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A Resonance in Agriculture

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BEYOND CLASSROOMS & GARDENS

How a Professor Turned His Passion into Purpose

A Discussion with Dr. Devesh Pandey, Dean of the Faculty of Agricultural Science & Technology at Mansarovar Global University, Bilkisganj, Sehore (M.P)

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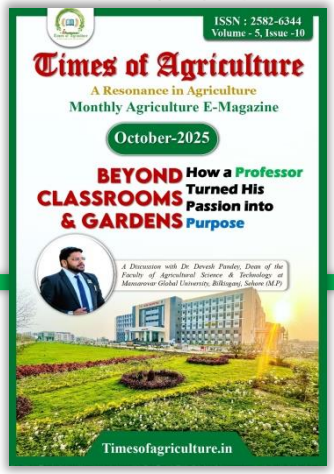

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From the Editor's Desk

Dear Readers, with great pleasure, the October issue of **Times of Agriculture** magazine is being presented to you. In the October issue, we have published an interview article in our cover story.

In this article, we have shared the story of a professor who, while being associated with education, followed his skill and passion and practically applied his knowledge. In today's field, when the youth is running only for academic degrees, there is a lack of skill visible in them. At this time, such inspiring stories will motivate our young students so that they work more on skill development.

In this issue, we have covered how, while being in the position as Dean Faculty, he designed an entire landscape project without the help of any commercial firm. This shows his dedication, passion, and skill. In today's time, we must focus on such skill development where agriculture is not limited only to bookish knowledge but becomes a means of employment-oriented growth. Today, many agri startups are being started in the country, but the number of agriculture students in those startups is very low. Agriculture students have good knowledge, but due to lack of skill, they are afraid to apply it. Today, the youth need to work on their skills and create such an ecosystem where they become capable of giving jobs rather than asking for jobs.

In this issue, you will also find other articles in which people from the industry have shared their views. We hope that you will like this October issue. You can send us your suggestions.

Thank you very much. Enjoy reading...

Editor-In-Chief

CONTENT

Times of Agriculture
A Resonance in Agriculture

AGRICULTURE UPDATES

Centre Launches ₹600 Crore "Kapas Kranti Mission" for Cotton Farmers

The Union government has launched the ₹600 crore Kapas Kranti Mission to enhance the cultivation of high-yield, long-staple cotton through modern agricultural practices and technological innovation. The initiative seeks to replicate the successful High-Density Plantation (HDP) model from Maharashtra in states such as Telangana, with a focus on scientific farming methods, sustainable cultivation, and farmer education. The mission aims to improve productivity and fibre quality, enabling India to strengthen its position in the global cotton market while ensuring better income opportunities for farmers.

A central feature of the initiative is the introduction of the "Kapas Kisan App," developed to streamline the cotton procurement process and ensure fair prices for farmers. Through the app, cultivators can register themselves, book slots for selling their produce, and check payment statuses—all without relying on intermediaries. The system aims to reduce crowding at procurement centres, increase transparency, and guarantee direct payments at the minimum support price (MSP). By leveraging digital tools, the government hopes to make the cotton trade more efficient and farmer-friendly, ensuring that growers benefit directly from market reforms.

Despite its ambitious goals, the rollout has encountered early challenges in some regions, where farmers have reported difficulties registering on the app or accessing procurement slots. These issues have, in some cases, forced growers to sell cotton below MSP rates. In response, the Cotton Corporation of India and state authorities are extending registration deadlines, conducting awareness campaigns, and improving digital infrastructure to facilitate smoother operations. The Kapas Kranti Mission, with its emphasis on high-density cultivation, farmer training, and technology-driven marketing, represents a crucial step toward modernising India's cotton sector, provided that its implementation remains inclusive and accessible to farmers at the grassroots level.

Sundarbans Aquaculture Model Wins FAO Global Award

The Nature Environment and Wildlife Society (NEWS) of West Bengal's Sundarbans has earned global recognition from the Food and Agriculture Organization (FAO) of the United Nations for its pioneering "Sustainable Aquaculture in Mangrove Ecosystems" (SAIME) model. The organization received the Global Technical Recognition Award during FAO's 80th Anniversary Celebrations and the World Food Forum in Rome, Italy. The SAIME model has been hailed as a climate-adaptive, ecosystem-based innovation that integrates aquaculture with mangrove conservation, providing both ecological balance and sustainable livelihoods for coastal communities.

Developed to address the twin challenges of environmental degradation and income insecurity in the Sundarbans delta, the SAIME model promotes aquaculture that maintains 5% to 30% mangrove cover within shrimp-farming ponds. This approach not only sustains the health of the mangrove ecosystem but also improves productivity for local farmers. Implemented across nearly 30 hectares and involving 42 fish farmers in North and South 24 Parganas districts, the model supports the cultivation of Black Tiger Shrimp (Penaeus monodon) using mangrove litter as natural fodder. This reduces dependence on costly chemical inputs, and over time, farmers' net annual profits have more than doubled—showing that ecological restoration and economic growth can complement each other effectively.

Beyond its economic impact, SAIME enhances coastal resilience by preserving mangroves that serve as natural barriers against cyclones, tidal surges, and erosion—crucial protections in a region highly vulnerable to climate change. The reduction in chemical use also minimizes water pollution, while mangrove conservation aids carbon sequestration and biodiversity preservation. The FAO's recognition of the SAIME model underscores its potential as a global blueprint for sustainable aquaculture, demonstrating how community-based environmental stewardship can drive climate adaptation and food security in fragile coastal ecosystems.

Centre bolsters maize push in Punjab with ICAR-IIMR visit and new infrastructure

Union Minister for Agriculture, Farmers' Welfare, and Rural Development, Shri Shivraj Singh Chouhan, visited the Indian Council of Agricultural Research – Indian Institute of Maize Research (ICAR-IIMR) in Ludhiana, Punjab, where he inaugurated a new administrative building and interacted with farmers, maize stakeholders, and women Self-Help Groups. The visit highlighted the government's growing focus on maize as a key crop for agricultural diversification and rural prosperity in Punjab. The minister emphasized that the government's vision is to enhance foodgrain output, cut input costs, and boost farmers' incomes while promoting crop diversification in traditionally wheat- and rice-dominated regions.

During his visit, Shri Chouhan underlined the potential of maize as a versatile crop with uses extending beyond food, including animal feed and industrial applications. He noted that maize serves as a water-efficient alternative to paddy and offers better returns to farmers. The ICAR-IIMR, he said, plays a pivotal role in improving maize productivity, encouraging climate-resilient practices, and driving sustainable farming innovations. The newly inaugurated building will enhance the institute's ability to support farmers, strengthen research infrastructure, and expand outreach activities across Punjab.

To complement these efforts, the government announced several support measures for farmers. An allocation of ₹74 crore has been made for free wheat seed distribution to compensate for crop losses in the state. Additional funding has been approved for mustard and other seed varieties. Under the PM-Kisan Samman Nidhi scheme, ₹222 crore has been transferred in advance to over 11 lakh farmers. Assistance is also being provided to horticulture farmers under the Mission for Integrated Development of Horticulture (MIDH). These initiatives collectively reflect the government's holistic approach to strengthening Punjab's agriculture, improving rural livelihoods, and promoting long-term sustainability in farming.

New Red-Leafed Begonia Discovery Highlights Arunachal's Botanical Wealth

A team from the State Horticulture Research & Development Institute (SHRDI) in Arunachal Pradesh has uncovered a previously unrecorded species of the genus Begonia in Basar, Laparada district. The newly identified plant, distinguished by its shimmering red foliage, was verified by experts at the Botanical Survey of India including Dr. Dipoo Dipankar Borah, Dr. Momang Taram and Dr. Krishna Chowlu. Local nomenclature and Sanskrit naming conventions reflect the cultural and scientific importance: the plant is called *"Chowna Buku Chulu"* (meaning "noble red" in the indigenous language) and *"Aryarakta"* in Sanskrit, honouring the region's horticulture development efforts.

This discovery underscores the rich biodiversity of the Eastern Himalayas and the research potential that exists in remote corners of the state. The red-leaved Begonia not only adds a new entry to the flora of Arunachal Pradesh but also draws attention to the importance of documenting indigenous plant species and conserving their habitats. Researchers believe the plant offers strong commercial promise due to its ornamental appeal, and the institute is actively working on propagation, cultivation and value-chain development so that local farmers and horticulture industries may also benefit.

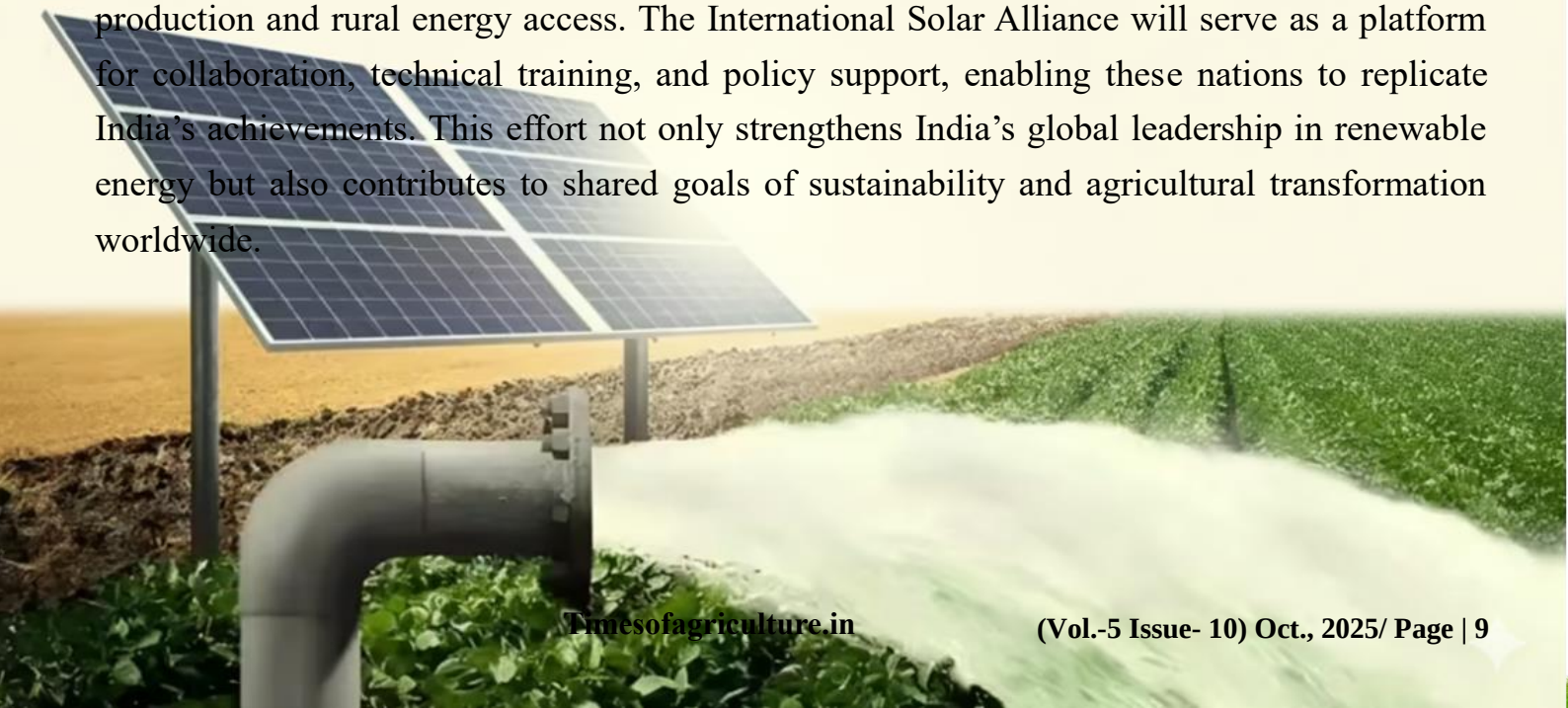
Beyond its aesthetic value, the finding carries broader ecological and economic significance. By developing a horticultural crop rooted in local biodiversity, the region stands to combine scientific exploration, livelihood support and environmental conservation. The naming of the species in honour of key regional leadership reflects a growing synergy between research institutions and policy support in the state. Overall, this botanical milestone strengthens Arunachal Pradesh's mission to become a hub of agricultural innovation and sustainable development.

