ISSN : 2582-6344
Volume - 6, Issue -1

# Times of Agriculture

A Resonance in Agriculture

Monthly Agriculture E-Magazine

January-2026

## DRONES Are Democratizing Precision Farming in India

Timesofagriculture.in


**ISSN No.:** 2582-6344
**Frequency:** Monthly
**Month**: January
**Volume**- 6, **Issue**- 1
**Pages in Magazine**- 38



**Timesofagriculture.in**

Times of Agriculture
A Resonance in Agriculture

## From the Editor's Desk

**Dear Readers,**

We are pleased to present you January issue of **Times of Agriculture magazine**. In this January issue, we have included various important news related to the agriculture sector along with articles sent by many experts. In the cover story of this issue, we have given a special place to **Garuda Aerospace.**

Dear readers, as you know, drone technology in farming is rapidly emerging as a new and effective technology. In this era of precision farming, the use of drones is continuously increasing—whether it is pesticide spraying, land mapping, crop protection, or monitoring. Through drone technology, farmers are being provided every possible assistance, due to which time, resources, and cost—all three are being saved. Drones are not just a technology, but can be seen as a new revolution that has come into farming. Until now, we have mainly seen the use of drones in fields like electronics or surveys, but today their use in agriculture is increasing rapidly. In our country, many startups are actively working in the field of drone manufacturing and services.

Although it is not possible for every farmer to buy a drone, through Drone-as-a-Service this technology is now becoming easily available. Farmers can avail drone services for a limited time at affordable rates, where under the guidance of trained drone pilots and experts, pesticide and chemical spraying in fields, mapping, crop health checking, etc., are carried out. All these tasks are completed in a very short time, due to which farmers save both time and cost.

Dear readers, we hope that this January issue of **Times of Agriculture** will be liked by you. Please do send us your valuable suggestions through e-mail.

Heartfelt thanks for your support.

Thank you.

Enjoy Reading!

**Editor-In-Chief**


# CONTENT

Times of Agriculture
A Resonance in Agriculture

# AGRICULTURE UPDATES

# Milma and NDDB Launch Advanced Food-Testing Laboratory in Kochi to Boost Quality Assurance

Kerala Co-operative Milk Marketing Federation Limited, popularly known as Milma, has joined hands with the National Dairy Development Board (NDDB) to operationalise a modern food-testing laboratory in Kochi, strengthening food quality and safety systems in the region. The new facility, established under the NDDB CALF (Centre for Analysis and Learning in Livestock and Food) Limited, will be inaugurated by George Kurian, Union Minister of State for Fisheries, Animal Husbandry and Dairying. Functioning as a branch of NDDB CALF Limited, the laboratory will strictly follow the professional and quality standards adopted by NDDB laboratories elsewhere in the country. In its initial phase, the laboratory will focus on meeting the testing requirements of the dairy sector in Kerala and neighbouring states, with facilities already created for comprehensive quality and safety testing of milk and milk products.

According to C. N. Valsalan Pillai, Chairman of the Ernakulam Regional Co-operative Milk Producers' Union (ERCMPU), the laboratory is equipped with advanced infrastructure to support the growing needs of the dairy industry. The facility has received accreditation from the National Accreditation Board for Testing and Calibration Laboratories (NABL), New Delhi, which underscores its technical competence and reliability. In a phased manner, the scope of services will be widened to include testing of various food and agricultural commodities such as spices, fruits, vegetables, bakery products, ready-to-eat foods, fish, and allied products. This expansion is expected to benefit food producers, processors, exporters, and regulatory authorities by providing accurate and timely analytical services under one roof.

NDDB CALF Limited is a wholly owned subsidiary of the National Dairy Development Board, with its head office located in Anand, Gujarat. For more than 17 years, the organisation has been offering comprehensive analytical testing, research, and advisory services to the dairy, food, and agricultural sectors, as well as to regulatory bodies and allied industries. The establishment of the Kochi laboratory through the Milma–NDDB collaboration is seen as a significant step towards enhancing food safety standards in Kerala and the southern region. By improving access to high-quality testing facilities, the initiative is expected to strengthen consumer confidence, support compliance with regulatory norms, and promote sustainable growth across the dairy and food processing sectors.

# Ripple Foods Launches Organic Plant-Based Milk with Clean Ingredients and High Protein

Ripple Foods, a leading player in plant-based nutrition, has unveiled Ripple Organic Plant-Based Milk, a new organic, dairy-free beverage designed to meet the growing consumer demand for nutritious and clean-label alternatives to traditional milk. The new product range is available in Original and Vanilla flavours and delivers 5 grams of plant-based protein per serving, positioning it as a more protein-rich option compared to many existing non-dairy milks. Made using organic pea protein, Ripple Organic offers up to 2.5 times more protein than conventional almond milk while avoiding common allergens, making it suitable for a wide range of consumers, including families with dietary sensitivities.

As interest in organic and better-for-you food products continues to rise, Ripple Organic seeks to combine strong nutritional benefits with an enjoyable taste and texture. The company has focused on creating a smooth, creamy beverage that can be easily incorporated into everyday routines, whether poured over cereal, blended into smoothies, or consumed on its own. The milk is free from the top nine allergens and is vegan, nut-free, dairy-free, soy-free, lactose-free, and gluten-free. This broad allergen-friendly positioning enhances its appeal to consumers who are increasingly looking for inclusive food options that align with health, ethical, and lifestyle preferences.

