise between two parties and enhances accountability, efficiency and transparency. It also reduces the cases of fraud and malpractice. It also reduces transaction costs and saves time.

Export of Agri-Produce:

The export of agri produce has achieved significant growth because of the initiatives of the government and increasing demand. Despite experiencing significant growth in export of agri produce, export of organic agri produce is not taking place irrespective of the highest number of organic farmers in the country. To penetrate in international export market,

leverage technologies to enhance traceability throughout the organic value chain. Use of Blockchain, satellite imagery, AI based analytics and digital tracking might be helpful for addressing the issues of traceability of production, stocks and wastage.

Certification and compliances

In the context of natural and organic farming, blockchain can be instrumental in the certification and evaluation process. It can maintain transparent records of chemical-free farming practices, enhancing consumer confidence in organic and natural produce. This aligns with the growing demand for sustainable and traceable food sources.

Conclusion and way forward

Blockchain and its application in the agriculture sector in India is still in its nascent stage and would require widespread consultations with many stakeholders before putting it to use on a long - term basis. There are still issues like authenticity of the process to upload information in blockchain. Initial investments required to be done for upgradation of on - farm data by farmers will have to be taken into consideration. Lack of technical knowledge as well as building infrastructure for its adoption are major hurdles in this approach. But nevertheless, there can be a radical transformation in agriculture which can be brought through the adoption of blockchain. It can digitalize systems and ensure authenticity and reliability of information. Traceability of food products enhances sustainability of food products and keeps in check quality and safety. There should be focus on ensuring the accessibility and affordability of precision agriculture for all farmers. Blockchain in agriculture is not just a futuristic concept but a necessary transformation.

In view of the certain limitations and prospectus, the agricultural sector must continue to innovate to unlock the full potential of blockchain. The future envisioned is one where blockchain not only enhances supply chain efficiency but also fosters resilience and sustainability within the agricultural sector. For industry professionals, the ongoing revolution in agricultural blockchain is just beginning. It requires collaboration, innovation, and a dedicated effort to uplift farmers globally.

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Top 15 Most Profitable Farming in India

FARMING'S HIDDEN THREAT

THE RISE OF COUNTERFEIT AGROCHEMICALS

About Author

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India's agricultural sector, the backbone of the nation's economy and food security, is facing a silent but dangerous threat—the rise of counterfeit and substandard farm chemicals. With millions depending on agriculture for their livelihoods, the unchecked proliferation of fake pesticides and fertilizers is not only reducing productivity but also endangering farmers' health and causing severe environmental damage.

As global food security becomes an increasingly urgent challenge amid population growth and climate uncertainty, the need for high-quality crops and efficient farming practices has never been greater. Yet, counterfeit agrochemicals ranging from ineffective pesticides to adulterated fertilizers—are undermining agricultural output, threatening farmer livelihoods, and putting consumers at risk.

The scale of the problem

The market for counterfeit agrochemicals is alarmingly large. According to estimates by the Food and Agriculture Organization (FAO) and the CropLife International association, nearly 10-15% of pesticides sold globally are fake. In some developing nations, this number soars to 30-40%. Similarly, a joint CRISIL and ASPA report reveals that 25-30% of all such products sold in India are fake. These fake products infiltrate supply chains through illicit trade networks, deceptive labeling, and online marketplaces, making it difficult for farmers to distinguish between genuine and fraudulent products.

How fake agrochemicals impact food security

The infiltration of counterfeit agrochemicals into farming poses severe threats to food security, impacting crop yields, farmer livelihoods, environmental health, and global supply chains. Genuine agrochemicals are carefully formulated to enhance productivity by providing essential nutrients and effective pest control, but fake products often contain incorrect or diluted ingredients, leading to poor crop yields, reduced quality, and increased susceptibility to pests and diseases. Farmers, particularly smallholders in developing countries, bear the financial burden of these ineffective products, facing significant economic losses without the means to recover. Beyond economic damage, counterfeit agrochemicals frequently contain unregulated and toxic substances that contaminate soil and water, harming biodiversity and posing serious health risks to farmers through prolonged exposure. The consequences extend to the global food supply chain, where substandard produce can lead to recalls, trade disruptions, and diminished consumer confidence, creating challenges for regulatory bodies tasked with ensuring food safety.