India to Export Its Solar Agriculture Model to Africa and Island Nations

India is taking its flagship PM-KUSUM solar energy scheme to the international stage, promoting it as a model for sustainable rural development and clean energy-driven agriculture. Through the International Solar Alliance (ISA), the government plans to share its experience with African and island nations, focusing on improving irrigation access, energy independence, and agricultural productivity using solar power. The initiative aims to demonstrate how renewable energy can transform rural livelihoods and reduce reliance on fossil fuels while promoting climate resilience in developing regions.

The Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyan (PM-KUSUM) was launched in 2019 with a budget of ₹34,000 crore. Its targets include installing 100 GW of solar power plants on farmer-owned land, deploying 14 lakh standalone solar pumps, and solarising 35 lakh grid-connected agricultural pumps. As of September 2025, about 70% of the standalone solar pumps have been installed, while progress on decentralised and grid-connected systems remains slower. The Ministry of New and Renewable Energy has indicated that the scheme may be extended beyond 2026 to achieve its full goals and ensure all components deliver tangible benefits to farmers.

The success of India's solar pump programme has generated strong interest among African nations, where only about 4% of arable land is currently irrigated. Many of these countries rely heavily on food imports despite vast agricultural potential. By adopting solar irrigation technologies inspired by the PM-KUSUM model, they aim to enhance local food production and rural energy access. The International Solar Alliance will serve as a platform for collaboration, technical training, and policy support, enabling these nations to replicate India's achievements. This effort not only strengthens India's global leadership in renewable energy but also contributes to shared goals of sustainability and agricultural transformation worldwide.



e-NAM Expands Platform with Nine New Commodities, Enhancing Market Access for Farmers

The e-NAM (National Agriculture Market) platform has broadened its reach by adding nine new tradable agricultural commodities, taking the total number of items available for trade to 247. This expansion is part of the Department of Agriculture and Farmers' Welfare's effort to strengthen farmers' bargaining power, ensure fair pricing and deepen integration of fragmented agricultural markets across India. The newly included commodities are Green Tea, Tea, Ashwagandha Dry Roots, Mustard Oil, Lavender Oil, Mentha Oil, Virgin Olive Oil, Lavender Dried Flower and Broken Rice.

By incorporating these additional items, the platform offers farmers and traders enhanced access to a transparent and competitive digital marketplace. The move ensures that producers of value-added, niche and oil-based crops can engage in standardised trade rather than remaining confined to local mandis. The Directorate of Marketing and Inspection (DMI) has developed "tradable parameters" for these commodities following consultations with state agencies, traders, experts and the Small Farmers' Agribusiness Consortium (SFAC). These parameters set quality grades or ranges, linking the price of a produce directly to its quality and reducing middle-men reliance.

The expansion underlines the government's broader vision of using digital tools to empower farmers, promote inclusive growth and support long-term resilience in India's agricultural economy. By standardising quality, enabling pan-India market access and covering a more diverse set of commodities, the platform helps integrate previously isolated producers into the national trade ecosystem. Ultimately, this step signals a move toward a more unified, efficient and equitable marketplace for Indian agriculture.

COVER STORY

BEYOND CLASSROOMS & GARDENS

How a Professor Turned His Passion into Purpose

A Discussion with Dr. Devesh, *on his journey from academic excellence to transforming landscapes through design.*

Dr. Devesh Pandey
Dean, Faculty of Agricultural Science & Technology, Mansarovar Global University, Bilkisganj, Sehore (M.P.)

Q1. Every journey has a beginning. How did yours start — from studying floriculture to becoming Dean and leading creative landscape projects?

A: I hold a Ph.D. in Floriculture and Landscape. Along with my academic journey, I have been actively involved in teaching, research, and practical projects that connect environmental science with real world applications.

Q2. What inspired you to pursue floriculture and landscaping design?

A: From a young age, I was fascinated by plants, open spaces, and the way greenery transforms our surroundings. Over time, this interest grew into a deep passion for creating spaces that are not only beautiful but also healing and sustainable.

Q3. Before joining the college, where did you work to gain experience? How did that experience influence you?

A: Before joining college, I worked with NHAI and the Tata Group, specifically in the Horticulture Departments of Tata Steel and Tata Motors. Working with that organization was a great start to my professional journey. I learned a lot from those projects — especially about plantation management, large-scale landscaping, and the practical aspects of gardening. This hands-on experience greatly strengthened my foundation in landscape planning and deepened my understanding of the field.

Q4. Many people prefer government jobs after their studies. Why did you choose a different path?

A: Being a Ph.D. scholar in Floriculture, I always had a passion for teaching and guiding students. I wanted to give them practical exposure to every aspect of floriculture and landscaping. After my experience with NHAI and TATA group, I realized that my true calling was in academics — to share knowledge, inspire students, and help them connect theory with practice.

Q5. How did you get the opportunity to design the landscape of this college campus?

A: Honestly, I hadn't expected such an opportunity, but by God's grace, it came my way. As the Dean of the Faculty of Agricultural Science & Technology, the leadership of Mansarovar Global University recognized my potential and entrusted me with the responsibility of developing and designing the landscape of the Medical College and Hospital campus.

I gladly accepted the opportunity and began working on the project without involving any external landscaping firm — completing the design with the support of our dedicated team of gardeners.

Q6. How did the idea of redesigning the college landscape come about?

A: With an academic background in floriculture and a deep passion for the field, I have always wanted to apply my knowledge in a practical way. I believed that, with the expertise we have, we could create something unique and meaningful right on our own campus. This belief — that we could design and implement our vision ourselves — inspired me to take on this project.

Q7. What were the biggest challenges you faced in terms of resources, time, and support?

A: Since we didn't hire any professional landscaping firm, I was the only expert guiding our team of gardeners throughout the entire process. Ensuring timely execution was a major task. The most challenging part was carrying out the gardening work alongside the ongoing civil construction — which was both a difficulty and a unique aspect of this project. Usually, landscaping is done after the completion of construction, but in this case, I designed it simultaneously with the civil work. In addition, the limited water supply posed another challenge, as water is crucial for maintaining gardens and lawns. Despite these obstacles, our team's dedication and strong belief in the project helped us complete it successfully.

Q8. What were the major steps you followed in designing the landscape?

A: The process began with a detailed study of the site to understand its soil conditions, slope, and available natural resources. Based on this assessment, I developed a master plan that aligned with the institution's vision of creating a green and healing environment.
The next step was selecting plant species that could thrive in the local climate while requiring minimal maintenance.

Q9. Is there any memorable incident from this project that stays close to your heart?

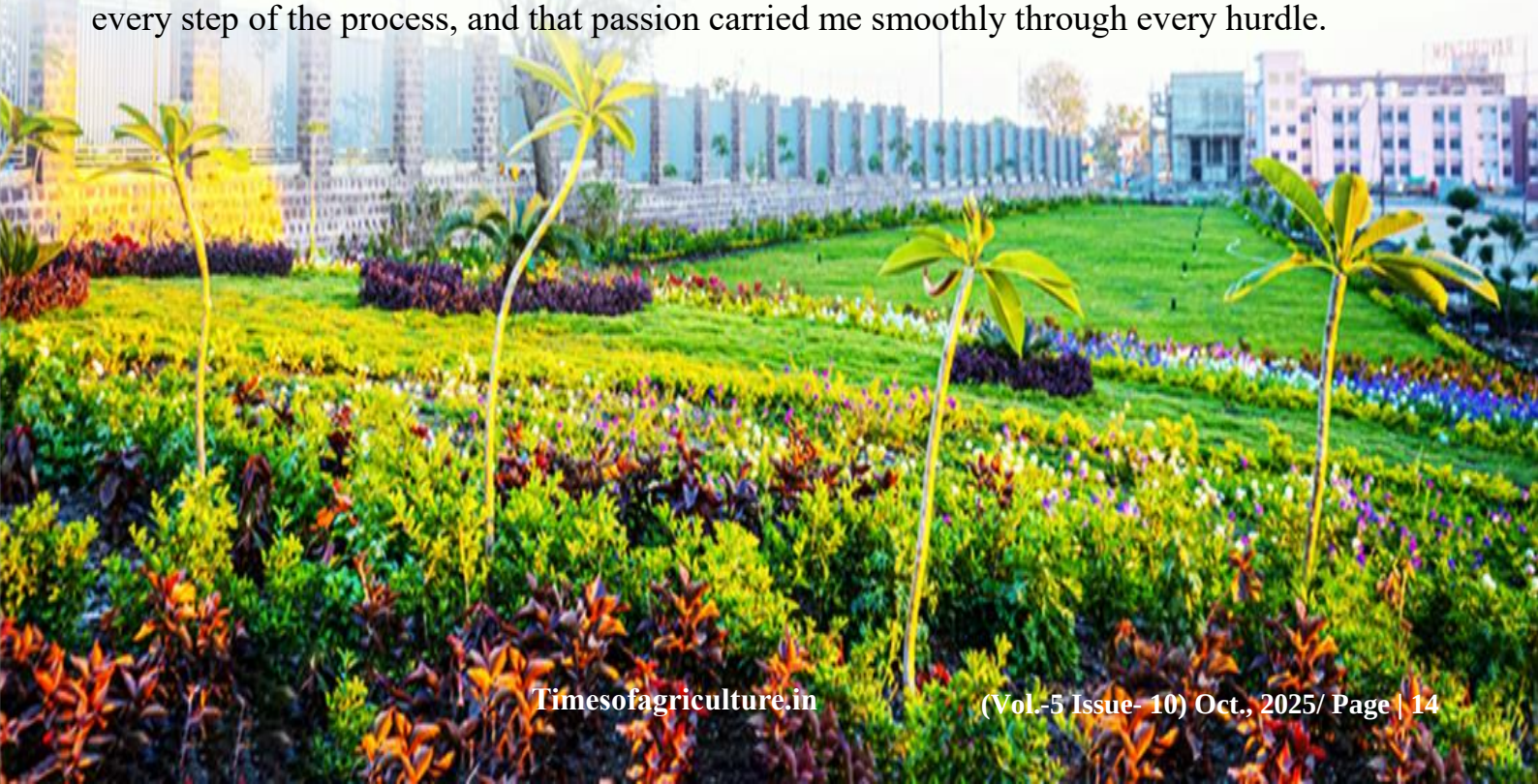
A: When you work with nature, you can never fully predict the outcome — and that's what makes it so special. I still remember the day when the first seasonal flowers bloomed. I was on the lawn guiding the gardeners when I noticed patients and their families stopping to take pictures. People entering the hospital paused to admire the flowers, and for a moment, everyone's faces lit up with joy. The entire atmosphere at the entrance felt alive and peaceful. That day, I realized that our hard work had truly made an impact. Seeing people smile and feel happy because of your efforts is one of the most rewarding experiences one can have.