One of the standout features of Ripple Organic Plant-Based Milk is its short and transparent ingredient list, which contains five ingredients or fewer. The formulation excludes gums, oils, and artificial additives, reflecting a growing consumer preference for simplicity and recognisable ingredients. By prioritising organic sourcing and minimal processing, Ripple Foods aims to address concerns around over-formulated plant-based products while maintaining taste and functionality. Ripple Organic is scheduled to roll out at major retail outlets beginning January 2026, with availability expanding across prominent grocery chains and additional retailers in the months that follow. The launch marks a strategic move for Ripple Foods as it strengthens its presence in the competitive plant-based milk segment, offering a product that balances nutrition, clean ingredients, and versatility in response to evolving consumer expectations.

# Microsoft Partners with Indian Startup Varaha to Scale Biochar-Based Carbon Removal

Microsoft is strengthening its global carbon removal strategy by turning to India's vast agricultural sector, signing a long-term agreement with climate-tech startup Varaha to purchase more than 100,000 tonnes of carbon dioxide removal (CDR) credits through 2029. The deal supports Microsoft's broader goal of becoming carbon negative, as emissions from its rapidly expanding cloud computing and artificial intelligence operations continue to rise. By investing in durable, nature-based removal solutions outside the United States, the technology giant is seeking scalable pathways that can deliver measurable and long-lasting climate impact while also generating local economic and environmental benefits.

At the heart of the partnership is the conversion of cotton crop residue into biochar, a stable, charcoal-like substance that locks carbon into soils for decades. In many parts of India, cotton stalks are routinely burned after harvest, contributing significantly to seasonal air pollution and greenhouse gas emissions. Varaha's approach diverts this agricultural waste into controlled biochar production, preventing open-field burning while enhancing soil fertility and moisture retention. The project will initially be implemented in Maharashtra and is expected to involve around 40,000 to 45,000 smallholder farmers, integrating carbon removal with improved farm resilience and sustainable agricultural practices.

Under the agreement, Varaha plans to deploy 18 industrial biochar reactors, each with an operating lifespan of approximately 15 years. Over the lifetime of the project, these facilities are projected to deliver more than 2 million tonnes of carbon removal. The first reactor will be installed adjacent to Varaha's 52-acre cotton research farm in Maharashtra, where farmers are already testing biochar application under real-world field conditions. The collaboration underscores India's growing importance as a hub for carbon removal projects, given its abundant agricultural residue and extensive farming base. It also reflects a broader shift among global corporations toward investing in carbon removal solutions that not only address climate goals but also tackle local challenges such as air pollution, soil degradation, and farmer livelihoods.

# India Eases Wheat Export Curbs with Limited Approval for Wheat-Based Products

India has approved the export of select wheat-based products, marking a cautious easing of restrictions that have been in place for more than three years. The move comes amid expectations of a strong domestic harvest, supported by favourable monsoon conditions, which is likely to improve overall wheat availability in the country. As part of the decision, the government has allowed the export of up to 500,000 tonnes of wheat flour and related products such as semolina. However, the approval is limited to a one-time quota, and the broader ban on the export of raw wheat grains continues to remain in force. India is the world's second-largest producer of wheat, and its export policies are closely watched by global markets.

The partial relaxation of export curbs coincides with India's ongoing trade discussions with the United States, where agriculture has emerged as a key area of negotiation. Washington has been urging New Delhi to provide greater market access to American agricultural products, while India has remained cautious in protecting domestic food security. Wheat exports were halted in May 2022 as India faced rising domestic prices and concerns over supply shortages following heatwaves and global disruptions. The current decision reflects a balancing act between safeguarding domestic needs and responding to improved production prospects, as well as demands from local processors seeking to tap into international markets.

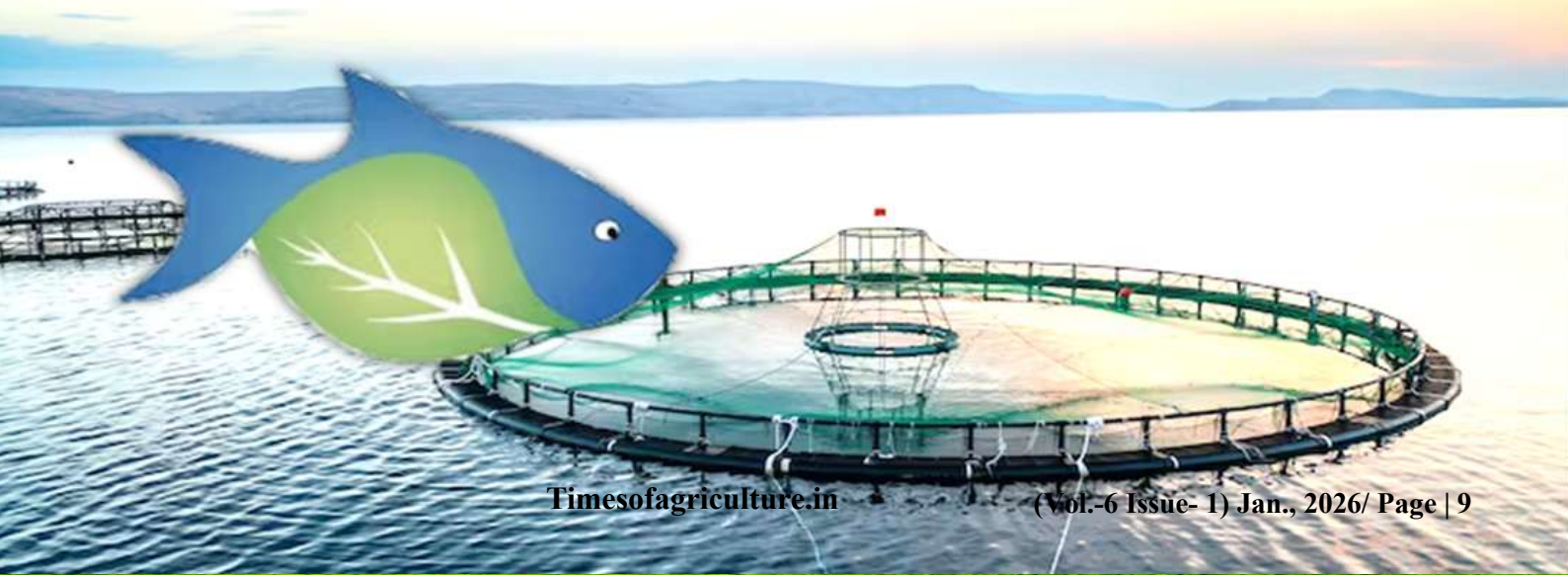
A strong monsoon, described as the best in five years, has played a significant role in creating conditions for easing the restrictions, even if only temporarily. Industry stakeholders have been calling on the government to allow exports of value-added wheat products, arguing that such shipments help stabilise farmer incomes without significantly impacting domestic food availability. India's limited return to the global wheat products market is expected to marginally improve international supply, offering some relief to import-dependent countries across Asia, Africa, and the Middle East. By allowing exports of processed wheat items rather than raw grain, India aims to support its domestic milling industry while maintaining control over food inflation. The move signals a more flexible approach to trade policy, linked closely to crop performance and domestic supply conditions, and leaves open the possibility of further relaxations if production and stock levels remain comfortable.