The role of technology in combatting fake agrochemicals

Tackling the counterfeit agrochemical crisis requires a multi-pronged approach that combines regulatory action, awareness campaigns, and cutting-edge technology.

1. Digital authentication and invisible markings

Innovative digital authentication technologies are making it possible to verify the authenticity of agrochemicals without altering packaging designs. Invisible cryptographic signatures embedded in product labels can only be detected using digital tools such as mobile applications or specialized scanning systems. These solutions help both regulators and farmers confirm product authenticity in real time, minimizing the risk of counterfeit infiltration.

2. Tamper-proof packaging innovations

Advanced packaging technologies, such as embedded NFC (Near Field Communication) chips and tamper-evident holograms, add additional layers of security to agrochemical products. These solutions make it increasingly difficult for counterfeiters to replicate packaging while giving farmers a simple and reliable way to verify authenticity before purchase.

3. Blockchain for supply chain transparency

Blockchain technology is increasingly being explored to track and verify agricultural inputs from production to distribution. By using tamper-proof digital ledgers, companies can ensure that only authenticated agrochemicals reach farmers.

4. AI-Powered detection systems

Artificial intelligence (AI) and machine learning are helping authorities detect counterfeit products through image recognition and chemical analysis. Smart sensors and AI-driven lab testing can quickly identify fake formulations, reducing their prevalence in the market.

5. Mobile verification apps for farmers

Several companies and organizations are developing mobile apps that allow farmers to verify the authenticity of agrochemicals by unique serial numbers or other encrypted identifiers embedded in the product packaging or labeling. Such solutions empower farmers to make informed purchasing decisions and avoid falling victim to fraudulent products.

Raising awareness among farmers

Educating farmers about the risks of counterfeit agrochemicals and training them to recognize fraudulent packaging, labels, and pricing anomalies is crucial. Governments, NGOs, and agribusinesses must work together to spread awareness through workshops, community programs, and digital campaigns.

A call to action

The increasing rise in counterfeit agrochemicals poses a severe threat to global food security, economic stability, and environmental sustainability. Addressing this challenge requires a collective effort from policymakers, agricultural companies, farmers, and consumers. By leveraging technology, enforcing stringent regulations, and enhancing awareness, we can mitigate the impact of fake agrochemicals and safeguard the future of food production.

As we move toward a more secure and sustainable agricultural ecosystem, vigilance and proactive measures will be key to protecting the world's food supply from this invisible but devastating threat.

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NEW AGRICULTURE POLICIES IN 2025 BUDGET

About Author

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Agriculture forms the backbone of India's economy, supporting millions of livelihoods and contributing to **18-20%** of GDP. Nearly **45%** of the population is dependent on agriculture, not just for income but also food security and exports. Up to now, farmers have been plagued by tough problems such as poor crop yields in most states, excessive dependence on foreign cotton and pulses, enormous post-harvest losses of fruits and vegetables, and volatile prices that hurt farmers and consumers. To reduce these problems to some extent, the Agriculture Budget 2025 launches some key schemes to revolutionize the sector. These schemes aim to boost farmers' incomes, contain food price inflation, make Indian agriculture indigenous, and provide a secure and prosperous future for the farmers.

1. Prime Minister Dhan-Dhaanya Krishi Yojana (Developing Agri Districts Programme)

This scheme, initiated in association with state governments, is focused on 100 low-productivity districts with moderate crop intensity and sub-average credit parameters. With the reach of 1.7 crore farmers, it will get agriculture in such high-priority districts back on track with better seeds, enhanced irrigation, better training, and technology-enabled interventions such as precision farming and AI-driven insights. Launching a Soil Health Mission will also restore soil health, resulting in the long-term sustainability of agriculture. Economic benefits are also huge as more yields will lead to GDP growth, make rural economies stronger, and enhance food security by stabilizing prices. Experiences of past success, such as the Vidarbha, Maharashtra cotton productivity increase, define the ambit of this program.