Q10. How did the community react after seeing the completed project?

A: Honestly, I never expected the landscape to become such a center of attraction on campus. The response exceeded my expectations. Students, staff, patients, and visitors all shared how the greenery brought a sense of positivity and calm to the environment. Many mentioned that the campus now feels more welcoming, soothing, and truly connected to nature. It's remarkable how plants, when nurtured with care and attention, can completely transform the energy of a place.

Q11. What challenges did you face during the project, and how did you overcome them?

A: You'll relate to this — when you truly love what you do, it doesn't feel like a challenge. Just like in sports or any activity you're passionate about, others might find it difficult, but for you, it flows naturally. The same was true for me. Landscaping and design are my passion, so even though there were challenges, I never felt burdened by them. I enjoyed every step of the process, and that passion carried me smoothly through every hurdle.



Q12. You completed this project without any external firm's support. What motivated you to take it on yourself?

A: I've always believed that passion and knowledge should go hand in hand. If students from IITs and IIMs can build successful agri-startups using their technical skills, then why shouldn't agriculture professionals use their own expertise to create something unique? When I received this opportunity, I saw it as the perfect platform to apply my knowledge and passion for landscape design. I wanted to demonstrate that with skill, vision, and commitment, we can achieve results that match — or even surpass — those of professional firms. Today, when I look at the campus, I feel proud that our hard work has not only enhanced its beauty but also set an example of what can be accomplished through dedication and self-belief.

Glimpse of Project

Q13. In your view, what is more important today—skills or degrees?

A: Both education and skills have their importance, but in today's world, skills definitely hold more weight. A degree provides knowledge and credibility, but it's practical skills, creativity, and the ability to solve real-world problems that truly set you apart. Without these skills, even the best degree cannot make you stand out. The world values doers — people who can transform knowledge into action.

Q14. How do you balance your administrative role as Dean with your passion for landscaping?

A: That's an interesting part of my routine. After finishing my classes and administrative work, I often visit the medical college campus to plan or supervise the landscaping activities. Sometimes I return home late at night, but I never find it tiring. I'm especially thankful to my family — without their support, it wouldn't have been possible to complete this task. When you go through challenges, you're not the only one striving; your family stands with you on that journey. When you're building something meaningful, those struggles actually become your motivation. For me, it's not extra work — it's something I genuinely enjoy, especially with the encouragement and support of my loved ones.

I would also like to specially thank the Chief Managing Director, Hon'ble Chancellor Ma'am, Chief Executive Director, and Pro-Chancellor Sir for trusting me and providing these opportunities.

Q15. Many IT students start Agri startups. What advice do you have for agriculture students who want to start their own ventures?

A: If you look around, many successful agri-startups today are founded by people from technical or business backgrounds. Yet, surprisingly, agriculture students — who study crops, soil, and farming systems — are often hesitant to take that step. Many prefer traditional paths like government jobs, and in doing so, they miss the opportunity to apply their knowledge creatively. My advice to young agriculture students is simple: develop your skills first. Once you have them, don't be afraid to take risks or create something of your own. By starting something new, you're not just building your career — you're also creating opportunities for others. Agriculture holds tremendous potential, and the future belongs to those who combine knowledge with innovation and action.

Q.16-How do you encourage young people to follow their passion and execute their ideas?

A. In today's challenging times, many students are actively seeking employment, but the reality is that only a small percentage succeed in securing jobs. One of the key reasons is the lack of relevant skills among job seekers. This challenge exists not only in the government sector but also in the private sector, where employers consistently look for skilled and capable individuals. Therefore, I strongly recommend that students focus on developing practical skills — in any field they are passionate about. I'm not saying everyone should learn landscaping, but rather, they should build expertise in their area of interest. For example, those interested in agriculture can explore value-added products or start small-scale ventures. Today, there is a growing demand for exotic fruits and vegetables such as strawberries, mushrooms, saffron, avocado, and dragon fruit. Emerging fields like hydroponic farming also offer great opportunities.

If someone is more inclined toward the digital world, they can even start their own e-commerce business to promote and sell regional products that may not be available across India. The possibilities today are endless — but the key to success is skill development. Without skills, it's difficult to gain the confidence needed to take initiative or start something on your own. I strongly believe that whether you are already employed or still a student, you must develop practical skills. You can start with something small that relates to your interests or abilities. Skill development not only builds confidence but also opens doors to creativity and growth.

Q.17- What message would you like to give to students who are hesitant to follow their passion?

A: Many students hesitate to take initiative because they lack both knowledge and skills. Knowledge can be developed through study, but skills cannot be built without practical exposure. That's why it's important to apply what you learn — to build something, experiment, and gain hands-on experience. You should also aim to develop a deep understanding of your field, because without sufficient knowledge, you won't have the confidence to take action. Start by gaining theoretical knowledge, and then work practically to convert that knowledge into skill. Collaborating with experts or professionals in your field can also help you learn faster and more effectively.

18. Any suggestions you would like to give to young people who are willing to start their career in gardening?

A: Gardening is a broad and diverse field, and without genuine interest, it's difficult to sustain yourself in this journey. It's important to stay updated with the latest knowledge and design trends, especially those used in western countries, as observing them can inspire new ideas for your own landscape designs. I have also written a book titled *"Green Environments: A Handbook of Modern Landscape Design,"* which covers practical knowledge and techniques used in landscaping and gardening. Anyone who wants to learn the basics of gardening can start with this book. I always encourage young enthusiasts to begin with small efforts, as these small steps build confidence and pave the way toward achieving bigger dreams in the field of landscape design.

19: Any future projects or initiatives you are planning that our readers should look forward to?

A: Definitely. I would love to offer my consultation and expertise for any upcoming landscaping projects. Since I know my field well, taking on new projects is never a challenge for me — it's something I truly enjoy. I'm always open to collaborating with agencies or organizations that need professional guidance in landscaping, and I've already provided consultations to several institutions. I strongly believe that knowledge becomes meaningful only when it's applied. Landscaping is not something that can always be explained in words — it's a form of art that must be experienced. For example, if I tell you that I'll design an area using lawns and shrub borders, it may be difficult to visualize the final result. But as an expert, I can see the vision clearly and understand exactly how it will be executed to bring that design to life.

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SUSTAINABILITY IN EVERY DROP

HOW RESPONSIBLE PALM OIL CAN STRENGTHEN INDIA'S FOOD ECOSYSTEM

About Author

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Chairman, IPOA

Global food systems are being reshaped by a perfect storm of climate change, geopolitical supply disruptions, and shifting market demands. In this volatile landscape, India stands at a pivotal moment in its enduring effort to ensure affordable, reliable, and nutritious food for its 1.4 billion people. The choices made today will resonate for decades, determining not just the price of a meal but the very resilience of the nation's agricultural economy.

At the very heart of this challenge lies a single, crucial commodity: edible oil. And within that category, one oil stands apart for its efficiency, affordability, and versatility, palm oil. Too often misunderstood in global discourse, palm oil remains irreplaceable to India's food security. To understand why, one must look at the fundamental arithmetic of land use. In a world of finite arable land, maximizing yield per hectare is not just an economic imperative but an environmental one. The oil palm is remarkably efficient, producing an average of 3.91 tons of oil per hectare, far surpassing the meagre 0.7 tons yielded by soybeans, rapeseed, or sunflowers. To replace the palm oil India imports with these alternatives would require converting tens of millions of additional hectares of land a devastating prospect for global forests and biodiversity. Its high yield, cost efficiency, and functional properties make it indispensable in balancing affordability with rising consumption. The next chapter for palm oil, however, must focus unwaveringly on responsible production and sourcing - anchored in transparency, efficiency, and collaboration across the value chain.

The growing partnership between Indonesia and India offers a powerful model for this necessary evolution. By moving beyond a simple commodity trade to building a traceable, future-ready supply chain, both nations can promote shared economic growth while addressing pressing environmental and market priorities. This collaboration is not a mere transaction; it is a strategic alliance that can strengthen India's edible oil security while contributing to a more resilient and sustainable agricultural ecosystem across the region.

India's edible oils landscape: Dependence, volatility, and shifting dynamics

India's story with edible oils is one of a nation navigating the complexities of self-sufficiency in the face of overwhelming demand. The country remains heavily reliant on imports to bridge the gap between domestic production and consumption. This reliance is a structural reality, driven by a growing population, rising incomes,

and dietary shifts. The fundamental equation is simple: domestic production cannot keep pace. In the 2023/24 marketing year, India imported 8.9 million metric tons (MMT) of palm oil, a decline of around 11% year-on-year, as the government tightened import duty regimes.

A closer look at recent months reveals a market characterised by significant volatility, underscoring the fragility of the supply chain. In May 2025, India's palm oil imports surged 84% month-on-month to 592,888 metric tons, the highest since November 2024. This was followed by a 61% jump in June 2025 to ~953,000 tons, their highest in 11 months. The trend continued into August 2025, with imports rising to 990,528 metric tons, up 15.76% over July, hitting the highest level since July 2024. These swings translate directly into price fluctuations for the end-consumer and planning nightmares for India's food processing industry. This volatility exposes the Indian economy to external shocks and highlights the urgent need for a more stable and predictable sourcing model.

On the whole, dealers estimate that in the 2024/25 marketing year, palm oil imports might fall ~13.5%, to about 7.8 MMT, the lowest since 2019/20, as the momentum shifts toward soyoil and other alternatives. Yet, paradoxically, overall edible oil imports in 2025/26 are projected to hit a record 17.1 MMT, with palm oil alone potentially rising to 9.3 MMT. This fluctuating illustrates a critical point: India's exposure is systemic. Imports remain essential, but they are subject to the whims of abrupt demand shifts, international price fluctuations, and domestic policy changes, creating a cycle of reactionary buying that benefits neither producer nor consumer.

On the policy front, notable changes occurred in mid-2025. India slashed the basic customs duty on crude edible oils (including palm oil) from 20% to 10%, narrowing the duty differential between crude and refined oils. This move is seen as an effort to ease pressure on edible oil prices for consumers. Such policy interventions, while well-intentioned, add another layer of uncertainty for long-term investment in the supply chain. What the industry needs is not just reactive measures, but a proactive, strategic framework for edible oil security. According to IMARC, India's palm oil market reached 10.2 million tons in 2024, and is forecast to grow to 14.1 million tons by 2033 (CAGR ~3.4%), signaling unwavering long-term demand growth. This is not a trend that can be managed with short-term tools; it requires a long-term partnership.