# India Launches Smart Green Aquaculture Facility to Transform High-Value Fish Farming

India has taken a significant step towards technology-driven aquaculture with the inauguration of a Smart Green Aquaculture Farm and Research Institute in Telangana, signalling a major shift in the country's approach to high-value fish cultivation. The state-of-the-art facility, featuring an advanced Recirculatory Aquaculture System (RAS), will be inaugurated on January 5, 2026, in Hyderabad by Union Minister for Fisheries, Animal Husbandry and Dairying, and Panchayati Raj, Rajiv Ranjan Singh. Established by Smart Green Aquaculture Limited at Kandukur Mandal in Ranga Reddy district, the project highlights how modern engineering and controlled production systems can overcome traditional climatic barriers in Indian aquaculture.

The facility is India's first commercial-scale tropical RAS-based Rainbow Trout Aquaculture Farm and Research Institute. Rainbow trout, a species traditionally associated with cold-water environments in Himalayan regions, has now been successfully cultivated year-round in a tropical climate. This breakthrough demonstrates the potential of precision engineering, advanced water recirculation, and tightly controlled biological systems to redefine aquaculture viability. By maintaining optimal water quality, temperature, and biosecurity conditions, the RAS technology enables efficient production with minimal water usage and reduced environmental impact. The achievement underscores a paradigm shift where technology, rather than geography or climate, becomes the primary determinant of aquaculture success in India.

Beyond commercial production, the Smart Green Aquaculture facility is envisioned as a live training and demonstration hub for the fisheries sector. It will provide hands-on exposure to youth and entrepreneurs in advanced aquaculture practices, including automation, biosecurity management, and sustainable production techniques. By building skilled human capital, the initiative aims to support long-term growth and innovation in fisheries and allied activities.



# India to Establish Centre of Excellence for Broccoli to Boost Horticulture and Nutrition

In a significant move to strengthen India's horticulture ecosystem and promote healthier dietary choices, the Government of India has announced plans to set up a Centre of Excellence (CoE) for broccoli. The initiative signals growing institutional support for the cultivation, value-chain development, and wider consumption of the nutrient-rich vegetable. The announcement was made by Dr. P. K. Singh, Agriculture Commissioner, Ministry of Agriculture and Farmers Welfare, at the Broccoli Consumption Conference India 2026 held in Mumbai. Organised by Sakata Seed India, the conference brought together key stakeholders from across the agricultural, nutrition, and retail sectors.

The proposed Centre of Excellence will focus on improving cultivation practices, strengthening post-harvest management, expanding cold storage facilities, and enabling processing and value addition. It will also provide technical training, advisory services, and market linkages for farmers to ensure better price realisation and reduced wastage. Highlighting broccoli's potential, Dr. Singh said the crop can play an important role in food security, public health, and farmer empowerment, especially through cluster-based development models and assured market access. He noted that this was the first time broccoli had been discussed at such scale within India's vegetable sector, reflecting its emerging importance.

Addressing gaps in the current value chain, Dr. Singh emphasised that while Indian farmers are capable of producing high-quality broccoli, infrastructure and market connectivity remain key challenges. He pointed out that existing potato cold storage infrastructure could be adapted for broccoli storage and confirmed government support for organic cultivation, cold chains, and processing facilities. The possibility of technical collaboration with Japan, including varietal development and best practices, is also being explored. Participants at the conference highlighted the need to integrate cultivation, processing, retail, and consumption into a single ecosystem to sustainably scale the crop.

COVER STORY

# DRONES
## Are Democratizing
## Precision Farming in India


About the Author

**Agnishwar Jayaprakash**

*Founder and Director*

**Garuda Aerospace**


Drones have expanded from large agribusinesses, rapidly democratizing precision farming in India by putting advanced crop intelligence and targeted interventions into the hands of small and marginal farmers. This paradigm shift completely restructures how Indian agriculture manages risk, resources, and productivity across highly fragmented and climate-stressed landscapes.

## The Unique Indian Benefit

Indian farms as a whole haven't really evolved from the times of traditional blanket spraying and guesswork-based decisions. Drones completely change this pattern by giving farmers a literal bird's-eye view of their fields, revealing subtle variations in crop health, soil moisture, and pest pressure that are impossible to see from the ground. Precision agriculture is a gamechanger, by acting only where intervention is needed instead of treating the entire field the same way. When a drone maps a field, it can highlight stressed patches, waterlogged areas, or nutrient-deficient zones, allowing the farmer to direct water, fertilizer, or pesticides only where necessary. Targeted approaches like these reduce wastage, cut costs, and help protect soil and water bodies from overuse of chemicals, which has been a growing concern in many intensive farming belts. This leads to not only economical but ecologically-sound approaches.