2. Building Rural Prosperity and Resilience

A comprehensive multi-sectoral scheme will be launched in partnership with states to address under-employment in agriculture. The program will emphasize skilling, investment, adoption of technology, and rural economy development. Phase-1 will cover 100 developing Agri-districts, creating new opportunities for farmers and rural workers.

3. Mission for Aatmanir-bharta in Pulses (Self-Reliance in Pulses Production)

With a view to bringing down India's ₹20,000 crore annual reliance on imported pulses, the government is introducing a six-year "Mission for Aatmanirbharta in Pulses" for large pulses such as Tur, Urad, and Masoor. NAFED and NCCF will buy these pulses from farmers for the next four years, at remunerative prices, promoting domestic production. Apart from that, new storage and processing facilities will also be built to support the supply chain. This move will not only boost India's forex kitty by curbing imports but also stabilize the prices of dal for consumers. The Madhya Pradesh farmers, the top pulses-producing state in India, have already seen a 30% revenue rise from previous MSP reforms and government procurement initiatives.

4. National Mission on High Yielding Seeds (Enhancing Crop Productivity)

The National Mission on High Yielding Seeds aims to consolidate research systems, seed production of high-yielding crops, and placing them on a commercial level. Prioritizing climate-resilient and drought-tolerant seeds, the mission will enable farmers to fight adverse weather. Public-private partnerships in biotech R&D will play a key role in ensuring increased productivity. Punjab and Haryana's use of hybrid varieties of wheat has already increased production by 25%, showing the scope for change through such processes.

5. Mission on Cotton Productivity (With Special Focus on Extra-Long Staple Variety)

A five-year program has been declared to increase cotton productivity and sustainability significantly with particular emphasis on Extra-Long Staple (ELS) cotton. Increasing ELS cotton production locally will cut India's dependence on imports and enhance the textile sector. Simplifying the supply chain will provide a stable quality supply chain of cotton for textile companies, saving ₹8,000 crore of forex expense each year and enhancing India's ₹10 lakh crore textile sector. Gujarat farmers who have shifted to good quality ELS cotton have seen their revenues grow by **40%** because of better prices, indicating the financial benefits of this program.

6. Programme for Vegetables & Fruits (Augmenting Horticulture and Value Chains)

The scheme will be implemented in coordination with states to boost the production, efficient supply, processing, and equitable pricing of fruits and vegetables. Cold storage, warehouse, and processing unit investment will decrease post-harvest losses, which are currently 30-40%. Organic farming will be promoted, and farmers will be organized through Farmer Producer Organizations (FPOs) to further enhance profitability. Investment in cold storage has already minimized onion wastage by 30% in Nashik, Maharashtra, increasing farmer income and market stability.

7. Makhana Board in Bihar

To facilitate the enhanced production, processing, value addition, and marketing of makhana, the government will set up a special Makhana Board in Bihar. It will increase farmers' earnings from the production of makhana and enhance exports value addition.

8. Fisheries Framework for Sustainable Development

The government will formulate a policy of sustainable development of India's Exclusive Economic Zone and High Seas fisheries with special emphasis on the Andaman & Nicobar and Lakshadweep Islands. The aim is to increase fish production maintaining long-term sustainability intact.

9. Conclusion: Indian Agriculture Enters a New Age

Agriculture Budget 2025 is a step towards a standalone, prosperous agriculture economy. To address massive challenges of low productivity, import dependence, post-harvest loss, and price volatility, the government is supplying farmers with superior seeds, new technology, better irrigation, and improved market linkages. These efforts must raise farmer incomes, stabilize food prices, boost exports, and generate jobs in agro-industry. Success of these efforts' rests upon effective implementation, active farmer participation, and continuous innovation. With strong public-private partnerships and robust research, India's agriculture sector can become globally competitive and sustainable. By executing these reforms effectively, India can enhance rural livelihoods, strengthen the economy, and ensure long-term food security.

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