Indonesia's supply side and evolving export dynamics

On the other side of this equation stands Indonesia, the world's undisputed leader in palm oil supply. Our 2025 projections show production at 53.6 million tonnes, with domestic consumption around 26.1 million tonnes, leaving exports at ~27.5 million tonnes. However, it is crucial to understand that Indonesian production is exhibiting signs of maturation and stagnation. As of April 2025, crude palm oil (CPO) production reached 16.49 million tons, only marginally higher than the same period in prior years. This signals that the era of unlimited supply growth is over. Future volumes will depend increasingly on intensification, productivity gains, and sustainable replanting, not on forest conversion.

In May 2025, CPO production declined further, though exports jumped ~49.75%, reaching ~ USD 2.82 billion. June 2025 saw a stronger rebound, with CPO production at ~4.823 million tonnes. By June, Indonesian palm oil exports had reached USD 17.28 billion (January–June), up 34.64% year-on-year. This export value growth, coupled with rising average CIF prices (USD 1,180/ton in 2025 vs. ~USD 1,000/ton the prior year), indicates a robust global market that is increasingly valuing the commodity, even amid sustainability debates.

Simultaneously, Indonesia's domestic biodiesel program is creating a fundamental shift in our own market dynamics. The government's steadfast move toward B50 (50% palm oil blending) by 2026, up from the existing B40 mandate, will substantially raise domestic palm oil demand. This policy is a cornerstone of Indonesia's energy security and decarbonisation strategy, but it also means that the exportable surplus will face increasing competition.

Why responsible palm oil is non-negotiable for India's food security

In this new reality, responsible palm oil sourcing transitions from a niche concern to a central pillar of India's food security and supply resilience. As the world moves decisively toward net-zero targets and deforestation-free supply chains, every drop of palm oil now carries both an environmental and a reputational premium. By proactively sourcing from traceable, NDPE-compliant (No Deforestation, No Peat, No Exploitation) supply chains, Indian businesses can future-proof themselves, avoiding hidden carbon costs and regulatory hurdles.

Technology is making this easier than ever before. Advanced tools such as remote-sensing, geospatial mapping, and AI-driven monitoring are being deployed across Indonesia to ensure transparency and prevent illegal forest conversion. For instance, a

recently published open dataset cataloguing oil palm planting stages across Indonesia (2020–2024) offers unprecedented visibility into plantation development and land use trends. This level of transparency is our industry's commitment to accountability, and it provides Indian partners with the verified data they need to meet their own sustainability commitments.

Equally critical is the role of responsible sourcing in building supply chain resilience against market volatility. The monthly import fluctuations we see in India are a symptom of a fragile system. Responsible sourcing models that incorporate forward contracts, shared premiums, and traceable supply commitments can create a buffer, protecting refiners and processors from abrupt policy or price shocks.

Furthermore, sustainability in palm oil carries a profound social dimension that is often overlooked. Around 40% of Indonesia's palm oil production comes from smallholders, whose livelihoods depend directly on stable, inclusive markets. Integrating them into sustainability programs through access to training, financing, improved agronomy, and guaranteed off-take agreements is a win-win. It strengthens community welfare and, in turn, guarantees a more reliable and quality-conscious supply for India's growing demand.

Finally, embracing responsible palm oil trade aligns perfectly with India's broader policy goals. The government's drive for edible oil self-sufficiency through the National Mission on Edible Oils - Oil Palm (NMEO-OP) is commendable. However, this must be balanced with a parallel effort to secure sustainable imports. The Indian Palm Oil Sustainability (IPOS) Framework provides a natural mechanism to align domestic production and imports under unified sustainability standards.

Building a sustainable India-Indonesia Palm Oil Corridor

The next phase of our bilateral relationship is about transformation, not just trade. Both nations are poised to move toward a more strategic and future-oriented partnership anchored in innovation, inclusivity, and mutual growth. Indonesia's palm oil industry has been steadily transitioning from expansion to sustainability-focused development.

Smallholders, who manage about 40% of Indonesia's palm area, are now central to this change. They are supported by ambitious programmes on replanting with high-yield seeds, group certification, access to finance, and digital traceability systems that use satellite and geolocation tools to strengthen visibility and accountability. Empowering them is our greatest challenge and our most significant opportunity.

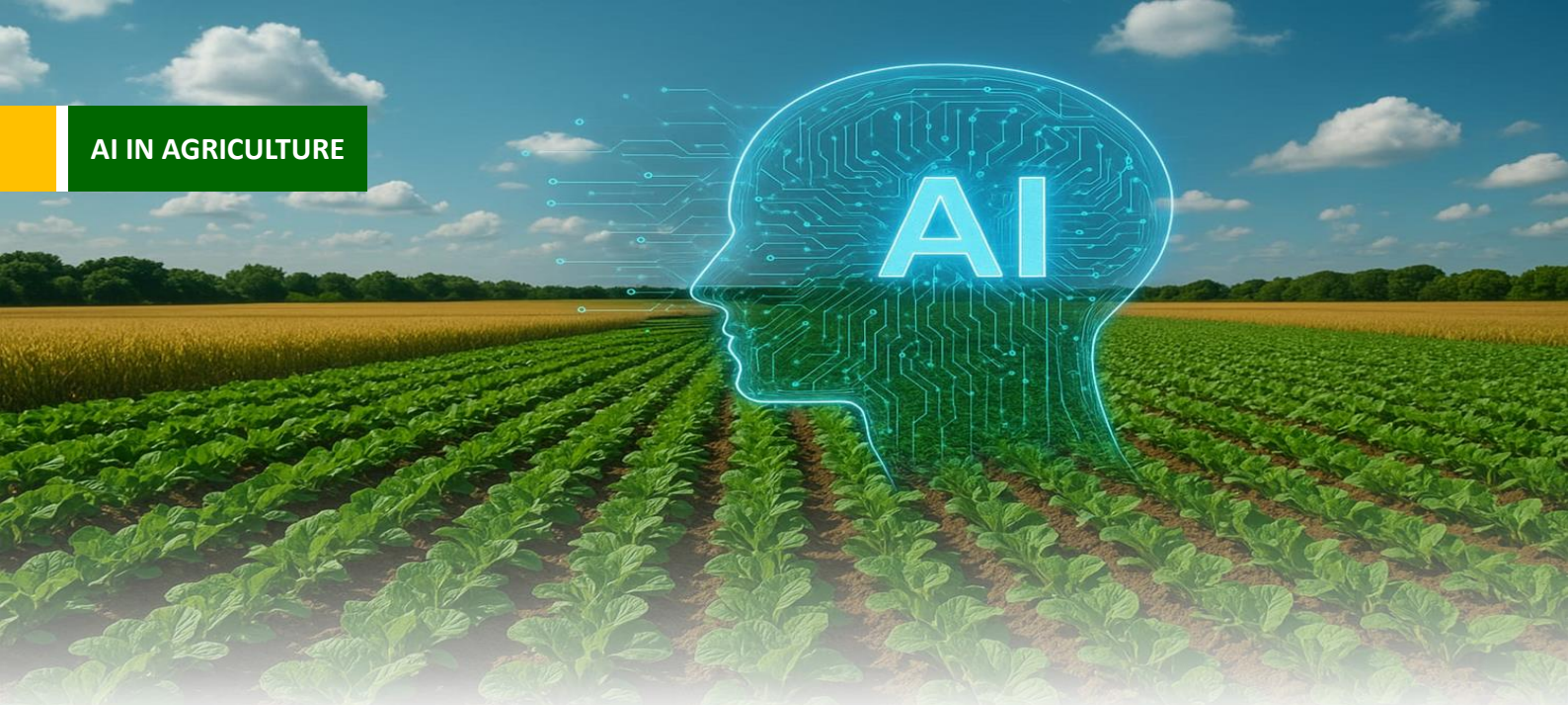
On the bilateral front, the potential for synergy is immense. Collaboration between the Indonesian Oil Palm Research Institute (IOPRI) and the Indian Institute of Oil Palm Research (IIOPR) can accelerate research on high-yield, pest-resistant, and climate-resilient hybrids, benefiting plantations in both countries. Indonesia's successful Plasma-Nucleus model offers invaluable lessons for India in smallholder inclusion and intercropping practices, which can be adapted to the Indian context to improve the viability of its own oil palm mission.

Furthermore, joint investments in downstream infrastructure in India such as refining, fractionation, and bonded storage at strategic ports like Kandla and Paradip can align with India's 'Make in India' vision while securing Indonesia's long-term market access. This moves value-addition and jobs to India, creating a deeper economic integration that goes beyond raw material exports. To sustain this progress, both governments must explore innovative policy and financial mechanisms. Coordinated tariff structures, export credit facilities, and a structured working group under the Comprehensive Economic Cooperation Agreement (CECA) can be established to promote stable, transparent, and responsible trade. Together, these efforts can transform the palm oil corridor into a celebrated model of South-South cooperation and shared prosperity.

Conclusion

The transformation ahead is about more than easing trade flows or tweaking tariff structures - it is about redefining how great nations collaborate for shared resilience in a turbulent world. The future of this vital sector will not be shaped by regulation alone, but by a collaborative vision - one where producers and consumers co-design frameworks rooted in trust, innovation, and shared prosperity.

Palm oil, when produced responsibly, is unequivocally part of the global sustainability solution. With its exceptional yield and minimal land footprint, it offers the most practical, scalable way to meet the world's growing vegetable oil demand without further compromising our forests or biodiversity. The narrative of palm oil as a villain is an outdated one, a relic of a time before satellite monitoring, smallholder empowerment, and national sustainability mandates. The task now is to replace misconception with clarity - to recognise palm oil not as a challenge to be managed, but as a smart, sustainable choice that intelligently balances human needs with the planet's wellbeing. The India-Indonesia corridor is the perfect place to build that new narrative, together.■



FROM REACTIVE TO PREDICTIVE

Why Agriculture Needs AI Now More Than Ever

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In a sugar mill in Latin America, a century old industry blended traditional wisdom with modern technology to achieve non-linear improvements. For generations, mill managers relied on their deep, intuitive understanding of the process—over decades of intimate experience—to predict sugar yields. These predictions, while sophisticated, were limited by the human mind's capacity and systems to process the vast variables involved in the process.

Recently, the mill embraced an AI-powered predictive system that integrated sensor data from lab data, real-time factory operations, and historical recovery rates. This technology didn't replace the managers hard-earned foresight but amplified it, providing a level of context and precision not possible by even the most seasoned human mind. The team could now forecast sugar recovery in advance with unprecedented accuracy. This enhanced foresight allowed them to fine-tune processing speeds, adjust chemical use, and optimize energy consumption. The result was a measurable increase in sugar yield, reduced wastage, and significant improvements in efficiency.

This is more than an isolated success. It illustrates the transformative power of merging agriculture, where the intuitive sophistication of the past is elevated by AI's ability to harness vast data and context, enabling teams to navigate uncertainty with greater confidence.

The bigger picture

The sugar mill example highlights a truth that extends across the agricultural value chain: whether in milling, planting, or harvesting, prediction is power. Farmers and agribusinesses that anticipate challenges, from weather shifts to pest infestations, gain a decisive edge.