## Precision with Drones

Agricultural drones have at their benefit an arsenal of high-resolution cameras or multispectral sensors that scan crops from above and generate detailed imagery. These images can be used by softwares to produce vegetation indices that distinguish healthy plants from stressed ones, often before symptoms become visible to the naked eye. Subtle differences like the color of leaves, canopy density, or plant vigor become clear patterns on a digital map. Once a map like this exists, drones can also carry out precise spraying of fertilizers, pesticides, or micronutrients. Gone are the days of farmers walking through fields with sprayers in their knapsacks, guessing dosage and coverage, these drones now follow pre-programmed paths and maintain a consistent height and speed. This ensures even coverage, reduces human exposure to hazardous chemicals, and significantly lowers the risk of under- or over-application. Over time, this kind of precision supports better yields, healthier soils, and more predictable outcomes for farmers.

## DaaS as a Savior

DaaS (Drone-as-a-Service) platforms are revolutionary when it comes to democraticizing agriculture. Very few small farmers can afford to buy a drone outright, but they do not need to. Across India, drone service providers are emerging as the bridge between advanced technology and ground-level use. Farmers can simply book a drone service for tasks like mapping or spraying, much like hiring a tractor or harvester. These services are often charged at a per-acre or per-job rate, making costs predictable and far more affordable than full ownership. Groups of farmers in a village can pool demand so that a single drone operator can cover many neighbouring plots in one visit. This shared access converts what might otherwise be an elite technology into a common resource.

## New Opportunities Taking Flight

Drone startups in India play a crucial role in creating tailor-made technology for local agricultural realities. New design airframes and payload systems are now available specifically for crops like paddy, cotton, sugarcane, banana, or horticultural orchards, where canopy structure and spray requirements vary widely. Some focus on rugged designs that can operate in hot, dusty, or humid monsoon conditions typical of Indian fields. Beyond hardware, innovation is evident in user interfaces and workflows. Mobile apps in regional languages guide drone operators and even farmers themselves through flight planning, job booking, and basic interpretation of maps. Literacy gaps are bridged through voice prompts, simple icons, and low-text interfaces. Several companies offer integrated packages where the same team handles data capture, analysis, and advisory, so the farmer receives simple, actionable recommendations instead of raw technical outputs, democratizing precision agriculture further.

## How The Government Helps

The government has also rolled out policies that have accelerated the shift towards agri-drones. The simplification of rules, digital permission platforms, and targeted schemes have moved drones from fringe gadgets to mainstream agricultural modernization. With financial support or demonstrations, public programs encourage the use of agri-drones towards activities such as crop health assessment, fertilization, and pesticide application.

The incorporation of drone-based experiments in agronomy, pest management, and yield forecasting by government institutions that include agricultural and research bodies help establish the fact that drone-guided spraying reduces chemical use and improves yield stability, leading to public acceptance and awareness. In some regions, drones are being integrated into broader digital agriculture initiatives combining satellite data, weather services, and soil testing, showing their broad and varied uses.

## Improvements on Quality of Life

Drones have been known to affect labour patterns in multiple ways. They reduce the need for manual spraying in fields, which is often physically demanding and exposes workers to harmful chemicals. Manual spraying in fields is often physically demanding and exposes workers to harmful chemicals, which drones reduce the need for, leading to direct health and safety benefits, particularly in crops that require frequent pesticide applications. Simultaneously, new roles are erupting around drone piloting, maintenance, data analysis, and local entrepreneurship. Training programs that teach drone operation and basic agronomy create a pathway for tech-enabled rural employment. Women's self-help groups and women-led cooperatives are also beginning to explore drone service enterprises, like the NaMo Drone Didi initiative, causing women to have stronger agency in the fields.

## Environmentally Beneficial

Sustainable agriculture is supported by precision farming via drones by taking into account plant needs when aligning inputs. The application of fertilizer precisely reduces the risk of nutrient runoff into canals and groundwater. Precise spraying reduces overall chemical use, limits the environmental footprint of intensive agriculture and decreases the chance of pesticide residues in food chains. Water management is also improved by drone-based maps highlighting dry patches and over-irrigated zones, prompting farmers to adjust their schedules or invest in techniques like drip irrigation or alternate wetting and drying in paddy fields. The long-term view favours this, with a sharper analysis of water behaviour on individual plots helping communities design better micro-irrigation schemes, field bunding, and drainage improvements, especially in areas prone to both droughts and floods.

## Real Life Examples in India

Different parts of India illustrate different strengths of drone-based precision farming. In intensively farmed grain belts, drones help monitor uniformity of germination, nutrient management, and disease spread across large swathes of fields, which otherwise would take days to inspect on foot. In horticulture and plantation crops, drones can scan tall or dense canopies, such as coconut or banana, where ground-level visibility is limited. Rainfed and semi-arid regions benefit from early identification of moisture stress and patchy germination, giving farmers a chance to re-sow or adjust crop choices quickly. Flood-prone delta regions use drone imagery to understand how water has moved across fields after heavy rains, which parts are salvageable, and where drainage interventions are urgent.

## Gaining Trust and Changing Mindsets

When it comes to democratizing precision agriculture, mindsets are more of a challenge than machines. The caution that farmers practice against adopting flying robots and data-driven recommendations is understandable. However, trust is being built slowly but steadily through patient demonstration, peer learning, and visible results. Seeing healthier crops and input-savings on their peers' fields after drone-guided interventions causes farmers to get curious and that turns into them experimenting as well, and seeing sure results. Training programs focus not only on technical use but also on decision-making. Farmers learn how to interpret maps, recognize patterns of stress, and translate advisory into field practice.