While agriculture has always involved managing risk, the tools to do so have changed. Intuition and experience remain vital, but they must now be complemented by data-driven foresight.

What is predictive analytics?

Predictive analytics is the science of using data, statistical models, and machine learning to anticipate future outcomes. Instead of simply reporting what has already happened, predictive analytics looks ahead and answers questions such as: *What is likely to happen next? What factors most influence that outcome?*

How predictive analytics works

While the term may sound complex, the process behind predictive analytics follows a logical and repeatable flow. Think of it as teaching a system to "learn from the

past" so it can make better guesses about the future. The main steps are:

1. Data collection

Predictive analytics begins with gathering large volumes of historical and real-time data. In agriculture, this could include rainfall records, temperature data, soil nutrient levels, past yield performance, irrigation schedules, satellite imagery, and even sensor readings from tractors and combines. The richer and cleaner the dataset, the more accurate the predictions.

2. Data preparation and integration

Raw data is rarely ready to use. It must be cleaned, standardized, and combined into a unified format. For example, rainfall records might be in daily logs, while soil tests are conducted monthly, and satellite images are captured weekly. Integrating these different timelines and units creates a coherent dataset for analysis.

3. Model training

Once the data is prepared, algorithms—mathematical models designed to detect patterns—are trained. Training means the algorithm "looks" at historical data to identify relationships between variables. For instance, it may learn that when early-season rainfall is below a certain threshold and soil nitrogen levels are low, yields tend to decline. These relationships become the foundation of predictive power.

4. Validation and testing

To ensure reliability, the model's predictions are tested against data it has not seen before. If the model can accurately forecast outcomes for this new data, confidence in its usefulness increases. Without this validation, models risk being misleading or overly optimistic.

5. Deployment and decision support

Once validated, the model is put into use. Farmers or agribusinesses interact with it through dashboards, alerts, or decision-support tools. For example, the system might recommend delaying planting by a week due to predicted late rainfall or suggest increasing irrigation in a specific field where soil moisture is expected to drop.

6. Continuous learning

Predictive analytics systems improve over time. As new data flows in, the models can be retrained, refined, and adjusted for shifting conditions such as climate variability or new crop varieties. This ongoing cycle ensures predictions remain relevant and adaptive.

Why prediction matters now more than ever

Agriculture has always been shaped by uncertainty, but today the stakes are higher than ever. Farmers and agribusiness leaders face a complex mix of pressures that make traditional "wait and watch" approaches unsustainable. Several converging factors are driving the urgent need to shift from reactive decisions to predictive intelligence:

1. Climate volatility

Weather patterns that once followed predictable seasonal cycles are now increasingly erratic. Sudden droughts, unseasonal rains, heatwaves, and floods can devastate entire harvests. A farmer who plants based on historical averages may suddenly face a season that looks nothing like the past. Relying solely on reactive adjustments often means it's too late to save yields. Prediction tools, on the other hand, provide early warnings. Helping farmers decide the right time to plant, irrigate, or harvest, even when climate patterns are shifting unpredictably.

2. Market demand

Global food consumption is rising steadily, fueled by population growth and changing dietary preferences. Consumers expect year-round availability of diverse crops, from staple grains to fresh fruits and vegetables. Meeting this demand requires precision in production planning, logistics, and pricing. Without predictive insights, producers risk mismatches. Oversupply that drives down prices or shortages that leave shelves empty. Predictive analytics enables more accurate forecasting of demand at local, regional, and global levels, allowing growers and suppliers to align production with market realities.

3. Resource scarcity

Land and water, the two most critical inputs in agriculture, are under severe pressure. Groundwater tables are falling, fertile soil is degrading, and competition for resources is intensifying. Every drop of water, every unit of fertilizer, and every acre of arable land must be managed with precision. Traditional blanket approaches: watering entire fields or applying the same fertilizer rate everywhere, are inefficient and wasteful. Predictive models guide farmers toward smarter allocation, showing *where* and *when* to intervene, ensuring higher productivity with fewer inputs. This is not only an economic necessity but also an environmental imperative.

4. Data availability

For centuries, agriculture depended on farmers' observations and inherited wisdom. Today, farms and factories are becoming digital ecosystems. Sensors in the soil, drones scanning fields, satellites capturing imagery, and connected machinery generate a constant flow of data. Yet, data by itself does not solve problems; in fact, it can overwhelm. Predictive and optimization systems powered by AI are what transform this raw data into foresight. Identifying hidden patterns, simulating scenarios, and recommending actions. This is how agriculture can move from

guesswork to guided decision-making at scale.

From reactive to predictive: A paradigm shift

Agriculture has historically been reactive as there where fundamental operational restrictions:

1. A pest outbreak appears → pesticides are applied.
2. Rainfall is delayed → emergency irrigation begins.
3. Yields fall short → lessons are noted for the next season.

In a world where data eliminates some of these operational restrictions, this sequence is reversed. AI models analyze historical patterns, real-time data, and environmental signals to anticipate outcomes before they happen.

1. Predicting pest outbreaks weeks before they grow out of control.
2. With limited resources, deciding where irrigation is most needed based on soil moisture and weather patterns becomes ever more critical.
3. Estimating yields with enough lead time to optimize harvesting, resources and margins.

This shift is not just incremental. It redefines agriculture's ability to plan, adapt, and thrive.

Practical applications of predictive AI

1. **Field-level decisions:** Optimizing seeding, irrigation, and fertilizer based on soil and weather predictions.
2. **Crop health monitoring:** Identifying disease outbreaks early through image recognition and weather-linked AI models.
3. **Yield forecasting:** Providing reliable estimates for planning logistics and market engagement.
4. **Supply chain synchronization:** Aligning production with demand forecasts, reducing losses.
5. **Sustainability gains:** Predictive water and nutrient models that maximize output while conserving resources.

Farmers at the center

For predictive AI to succeed, it must remain farmer-centric. The technology should not overwhelm with complexity but deliver insights in familiar, accessible ways e.g. SMS alerts, voice assistants, or mobile dashboards.

Adoption is already proving most successful when farmers see immediate value: reduced water bills, higher yields, or fewer crop losses. Prediction is not an abstract promise. It becomes real when it delivers results on the ground.

Barriers and enablers

The road to predictive agriculture is not without challenges. Data quality, trust, affordability, and skill gaps remain barriers. Yet collaborative ecosystems, linking farmers, agritech providers, governments, and investors, are steadily breaking these barriers.

A closing thought

The sugar mill in Latin America did not adopt AI to chase a trend. It did so because predictions of critical processes gave it reduced uncertainty. And that lesson applies across the sector.

Agriculture of the future is about compressing time to assertive agronomic and industrial action through optimization. Predictive AI is not about replacing farmer wisdom; it is about amplifying it with foresight that ensures resilience, sustainability, and prosperity.

The question is no longer whether agriculture needs AI. The real question is: how quickly can prediction become the new normal?

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EMPOWERING THE UNSUNG PILLARS

THE INDISPENSABLE ROLE OF WOMEN IN INDIAN AGRICULTURE

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Women play a pivotal role in Indian agriculture, contributing across crop production, livestock management and post-harvest operations. Despite their significant participation they face challenges including limited land ownership, restricted access to credit, technology, education, market exclusion and climate vulnerabilities. Gender-responsive policies, skill development and resource access are essential to enhance productivity, ensure food security and promote socio-economic empowerment of rural women.

Introduction

Women have always been the backbone of agriculture, contributing tirelessly to the growth and sustenance of nations. As beautifully expressed in Sanskrit, *"कृषकर्मणि स्त्रीणां योगदानं नित्यं फलदायकम्"* (*Kṛṣṇakarmaṇi strīṇāṃ yogadānaṃ nityaṃ phaladāyakam*), "Women's contribution in farming always bears fruit," highlighting the perennial value of their labor in the fields. Chanakya, in his *Arthashastra*, acknowledged this indispensable role by stating, *"अन्नं पुरुषाणां जीवनम्, स्त्रीणां परिश्रमः अन्नस्य स्रोतः"* (*Annaṃ puruṣāṇāṃ jīvanam, strīṇāṃ pariśramaḥ annasya srotaḥ*), meaning "Food is the life of men, and women's labor is the source of food." This ancient wisdom resonates with the timeless insight from the Rigveda, *"भूमेः धान्यं स्त्रियः परिश्रमेण स्यात्"* (*Bhūmeḥ dhānyaṃ striyaḥ pariśrameṇa syāt*), "By women's toil, the land yields its grain," emphasizing that agricultural prosperity is deeply intertwined with women's efforts. Even in modern perspective, the philosophical maxim adapted from historical understanding declares, *"स्त्रीशक्ति यदि कृषि में हो, तो राष्ट्र कभी भूखा न रहे"* (*Strīśakti yadi kṛṣi me ho, to rāṣṭra kabhi bhūkha na rahe*), "If women's power is in agriculture, the nation will never go hungry." Together, these voices from history and scripture affirm that empowering women in agriculture is not only a matter of social justice but a cornerstone for national food security and sustainable development.

The UN General Assembly has declared 2026 as the 'International Year of the Woman Farmer', recognizing women's critical role in global agriculture. Women contribute nearly half of global food production, accounting for 60-80% of output in developing

countries and 39% of South Asia's agricultural labor force. In India, around 80% of rural women are engaged in agriculture, including 3.6 crore women farmers and 6.15 crore agricultural laborers (Census 2011), representing 33% of the labor force and 48% of self-employed farmers. With rising male migration, women increasingly manage farms independently, reflecting the feminisation of Indian agriculture.

Feminisation of Agriculture

With increasing rural-to-urban migration of men, agriculture has witnessed a growing participation of women across multiple roles including cultivators, entrepreneurs and laborers. Empirical evidence globally underscores the critical role of women in ensuring food security and conserving local agro-biodiversity. Rural women manage diverse natural resources to meet household needs, highlighting the necessity for improved access to essential resources such as land, water, credit, technology and training. Ensuring their entitlements is vital for enhancing agricultural productivity, particularly in the Indian context, where disparities in access to inputs, markets and services persist. Women actively contribute across the entire agricultural value chain from production and pre-harvest operations to post-harvest processing, packaging and marketing necessitating gender-responsive interventions. Women also undertake numerous labor-intensive tasks, including weeding, hoeing, grass cutting, seed and fiber separation, livestock management, milking and milk processing, underscoring their indispensable role in agriculture and allied activities.

Role of rural women in agriculture

Rural women participate in agricultural activities in diverse capacities influenced by family socio-economic status and regional conditions. Their engagement can be categorized as:

1. **Wage laborers:** Women working for remuneration on others' farms or agricultural enterprises.
2. **Cultivators:** Women managing and working on their own land, performing primary farming operations.
3. **Agricultural managers:** Women overseeing specific aspects of production, including supervising labor and participating in post-harvest processes.
4. **Progressive farmer/ Agricultural Entrepreneurs:** Women in this category lead farms and agri-enterprises by implementing modern technologies, high-yield crop varieties and innovative cultivation practices.

Literacy among women in farming communities

Around 52 to 75 per cent of Indian women in agriculture are illiterate, restricting access to skilled labor and external agricultural knowledge. Limited literacy and mobility constrain information acquisition, though women actively share knowledge within and across communities. Programs such as self-help groups in Karnataka enhance social networks to overcome literacy barriers. Persistent gender wage gaps in women earn about 70% of men's wages and widespread unpaid subsistence work underscore women's economic vulnerability. Strengthening education, skill development and mobility is critical to enhance productivity, income and resilience among women farmers.

Women workforce in Indian agriculture

Agriculture continues to serve as a critical sector of employment in India, with women forming a significant portion of its workforce. According to the Periodic Labour Force Survey (PLFS) 2023-24, nearly 64.4 per cent of rural female workers were engaged in agricultural activities, compared to 36.3 per cent of rural male workers. This reflects the deep dependence of rural women on agriculture for livelihoods, especially in self-employment and unpaid family labour roles (Vikaspedia, 2025).

At the national level, agriculture accounted for 46.1 per cent of total employment, with women showing a much higher concentration than men. The data highlight persistent gendered occupational patterns women remain underrepresented in non-farm sectors like manufacturing (11.6%) and services, but overrepresented in agriculture and allied activities. The Labour Force Participation Rate (LFPR) for females in rural areas stood at 35.5%, compared to 57.9% for males, revealing ongoing disparities in labour inclusion. Despite this, the share of female self-employment (73.5%) is significantly higher than that of rural males (59.4%), emphasizing women's role in small-scale or subsistence farming rather than wage labour.

Table 1. Distribution of workers by broad industry division and gender, PLFS 2023-24

Broad Industry Division (NIC-2008)	Rural Male (%)	Rural Female (%)	Urban Male (%)	Urban Female (%)	Rural + Urban Male (%)	Rural + Urban Female (%)
Agriculture	49.4	**76.9**	4.8	**12.3**	36.3	**64.4**
Mining & Quarrying	0.3	0.0	0.4	0.1	0.3	0.1
Manufacturing	8.1	8.5	19.3	24.1	11.4	11.6
Electricity, Water etc.	0.5	0.1	1.3	0.5	0.7	0.2
Construction	18.7	7.1	11.2	3.6	16.5	6.3
Trade, Hotels & Transport	13.7	3.6	33.5	17.2	19.2	6.4
Other Services	9.3	3.8	29.5	42.2	15.6	10.9

Source: Annual Report, Periodic Labour Force Survey, 2023-24, (DGE, 2024)

1.Employment concentration in agriculture

The *Periodic Labour Force Survey (PLFS) 2023-24* reveals that 76.9% of rural women are employed in agriculture compared to 49.4% of rural men, indicating a pronounced gender concentration in the sector. At the national level, 64.4% of all female workers depend on agriculture, while the corresponding share for men is 36.3%. Even in urban areas, 12.3% of women remain engaged in agricultural activities.

2. Gendered employment and sectoral diversification

Women's employment remains heavily skewed toward agriculture and allied activities, with minimal diversification into non-farm sectors. Only 11.6% of women are engaged in manufacturing, 6.3% in construction and 6.4% in trade, hotels and transport, compared to higher male participation in each. This underscores limited access for women to education, skill training and wage-based employment.

3. Informality and Nature of Work

A large share of female agricultural workers are self-employed or unpaid family labour, particularly in smallholder and subsistence farming. The PLFS indicates that 73.5% of rural female workers are self-employed, compared with 59.4% of rural men, highlighting women's dominance in informal, low-income agricultural roles.

4. Rural-Urban employment divide

Agriculture remains the backbone of rural women's employment, while urban women have greater representation in manufacturing (24.1%) and services (42.2%). However, a residual 12.3% of urban female workers in agriculture shows continued dependence among peri-urban and migrant households.

5. Policy implications

The data emphasize the need for gender-responsive agricultural strategies, including access to credit, technology, land ownership and extension services to improve women's productivity and income security.

State-level highlights

While state-specific data vary, PLFS 2023-24 shows that states like Bihar, Uttar Pradesh, Madhya Pradesh and Odisha have over 60 per cent of their female workforce in agriculture, compared to below 40 per cent in more industrialized states such as Tamil Nadu, Maharashtra and Gujarat. Southern states exhibit gradual diversification toward manufacturing and services, but the northern and eastern states remain heavily agrarian with female dominance in farm activities.

Technology adoption and displacement of female workers

This broad sweep of the trends in labour absorption in agriculture over the last five decades suggests a positive impact on employment.

- Mechanization reduces female employment in farm operations like weeding and ploughing, particularly through tractors and advanced equipment, replacing tasks often done by women.
- Adoption of HYVs and modern technologies increases overall labour use with a notable rise in female participation in crop cultivation under paddy and similar crops.
- Increased female labour absorption is linked to shrinking operational holdings, cropping pattern shifts and male migration, even as large farms may see female workforce withdrawal due to technology-led income growth.

Challenges faced by women in agriculture

1. **Gender inequality in land ownership:** Women own only 8-14% of agricultural land, restricting access to credit, subsidies, technology and extension services and limiting decision-making power.
2. **Barriers to technology, education and skill adoption:** Limited access to financial services, modern technology and low levels of formal education, financial literacy and technical skills constrain adoption of efficient agricultural practices and scaling of agri-enterprises.
3. **Overburdened and unrecognized workload:** Women manage farming, household chores and childcare simultaneously, leading to physical exhaustion and time poverty. Contributions in livestock care, seed preservation and food processing often remain unpaid and unacknowledged.
4. **Market exclusion:** Restricted mobility, lack of transport and gender-based discrimination hinder access to markets, fair prices and value chains; information asymmetry further marginalizes women farmers.
5. **Vulnerability to climate change:** Increased frequency of floods, droughts and other climate shocks exacerbate women's workload and resource constraints, reducing time and capacity for agricultural activities.

Government initiatives for women's empowerment in India

In India, policy reforms have emphasized the holistic development of women, aiming to ensure socio-economic and health security. Since Independence, several flagship schemes have been launched to enhance rural women's status by promoting livelihood opportunities and paid employment. Programs such as the Prime Minister's Employment Generation Program (PMEGP), National Livelihood Mission, Deen Dayal Upadhyay Grameen Kaushalya Yojana (DDU-GKY), Pradhan Mantri Kaushal Vikas Yojana (PMKVY), Beti Bachao Beti Padhao and Pradhan Mantri Matru Vandana Yojana (PMMVY) have contributed significantly to gender parity and socio-economic empowerment. These initiatives provide rural women with access to education, productive resources, skill development, capacity building, healthcare and diversified livelihood opportunities thereby strengthening their agency and participation in socio-economic development.

Conclusion

Rural women are indispensable to agriculture and allied sectors, contributing across crop production, livestock management, post-harvest processing and household-based economic activities. Despite their extensive involvement, women's work often remains undervalued, underpaid and unrecognized due to entrenched socio-cultural norms, gender bias and limited access to resources, education and markets. The dual burden of agricultural labor and household responsibilities imposes significant physical and time constraints, restricting opportunities for skill development and education. Women's occupational choices are constrained by societal expectations, inadequate infrastructure and discriminatory labor practices, resulting in their concentration in informal and low-income roles. Addressing these challenges requires gender-responsive policies, improved access to land, credit, technology, skill development and social support systems. Empowering women in agriculture not only enhances productivity and food security but also strengthens their socio-economic status, fostering sustainable rural development and equitable growth across communities.

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HARVEST FESTIVALS

AGRARIAN ROOTS OF CULTURAL CELEBRATIONS

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Harvest festivals represent a convergence of agriculture, astronomy and cultural tradition. Rooted in seasonal cycles, they express gratitude for natural resources while strengthening social identity and cohesion. This article examines major harvest festivals of India and selected global traditions, highlighting their agrarian, ecological and cultural significance and illustrating how these events embody the enduring relationship between humans and nature.

Introduction

Festivals are an integral part of India's cultural identity, showcasing the nation's diversity, traditions and heritage. Among them, harvest festivals hold special importance as they are rooted in agriculture, which continues to be the backbone of the Indian economy and the primary livelihood for much of the rural population. With each state having distinct crops, climates and practices, harvest festivals are celebrated at different times of the year, reflecting regional diversity while maintaining a shared spirit of thanksgiving.

These celebrations go beyond rituals and festivities; they symbolize reverence for nature and acknowledgment of the

The following are the important harvest festivals celebrated in India:

The harvest festival	States in which it is celebrated
Makar Sakranti	Gujarat, Kerala, Tamil Nadu, Haryana, Himachal Pradesh, West Bengal, Karnataka and Punjab
Baisakhi/ Vaisakhi	Punjab and Haryana
Ladakh harvest festival	Ladakh, Zanskar and Kargil
Lohri	Punjab
Bohag Bihu	Assam
Wangala	Meghalaya and Assam
Ka Pomblang Nongkrem	Meghalaya
Nuakhai	Orissa
Nabanna	West Bengal
Onam	Kerala
Pongal	Tamil Nadu
Vishu	Kerala and Karnataka
Gudi Padwa	Maharashtra, Karnataka and Andhra Pradesh
Dree festival	Arunachal Pradesh
Hornbill festival	Nagaland
Hemis festival	Ladakh

elements such as earth, sun and rain that make agriculture possible. Whether observed through local foods, attire or customs, harvest festivals embody gratitude, prosperity and community bonding, uniting people across regions in their dependence on and respect for the natural world.

1. Makar Sankrati

Makar Sankranti, observed in mid-January, marks the sun's entry into Makara (Capricorn), aligning with the winter solstice transition to longer days. Agriculturally, it signifies the conclusion of the primary harvest cycle and a period of rest and gratitude for farmers. Regional practices vary: kite flying in Gujarat and Rajasthan and Pongal in Tamil Nadu, a four-day thanksgiving festival honoring the sun, rain and soil. The festival also fosters social cohesion through shared rituals,

food and cultural activities, while its solar alignment underscores the scientific link between astronomical transitions, seasonal shifts and agricultural practices in India.

2. Pongal – A Harvest Festival of South India

Pongal, celebrated in mid-January in Tamil Nadu, coincides

with the sun's northward shift (Uttarayan) and marks gratitude to the sun, rain and soil sustaining agriculture. Spanning four days, it involves rituals such as boiling newly harvested rice to symbolize prosperity, alongside Kolam art, communal cooking and traditional games. Its solar alignment underscores the interconnection between astronomical transitions, agricultural cycles and socio-cultural practices in South India.

3. Baisakhi/ Vaisakhi – Harvest and New Year Festival

Baisakhi, celebrated in mid-April, marks the harvest of the *rabi* crop and the onset of the solar New Year. Predominantly observed in Punjab and Haryana, it represents

both agricultural prosperity and cultural identity. For Sikhs, it also commemorates the founding of the Khalsa in 1699, adding historical and religious significance. Its solar alignment underscores the connection between astronomical cycles, seasonal transitions and agrarian practices.

4. Lohri – A Winter Harvest Festival of North India

Lohri, celebrated in mid-January in Punjab and nearby regions, marks the harvest of winter

crops like sugarcane and mustard. Its central ritual involves offerings to a bonfire, symbolizing gratitude for agricultural abundance and the transition from winter to longer days. The festival combines agrarian significance with cultural expression through folk songs, dances and communal gatherings, reflecting the link between seasonal change, farming cycles and social cohesion.