## Partnership with Other Digital Tools

The true power of drone technology emerges when they are seen as just the first layer in a broader digital agriculture stack. When combined with soil testing reports, historical yield records, and hyper-local weather forecasts, drone imagery creates hyper-sophisticated recommendations on how to go about farming. Over time, models can learn how specific fields respond to particular interventions, closing the loop between observation, action, and outcome. Integration with simple mobile advisory platforms means that a farmer might receive a drone-generated alert about nitrogen stress, followed by a message from an agronomist or an app explaining how much and what type of fertilizer to apply, and when.

## Building a Resilient and Equal India

In the future, the trajectory of drone growth in Indian agriculture is going to involve more automation, much improved endurance and close integration with artificial intelligence. Making hardware more reliable and affordable makes the emphasis shift to analytics, advisory quality, and fair access. As the capabilities of drones grow, so will those it benefits. Ensuring that small and marginal farmers remain at the center of this transition will require thoughtful policy, inclusive business models, and continuous feedback from the ground. Indian agriculture, indeed agriculture in general has always been about reaction rather than action, reacting to events rather than anticipating them. With drones and AI, we will now have a system that can manage variability intelligently and use resources more wisely. This kind of precision, once confined to a few large farms worldwide, is now within reach of ordinary cultivators across Indian villages, truly democratizing agriculture.

**********

# ULTRA-PROCESSED FOODS:
## SILENT SABOTEURS OF INDIA'S TRADITIONAL DIETS

About Author

**Shalu Giri**
**Junior Project Fellow**

Food Technology & Processing Lab,
PSSCIVE, NCERT Bhopal

### Introduction

The regional food systems of India have been grounded on pulses, coarse grains, vegetables, spices, and fermented foods for several years. These ancient diets provided sufficient fibre and vegetarian protein, which assisted intestinal bacteria and maintained metabolism.

However, in recent years, this balance has been disturbed. India is rapidly transforming its diet, from home-cooked, plant-based food to ultra-processed foods (UPFs). UPFs consist of processed foods and additives, and virtually no whole foods.

The food environment in India has been transformed due to the economic liberalisation of the country and the high urbanization that has occurred in the past three decades. In cities and towns, home cooking declined as supermarkets, international fast-food outlets, and branded packaged snacks expanded. The kitchens utilizing fresh grains and local vegetables are currently inclining towards the instant mixes, ready-to-consume curries, and sugary beverages due to their ease.

This change has increased the divide between country and city dwellers. In small towns, people still consume coarse grains and seasonal produce, yet TV and mobile advertising are altering their desires, even in small towns. Reduced millet with increased refined wheat and rice indicates a


shift in diverse traditional foods towards low-nutrient, high-calorie foods.

## The Nutrition Transition and Consumption Patterns

India is an example of a global nutrition shift whereby traditional food is being substituted by industrially processed foods. This movement cuts across age and income distributions, yet regional differences persist. Delhi, Mumbai, and Bengaluru are urban centres where more packaged snacks and bakery products are consumed, whereas in the states of the south and northeast, more traditional elements of the diet are maintained, such as fermented rice-lentil foods and meals based on tubers. These regional disparities are, however, becoming smaller due to increasing disposable income and accessibility of food-delivery applications.

Statistics on household food expenditure indicate that in the past ten years the proportion of money spent on processed and convenience food has almost tripled compared to the proportion spent on fruits, vegetables, and pulses. This change has been expedited by marketing approaches aimed at the youth and working population- stressing the go energy, fast food, and modern lifestyle trends.

## The most important population trends are:

**Adolescents (10-19 years):** Consume more of their daily energy in ultra-processed foods, in particular sugary beverages, packaged foods, and bakery products, which is often due to the fact that they are readily available in school cafes or through advertisements on the Internet.

**Urban working adults (25-45 years):** Obtain much of their calories by means of instant meals, snack bars, and ready-to-eat food, which they take on their way to work or for a quick break at work.

**Rural and older populations:** Consume more ultra-processed foods due to the substantial sales of the companies selling them, small and cheap packs, and the increased popularity of online shopping.

This shift is motivated by many factors, including rapid urbanization, time scarcity, an increased number of households having two adults working, and reduced cooking in the home. A greater number of women are in the workforce, and the normalization of ultra-processed foods has been created by the aggressive food advertisements and the emergence of food-delivery applications.

These habits are further promoted by emotional eating, peer-influenced consumption patterns and social media influence. Packaged snacks and beverages are increasingly being considered by young consumers as a status symbol, which is associated with modernity and independence. Online advertise-ments and digital influencers, as well as gaming tie-ins, present UPFs as a normalized aspect of leisure and entertainment and undermine the perceived value of traditional foods cooked at home.

## Health Consequences during the life course

Ultra-processed diets are always linked with poor metabolic consequences. The UPFs usually contain a high amount of glycaemic load, sodium, and added sugars, but are low in dietary fibre, which promotes chronic inflammation and insulin resistance.

Massive amounts of literature indicate that with each increment in UPF energy consumption, there is an increase in the risks of becoming obese, developing type 2 diabetes, and dying of heart-related diseases.

The new literature on clinical research in India associates the increasing cases of non-alcoholic fatty liver disease (NAFLD) and early-onset metabolic syndrome in young adults with the consumption of ultra-processed foods. Cases of liver and kidney disorders related to obesity are being reported in hospitals in urban centres, even in their twenties and thirties. Simultaneously, there are trends of anxiety, fatigue, and cognitive impairment related to high-refined sugar and processed fat diets, noticed by mental health experts.