5. Onam – Harvest Festival of Kerala

Onam, celebrated in Kerala during August-September, marks the rice harvest and spans ten days, with Thiruvonam as the focal day. Key

traditions include floral designs (Pookkalam), cultural performances, the Onam Sadhya feast and the Vallamkali snake boat race. Rooted in agrarian cycles, the festival symbolizes prosperity, social cohesion and Kerala's cultural identity, while reflecting the scientific link between seasonal change, agriculture and community life.

6. Bihu – Agricultural Festival of Assam

Bihu, celebrated in Assam in April, marks the Assamese New Year and the onset of the sowing season. Known as Rongali or Bohag Bihu, it combines agrarian rituals of

thanksgiving with cultural practices such as folk dances, songs and communal feasts. Beyond its agricultural basis, the festival fosters social unity and highlights link between seasonal cycles, farming practices and community life.

7. Nuakhai – Harvest Festival of Western Odisha

Nuakhai, celebrated in Western Odisha a day after Ganesh Chaturthi, marks the first consumption of newly harvested rice. Symbolizing gratitude to deities and nature, it unites communities through rituals, shared meals, folk performances and prayers. Rooted in agrarian cycles, the festival

highlights the dependence of society on seasonal productivity and natural resources.

8. Ugadi

Ugadi, celebrated in March-April as the New Year of the Deccan

region, marks the start of the Hindu lunisolar calendar and seasonal transition. Traditions include home decorations, community gatherings, and preparing Ugadi Pachadi, symbolizing life's varied experiences. The festival reflects the scientific link between calendrical systems, agriculture and cultural renewal.

9. Gudi Padwa

Gudi Padwa, observed in Maharashtra in March-April, marks the Hindu New Year and the onset of the harvest season.

Central to the festival is the raising of a decorated Gudi, symbolizing prosperity and protection. Rooted in the lunisolar calendar, it reflects the alignment of astronomical cycles with agricultural and cultural traditions.

10. Holi

Holi, celebrated in March, marks the arrival of spring and the harvest of *rabi* crops. It begins with Holika Dahan, symbolizing the triumph of good over evil, followed by

communal celebrations with colors and water. The festival reflects the alignment of seasonal transitions, agricultural cycles and cultural practices fostering social unity.

11. Basant Panchami

Basant Panchami, observed in January-February, marks the onset of spring and is dedicated to Goddess Saraswati, symbolizing knowledge and wisdom. Celebrated across regions with rituals, yellow-themed customs, and community gatherings, it reflects both cultural diversity and agrarian transitions. The festival highlights the link

between seasonal change, agricultural cycles, and spiritual traditions.

12. Wangala festival

Wangala, celebrated by the Garo tribe between September and December, is a post-harvest thanksgiving festival dedicated to the fertility deity *Misi-A-Gilpa-Saljong-Galapa*. Also called the "Hundred Drums Festival," it features synchronized dances led by warriors, accompanied by rhythmic drumming and symbolic hand gestures. The festival signifies the close of the agricultural year, the onset of winter

and includes rituals of sun worship, with participants adorned in traditional attire that highlights the cultural identity of the Garo community.

13. Nabanna

Nabanna, meaning "new rice," is a harvest festival of West Bengal observed in the month of Agrahayan. It marks the gathering of freshly harvested paddy, with the first yield traditionally offered to Goddess Lakshmi as a gesture of gratitude. The celebration includes the *Nabanna Fair*, featuring traditional Bengali delicacies such as

pithe, along with cultural performances of music and dance, reflecting the integration of agriculture, ritual and community life.

14. Ladakh harvest festival

The Ladakh Harvest Festival, held in early September for fifteen days, showcases the region's agrarian and cultural traditions. The event features masked dances, folk songs and ritual performances, with

the "Ladakh Festival Cup," a traditional polo tournament, serving as a major highlight.

15. Ka Pomblang Nongkrem

Ka Pomblang Nongkrem is a five-day autumn festival of the Khasi community in Meghalaya, observed in October-November. The celebration includes traditional Nongkrem dance, ritual goat sacrifices to the deity U-Lei Shillong and concludes with a thanksgiving prayer to the creator led by the Syiem.

16. Vishu

Vishu marks the New Year in Kerala and symbolizes the onset of spring. The festival is dedicated to Lord Vishnu, particularly in his Krishna incarnation and is traditionally associated with the

belief that on this day Krishna defeated the demon Narakasura.

17. Agera

Agera is celebrated by the Catholic community of East Indians in Mumbai. It marks the harvest of crops after the monsoons. Agera falls on the first Sunday of October. The word Agers comes from the Latin word Ager which means "farm". After the harvest, the first fruits are offered to God.

18. Dree festival

The Dree Festival, observed by the Apatani tribe in Ziro Valley, Arunachal Pradesh, is held annually on 5 July, with preparations beginning a day earlier. It involves

ritual offerings to deities such as Tamu, Harniang, Metii and Danyi to ensure agricultural prosperity, accompanied by the preparation and sharing of traditional rice and millet beverages.

19. Chhath Puja

Chhath Puja, primarily observed in Bihar, Uttar Pradesh, and Jharkhand, is a nature-centric festival dedicated to the Sun God (Surya) and Chhathi Maiya. It involves rigorous fasting, preparation of traditional offerings

and prayers performed at riverbanks or ponds, where devotees stand in water to present *arghya* to the rising and setting sun. The festival reflects the agrarian and ecological reverence for solar energy as a source of fertility, sustenance and life.

Important harvest festivals around the World

1. Thanksgiving, Plimoth Plantation, Massachusetts

Thanksgiving, observed in the United States on the fourth Thursday of November, traces its origin to 1621, when Pilgrims in Plymouth Colony marked a successful harvest with a three-day communal feast. Historical accounts note the participation of the Massasoit and Wampanoag people, with foods such as wild fowl, fish and local game. The event was later formalized as a national holiday by President Abraham Lincoln in 1863.

2. Vendimia, Mendoza, Argentina

The *Fiesta Nacional de la Vendimia* in Mendoza, Argentina,

begins on the last Sunday of February with the Archbishop blessing the first grapes of the season. The festival, dedicated to viticulture, extends through March and features parades, regional representatives and cultural performances. It concludes with a large amphitheatre ceremony, combining music, dance and fireworks, during which the Harvest Queen is crowned.

3. Rice Harvest, Bali, Indonesia

In Bali, rice cultivation is closely linked to the worship of Dewi Sri, the rice goddess. During harvest, villagers decorate fields with flags, erect bamboo shrines and place rice-stalk effigies in granaries as symbolic offerings.

4. Chanthaburi Fruit Fair, Thailand

Held annually in summer, this fair showcases the region's tropical fruits such as durian, rambutan and mangosteen through exhibitions, competitions and parades featuring elaborate fruit-based displays.

5. Sukkot, Jerusalem, Israel

This Jewish harvest festival commemorates both agricultural abundance and the Israelites' desert wanderings. Families build temporary shelters (*sukkah*) and perform ritual waving of willow, myrtle, palm and citron to honor nature's gifts.

6. Blessing of the Sea, Greece

At Epiphany, Greek communities hold seaside ceremonies where a cross is cast into the water and retrieved by swimmers, symbolizing purification and renewal.

7. Olivagando, Magione, Italy

This November festival celebrates olive oil production with religious blessings, community feasts, and medieval-themed gatherings in Magione.

8. Lammas Festival, United Kingdom

Traditionally marking the start of harvest, Lammas involved offering bread baked from the first grain to churches and crafting corn dolls as symbols of fertility and abundance.

9. Madeira Flower Festival, Portugal

Held each April in Funchal, this festival celebrates spring with floral carpets, parades and the *Muro da Esperança* ("Wall of Hope"), created by children placing individual flowers.

10. Incwala, Eswatini

Observed in late December, Incwala is a royal-centered harvest ritual. Sacred tree branches form a ceremonial bower for the king, who must first consume the season's fruit before it is shared by the community.

Conclusion

Harvest festivals, whether in India or across the world, embody the deep connection between agriculture, culture and community life. They reflect gratitude toward natural forces, mark seasonal transitions and reinforce social cohesion through shared rituals, food and performances. While each region celebrates with distinct traditions shaped by local crops and beliefs, the underlying spirit remains universal honouring nature's abundance and sustaining the cultural fabric of societies.■

Previous Issues

Website Statistics (Sept. 2025)

157K	33K	3.9M
Monthly Pageview	Monthly Visitor	Monthly Impression

Social Stats

6.5K	6.0K	9.7K	1.7K	2.1K

INSECT

UNLOCKING THE INSECT WORLD
APPLICATION OF OMICS IN ENTOMOLOGY

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Insects are the most diverse and adaptable group of animals on Earth. From pollinators like bees and butterflies to notorious pests like mosquitoes and locusts, they influence agriculture, ecosystems, human health, and even global economies. Understanding insects has therefore been at the heart of entomology for centuries. However, conventional approaches such as morphological identification, behavioral studies, and classical genetics often provided only a partial picture of their biology.

In recent decades, the rise of omics technologies—including genomics, transcriptomics, proteomics, metabolomics, and epigenomics—has revolutionized the study of insects. Collectively referred to as "omics," these approaches allow scientists to explore the complex molecular networks that drive insect growth, development, adaptation, and interactions with their environment. Omics is essentially about capturing the "big picture" of biological systems, making it a powerful tool for solving entomological challenges in agriculture, medicine, biodiversity, and conservation.

This article highlights the application of omics in entomology, emphasizing how these cutting-edge technologies are transforming pest management, pollinator health, vector-borne disease control, and ecological research.

The omics revolution in entomology

Omics refers to large-scale approaches that aim to map and analyze the complete set of molecules in living organisms. Each omics field focuses on a specific level of biological information:

1. **Genomics–** study of the complete DNA sequence of an organism.
2. **Transcriptomics–** analysis of RNA transcripts that reflect gene activity.
3. **Proteomics–** profiling of proteins expressed in cells or tissues.
4. **Metabolomics–** identification of small molecules and metabolites involved in physiology.
5. **Epigenomics–** study of heritable changes in gene expression not coded in DNA sequence.
6. **Microbiomics–** exploration of microbial communities associated with insects.

By combining these approaches (integrative omics), entomologists can move beyond studying single genes or traits to understanding entire biological systems.

Genomics: Decoding the blueprint of insects

Genomics has been the cornerstone of modern entomology.

With the advent of next-generation sequencing (NGS), insect genomes can be sequenced faster and cheaper than ever before.

Pest management: Sequencing of pest genomes like the fall armyworm (Spodoptera frugiperda) or cotton bollworm (Helicoverpa armigera) has revealed genes linked to insecticide resistance. This information helps in designing novel pesticides and monitoring resistance evolution.

Disease vectors: The genomes of mosquitoes (Anopheles gambiae, Aedes aegypti) and sandflies have been sequenced to identify genes responsible for transmitting malaria, dengue, and leishmaniasis. Genome editing tools like CRISPR-Cas9, informed by genomic data, are now being used to engineer sterile or resistant mosquito strains for vector control.

Pollinator health: The sequencing of the honeybee (Apis mellifera) genome has provided insights into immunity, social behavior, and responses to environmental stressors, supporting conservation strategies.

Thus, genomics provides the foundational "blueprint" to understand insect biology and apply it to practical challenges.

Transcriptomics: Listening to the voices of genes

While genomics tells us what could happen, transcriptomics reveals what is actually happening inside insect cells at a given moment. By sequencing RNA, scientists can study gene expression under different conditions.

Stress and adaptation: Transcriptomic studies have shown how insects respond to heat, drought, or pesticide exposure by switching on or off specific genes. This helps in predicting pest outbreaks under climate change scenarios.

Host–pathogen interactions: In mosquitoes, transcriptomics has revealed how immune genes are activated when they ingest malaria parasites. Such findings pave the way for blocking parasite development inside the insect.

Development and metamorphosis: The transformation of a caterpillar into a butterfly is guided by complex gene expression changes. Transcriptomics maps these changes, giving clues to hormonal control and developmental biology.

By capturing the dynamic "voices" of genes, transcriptomics provides a real-time snapshot of insect physiology.

Proteomics: Mapping the workhorses of life

Proteins are the functional molecules that carry out cellular activities. Proteomics, the large-scale study of proteins, helps entomologists understand the biochemical machinery of insects.

Insecticide targets: Proteomic studies identify detoxification enzymes such as cytochrome P450s, esterases, and glutathione-S-transferases that allow insects to survive pesticide exposure.

Venom and saliva analysis: The saliva of mosquitoes or the venom of parasitoid wasps contains proteins that suppress host defenses. Proteomics reveals their structure and function, aiding in medical entomology and drug discovery.

Pollinator nutrition: Proteomic analysis of bee hemolymph (insect blood) and royal jelly has provided information on nutrition and immune health in pollinators, vital for their conservation.

Proteomics therefore connects genes with their biological functions, serving as a bridge between genetic information and observable traits.

Metabolomics: The chemical fingerprint of insects

Metabolomics focuses on small molecules such as amino acids, sugars, lipids, and secondary metabolites. These molecules directly influence insect survival, reproduction, and ecological interactions.

Insect–plant interactions: Metabolomics helps unravel how herbivorous insects detoxify plant toxins or how plants alter their chemistry to defend against insect attacks.

Insect communication: Many insects rely on pheromones and chemical signals. Metabolomic profiling identifies these compounds, aiding in the development of eco-friendly pest management strategies like pheromone traps.

Disease vectors: In mosquitoes, metabolomics has shown how malaria parasites alter host metabolism, offering new intervention points.

Through metabolomics, entomologists gain insights into the "chemical language" of insects.

Epigenomics: Beyond the genetic code

Epigenomics examines how environmental factors modify gene expression without changing the DNA sequence itself. In insects, epigenetic modifications like DNA methylation or histone modification influence behavior, caste differentiation, and adaptation.

Social insects: In honeybees, epigenomic changes decide whether a larva develops into a worker or a

queen, despite having the same genetic code.

Insecticide resistance: Epigenetic regulation can turn on detoxification genes, enabling pests to adapt quickly to new chemicals.

Transgenerational effects: Epigenomic studies show how parental exposure to stress or toxins can influence offspring traits, relevant for predicting pest resilience.

Epigenomics adds another layer of complexity, showing that genes are not destiny but are regulated by flexible molecular switches.

Microbiomics: The hidden allies and enemies

Insects harbor diverse microbial communities—bacteria, fungi, and viruses—that influence their health, development, and ecological roles.

Symbionts in pests: Endosymbiotic bacteria like Wolbachia manipulate insect reproduction and reduce vector competence in mosquitoes, offering a biological control strategy.

Gut microbiota: In termites, gut microbes digest cellulose, while in mosquitoes they influence pathogen transmission. Manipulating gut microbiota is an emerging area in pest and vector management.

Pollinator health: Microbiome studies in bees have identified beneficial bacteria that enhance immunity and digestion, highlighting the role of microbial balance in pollinator decline.

Microbiomics reminds us that insect biology is not just about the insect itself but also its invisible microbial partners.

Applications of Omics in entomology

1. Pest Management

Omics tools provide insights into resistance mechanisms, pest population genetics, and novel control targets. For example, transcriptomic markers can detect early signs of insecticide resistance, while metabolomic studies aid in pheromone-based integrated pest management (IPM).

2. Vector Biology and Disease Control

Genomic and transcriptomic data are being used to design genetically modified mosquitoes that are resistant to malaria parasites. Microbiome manipulation through Wolbachia is already being field-tested in dengue control programs.

3. Pollinator Conservation

Honeybee genomics and proteomics have revealed stress responses to pesticides, pathogens, and nutrition deficits. These findings inform sustainable agricultural practices that protect pollinators.

4. Biodiversity and Evolution

Comparative genomics across insect species sheds light on evolutionary adaptation, speciation, and biodiversity conservation. DNA barcoding, based on genomics, allows rapid insect identification for ecological studies.

5. Climate Change Studies

Transcriptomic and metabolomic analyses reveal how insects cope with heat stress, drought, or changing host plants, helping predict shifts in pest ranges under global warming.

Future prospects

The integration of multiple omics—so-called systems biology—is the future of entomology. By combining genomics, proteomics, metabolomics, and epigenomics, researchers can build holistic models of insect biology. Artificial intelligence and machine learning will further accelerate data analysis, turning omics into predictive tools.

However, challenges remain, including high costs, complex data interpretation, and ethical considerations in releasing genetically modified insects.

Conclusion

Omics has opened a new era in entomology, enabling scientists to move from descriptive studies to predictive and applied sciences. From decoding insect genomes to profiling their microbiomes, these approaches provide unprecedented insights into insect biology. The applications in pest management, pollinator protection, and vector control demonstrate how omics is not only advancing fundamental knowledge but also addressing global challenges in agriculture, health, and the environment.

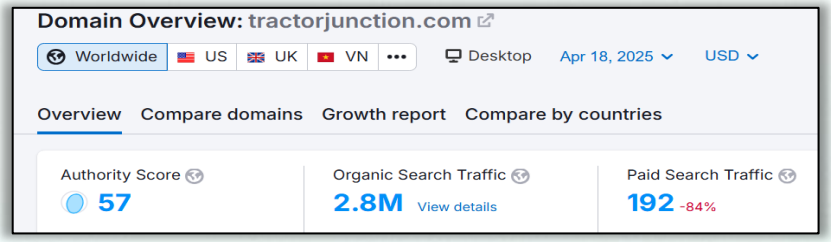
As omics technologies continue to evolve, the tiny world of insects will no longer remain hidden. Instead, it will be illuminated at molecular detail, offering innovative solutions for a sustainable future.

■■■

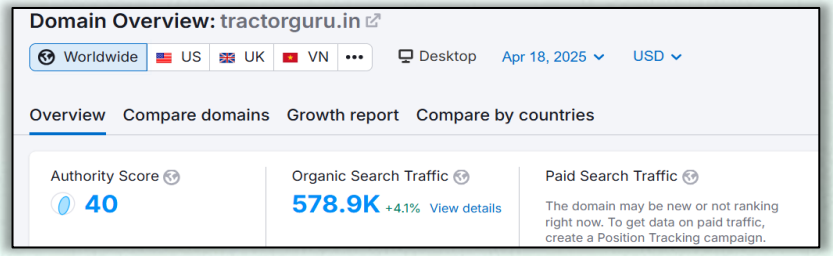
India’s Most Visited Agri-Websites

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

Tractor Junction



Tractor Guru



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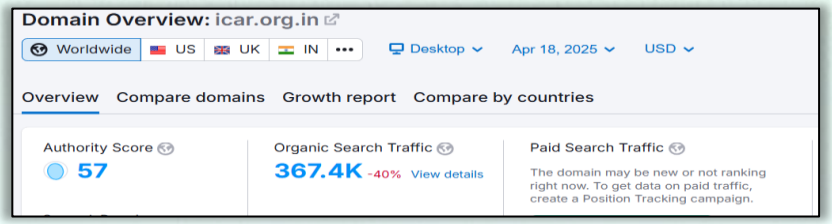

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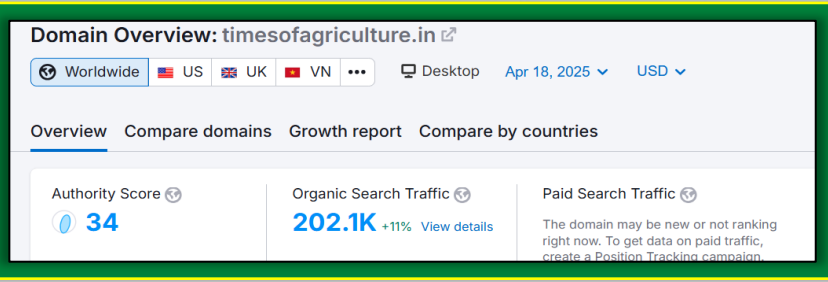

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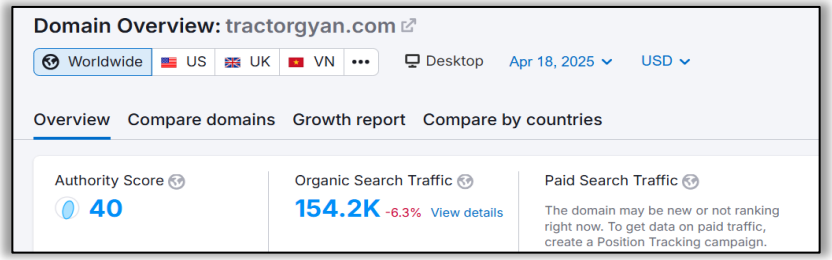

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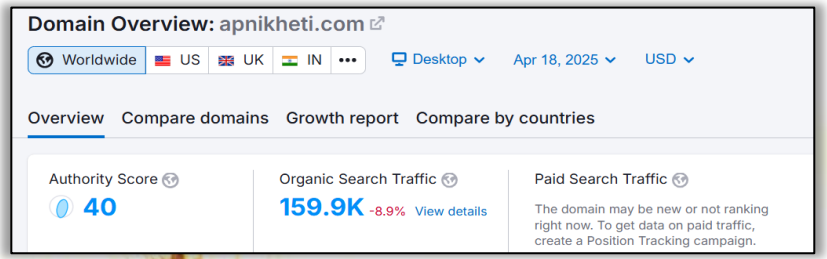
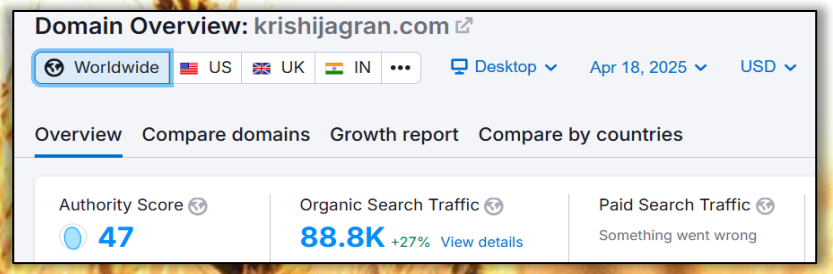


Krishi Jagran



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