Diabetes and obesity in India have already reached epidemic levels. The vulnerability to UPF-rich foods is enhanced by the feature of the Asian phenotype, which is increased visceral fat with insulin resistance at low BMI.

## Health effects of age-specific include:

**Children (5 -14 years):** Insulin resistance, increased BMI, and dental caries are the consequences of early exposure.

**Adolescents (15-30 years):** Visceral adiposity and premature development of metabolic syndrome are enhanced by high consumption of soft drinks and fast foods.

**Adults (30-50 years):** UPF-induced snacking and inactive work are the factors leading to high blood pressure, fatty liver, and infertility caused by obesity.

**The elderly (60 and above years):** Too much sodium and preservatives worsen high blood pressure, stomach and intestinal problems, and deficiencies of micronutrients.

## Composition and Industry Strategies

Ultra-processed foods are processed in factories, and they typically contain a very small number of whole foods. These extend the shelf life of the food and make it taste good, but eliminate most of the natural nutrients.

Recent technology, such as vacuum sealing, freeze-drying, and improved packaging, enables companies to maintain the freshness of food and transport it over a longer distance. Due to this, it is easy to buy ultra-processed foods even in isolated locations, supplanting homemade snacks and fresh foods.

A lot of food additives are permitted by Indian regulations, including preservatives and artificial sweeteners. Studies have found that some of these additives may lead to metabolic or gut bacteria problems.

People become confused with marketing strategies. Such words as multigrain, baked or zero cholesterol provide an illusion of health. Small and large corporations are using online advertising, cartoon character advertising to children, and celebrities. A sizeable segment of the ultra-processed food market is comprised of biscuits only.

The advertisement of sweet biscuits and instant noodles among children is strongly promoted by cartoon characters, stars, and ads about school snacks. This builds loyalty early.


Firms also pressure in order to delay label and advertisement regulations, and, thus, false health claims remain on packages. Such practices conceal the distinction between actual healthy food and food prepared primarily to make a profit and taste.

## Public-health and policy responses

- India has also initiated many rules and programs.
- It is considering a front-of-pack label system.
- Eat Right India Initiative promotes good nutrition and hygiene.

Good rules alone are not enough, even with good rules. Nutritional surveillance of the packaged foods is only done in certain cities and not in smaller towns and rural areas. Consumers are unaware of how to read the nutrition labels. Most of them believe that the term high fibre or the term low fat is healthy, yet they do not bother with sugar or sodium. To assist, the local NGOs and community kitchens are also carrying out awareness programs and school nutrition clubs.

Programs in schools educating about nutrition, establishing healthier rules in the canteen, and engaging parents have reduced the intake of ultra-processed foods. India gets an idea from the fact that warning labels work well in other countries.

The results were good in Chile and Mexico, which mandated warning labels on the packages. The sale of sugary drinks in the UK was significantly due to the tax applied to them. India can emulate the same strategy by integrating taxes, media regulations, and school canteen regulations in the same plan. These efforts would be reinforced with a national consciousness campaign, which would link them to long-term health and professional benefits.

## Economic and Agricultural Effects

In 2030, it is projected that there will be a very high rate of diabetes cases in India, and families are increasing their expenditure on non-communicable diseases (NCDs). Over fifty percent of the disease problem in the country is already composed of NCDs.

Disease-causing diets harm not just humans but also. The Indian system of health is more expensive due to obesity, diabetes, and cardiac diseases, and employees are less productive. However, the traditional and minimally processed foods should be encouraged, which might help to generate new employment opportunities in the local food processing, delivery, and sustainable farming.

Increased demand for refined wheat, sugar, and palm oil encourages farmers to produce a single crop, which is detrimental to biodiversity. Contrarily, promotion of crops that are climate resistant, such as ragi, bajra, and jowar, would combine both nutrition and sustainability. There is introduction of old grains will reduce imports, maintain healthy soil, benefit farmers, and reduce the consumption of carbon.

## Cultural and Behavioural Dimensions

Not only is nutrition influenced by ultra-processed foods, but it also disrupts cultural identity. Balance and variety are found in Old Indian fare such as the fermented lentil and rice dishes of the south, the millet breads of Rajasthan, and the stews of lentils of the northeast. Substituting them with packaged foods is a threat to our cooking traditions and the health of the community.

The popular Indian cooks and nutritionists fear the loss of the comfort of traditional cooking. Meals, which were once cooked slowly, fermented, and eaten with family members, are being transformed into fast and one-person meals. Adolescents perceive homemade food as something inconvenient and believe that packaged food is something fashionable and modern. This change decreases the quality of diet and undermines family and community cooking practices that assisted us in eating conscientiously.

Studies indicate that children who are exposed to numerous ultra-processed food advertisements desire sweet and salty food more than nutritious food. They should be taught food knowledge in schools, the community, and online to transform their tastes.

Pride in old recipes begins to come back when community cooking classes, school gardens, and online stories start to take place. These programs transform the perception of what is good and desirable in the current Indian diet by integrating food lessons with school lessons and publishing local prepared dishes on social media.

## Conclusion

The food in India is taking a new turn. The ultra-processed foods are convenient to use, yet their consumption is harmful to health, biodiversity, and ancient wisdom. It has been proven that the consumption of these foods increases the chances of obesity, diabetes, heart disease, and premature death.

By substituting even, a portion of ultra-processed calories with foods that have fewer processed ingredients, we will be able to reduce premature mortality. It requires the assistance of numerous spheres to solve the issue, including improved labels on food, healthier food environments, encouragement of native crops, and nutrition education.

# CROP WASTE TO CONSUMER PRODUCT

## INDIA'S AGRICULTURAL CIRCULAR ECONOMY

About Author

**Mr. Mahadev Chikkanna**
**Founder and CEO of MYNUSCo**

Every harvest season, India's farmers face a familiar dilemma. After the grain is collected, vast quantities of stalks, husks, and leaves remain scattered across the fields. The simplest solution? Set it ablaze. Within hours, the problem disappears in smoke - along with enormous amounts of potential value and environmental health.

This scenario plays out across millions of hectares, transforming what could be a national asset into a pollution crisis. But a quiet revolution is underway, one that's reimagining these agricultural leftovers as the building blocks of tomorrow's consumer products.

### The Invisible Economy Hiding in Plain Sight

Walk through any Indian agricultural landscape and you'll see it everywhere: rice straw piled high, sugarcane bagasse mountains near processing mills, coconut husks discarded by the roadside. These aren't just agricultural byproducts - they represent a parallel economy that never came to be.

Consider the mathematics. The crops we celebrate constitute only a fraction of what actually grows in our fields. The remainder, often double or triple the harvested yield, simply gets left behind. When you factor in processing waste from timber mills and other industries, plus dry biomass accumulating in forests, you're looking at material flows that dwarf many of India's established industries. Yet this massive material stream largely vanishes from economic consideration.

### The Carbon Cycle's Hidden Potential

Converting crop residues into consumer products requires sophisticated material science, but the breakthroughs unlock

something more valuable than just material substitution: they extend the carbon cycle itself.

Here's the critical insight: when plants grow, they pull carbon dioxide from the atmosphere. That carbon gets stored in the plant structure. When residues burn or decompose quickly, carbon returns to the atmosphere within months. But when transformed into durable products - furniture, building materials, home décor - that carbon stays locked away for years or decades, as long as those products remain in use, get reused, or enter recycling systems.

The mathematics are compelling. Each kilogram of crop waste can lock away 1.5 to 1.8 kilograms of $CO_2$. Theoretically, India's billion tons of annual crop waste could sequester enough carbon to neutralize the country's entire 3 billion tons of annual emissions. While too ideal to achieve in practice - consumer products alone cannot absorb all available crop waste - it demonstrates the extraordinary scale of impact.

The carbon story gets even more interesting when comparing different pathways. Using crop waste for energy, converting it to biofuels or biogas - prevents roughly 300 grams of $CO_2$ emissions per kilogram when replacing coal. Valuable, certainly.

Now consider the same kilogram transformed into a consumer product that replaces plastic by 50%. The carbon accounting shifts dramatically: 1.5 kg of $CO_2$ locked in the crop waste material itself, plus another 1.5 kg prevented by not producing virgin plastic. That's approximately 3 kg of $CO_2$ reduction per kilogram - ten times more impact than energy recovery.

This doesn't mean energy applications are wrong - they're essential parts of a balanced bioeconomy. But it highlights that where we direct crop waste matters enormously. The highest-value applications keep carbon locked in circulation while simultaneously displacing carbon-intensive materials like plastics, steel, ceramics, and glass.

## From Waste to High-Performance Materials

Plant fibers from agricultural waste can now be processed into materials that rival traditional options in strength, durability, and versatility. These aren't niche products for eco-conscious consumers - they're engineered materials competing on technical merit in automotive manufacturing, furniture production, and construction applications.

The applications span surprising breadth. Packaging materials that are either recyclable and biodegradable. Interior panels for vehicles that reduce weight and improve fuel efficiency. Flooring systems that withstand heavy use while sequestering carbon for decades. Textiles woven from fibers that would otherwise burn in fields.

The rice straw cluttering Punjab fields can become wall panels in Bangalore apartments. Sugarcane bagasse piling up near Maharashtra mills can transform into tableware replacing plastic. Coffee husks discarded in Karnataka can become raw material for products used in home, kitchen and garden.

## The Infrastructure Gap

For all the technical progress, a critical gap remains: the systems connecting material sources to manufacturing facilities don't exist at necessary scale.

Imagine you're a manufacturer interested in using crop-based materials. Where do you source them? How do you ensure year-round supply when residues are seasonal? What quality standards apply when natural materials vary by region and weather? Who aggregates material from thousands of small farms into volumes that make industrial processing economical? Some pieces are emerging - aggregation centers, processing hubs, logistics networks, digital platforms. But these remain scattered experiments rather than systematic infrastructure.

The economic challenge is equally real. Agricultural residues compete with materials that benefit from a century of optimization and massive economies of scale. Yet focusing only on direct cost comparison misses the broader picture. When

you account for lifecycle impacts - carbon emissions, resource depletion, waste disposal - the economics look different.

## Redistributing Value

Perhaps the most interesting aspect of an agricultural circular economy is how it redistributes value. Currently, farmers receive payment for crops but nothing for residues. Flip this equation and farmers suddenly have two revenue streams. The waste burning that happens because it's free now has an opportunity cost.

This isn't just economics - it's rural development strategy. Agricultural residues represent distributed material wealth across rural India. Building industries around these materials means building processing facilities, jobs, and economic activity in agricultural regions. It's manufacturing that complements farming rather than competing with it.

The ripple effects extend further. Reducing open burning improves air quality. Using residues for biochar production enhances soil health and water retention. Creating local processing industries reduces rural-to-urban migration pressures. Developing expertise in bio-based materials positions India advantageously in global markets increasingly focused on sustainability.

## The Coordination Challenge

If the opportunity is so clear, why hasn't it happened already? The answer lies in coordination complexity. Farmers won't invest in residue collection without reliable buyers. Manufacturers won't commit without reliable supply. Investors won't fund infrastructure without proof of demand. It's a classic chicken-and-egg problem, multiplied across thousands of actors.

Breaking this deadlock requires simultaneous action on multiple fronts. Government procurement policies creating baseline demand. Research investment improving material performance and reducing processing costs. Financial mechanisms bridging the gap while industries scale. Standards and certifications giving buyers confidence. Industry partnerships sharing risk and infrastructure costs.

Some of this is beginning to happen. Ethanol blending mandates create demand for crop residues as biofuel feedstock. Biogas programs incentivize collection infrastructure. Green building certifications recognize bio-based materials. Extended producer responsibility regulations push manufacturers toward sustainable sourcing.

## A Balanced Portfolio for Maximum Impact

Success requires agricultural residues flowing to multiple applications, each optimized for maximum carbon and economic impact. Consumer products, industrial materials, and energy recovery all play complementary roles.

This balance is crucial. Consumer and industrial products alone cannot absorb all billion tons of crop waste India generates annually. The volumes, seasonal variations, and geographic

distribution require diverse applications. Energy recovery will always have an important role, particularly for residues unsuitable for material applications.

But strategic emphasis should align with impact potential. Priority goes to applications that extend carbon cycles longest - construction materials sequestering carbon for decades, durable goods seeing multiple use cycles, products designed for repair and eventual recycling. Energy recovery becomes the valuable outlet for what cannot flow into these higher-impact applications.

The choice between burning crop waste for quick energy versus transforming it into long-lived products represents more than technical preference - it's a choice about time horizons and impact multiplication. Every year crop waste converted to consumer products doesn't just replace virgin materials once; it keeps carbon sequestered while those products serve their function, get reused, repaired, and eventually recycled. The carbon cycle extends from months to years or decades, multiplying climate benefits with each year of circulation.

## The Path Forward

India's agricultural residues aren't a waste problem waiting for disposal solutions. They're a material asset waiting for strategic deployment across a portfolio of applications, each chosen for maximum carbon and economic value.

The potential to neutralize substantial portions of national emissions through intelligent material circulation isn't just theoretical - it's an engineering and coordination challenge waiting to be solved. That's the promise of India's agricultural circular economy - not just managing waste better, but fundamentally rethinking what waste means and how carbon cycles through our economic systems.

The billion tons of material currently exiting our economy each year could instead drive manufacturing growth, rural development, and climate action simultaneously. The question isn't whether we can build consumer products from crop waste - we already can. The question is whether we can build the systems, incentives, and partnerships that direct these materials toward their highest-impact uses at the scale the opportunity deserves.

■■■

# DIGITAL LITERACY IS THE NEW FERTILIZER

## HOW TECH IS BOOSTING PRODUCTIVITY AND CONFIDENCE IN RURAL INDIA

About Author

**Ms Nidhi Bhasin**

**CEO**
Digital Green India

Rural India sits at the centre of the country's economic engine. It accounts for nearly half of total employment and contributes about 16–18 percent of the Gross Value Added (GVA), according to the Ministry of Statistics and Programme Implementation. Agriculture remains the principal livelihood for most rural households, nearly 60 percent depend on it in some form. Any gains in agricultural productivity or stability, therefore, ripple through the economy, influencing incomes, consumption cycles, food security, and poverty reduction.

The shift underway is quiet but unmistakable. Over the past five years, the expansion of rural connectivity and affordable smartphones has turned mobile devices into real-time agronomic advisors. According to TRAI's 2025 telecom data, India's broadband subscriber base reached nearly 995.63 million, with rural broadband growth significantly outpacing urban rates. What was once a communication device evolved into a real-time agronomy assistant, a weather forecaster, a marketplace access point, and in many cases, a risk management tool.

As India builds one of the world's largest rural digital infrastructures, the question before policymakers and industry experts is no longer whether technology can support agriculture but whether rural digital literacy can turn this infrastructure into a long-term productive advantage. In an economy where climate shocks and market volatility have become the new normal, the ability of farmers to interpret

digital advisory, follow data-linked guidance, and respond to alerts is becoming as critical as access to irrigation or good-quality seeds.

## India's Smallholder Farmers Face an Intensifying Climate Stress

India has over 150 million smallholder farmers, and most are confronting climatic pressures that are eroding both productivity and predictability. Temperature increases are altering optimal sowing windows; erratic monsoons affect nearly 7.5 million hectares every year; and states are reporting more frequent freak incidents of unseasonal rain, heatwaves, and flooding. For marginal farmers operating with narrow buffers, a single season of disruption can push families into debt or distress migration.

As a result, the average temperatures in India have risen by around 0.7°C since 1901, and IMD projects further intensification. Erratic monsoons affect 7.5 million hectares of cropland annually and heatwaves have increased fivefold in the last fifty years, particularly across central and eastern India.

Traditional agricultural support systems are unable to keep pace with this volatility. Extension officers are overburdened, advisories often follow a one-to-many model, and the gap between a farmer's problem and the formal advisory's arrival can be long enough to make the advice obsolete. Information asymmetry is becoming one of the biggest drivers of farm-level risk.

For smallholders operating on thin margins, these shocks translate into reduced yield stability. A delayed monsoon can force re-sowing, an unexpected downpour can destroy maturing crops, and early heatwaves can alter flowering cycles. Even a 10–12 percent deviation in rainfall during key crop stages could well be the difference between a healthy crop yield or total wipeout.

Therefore, traditional agriculture support systems, while crucial, are not equipped to respond to this speed of change. Extension officers often remain overburdened, farmer meetings and training camps follow a fixed calendar, not the unpredictable rhythm of climate risks. By the time an advisory arrives, the window for preventive action may have already passed.

In this context, information asymmetry, more than any other factor, is quietly becoming the biggest determinant of agricultural vulnerability. A farmer who learns of a pest infestation one week earlier or receives a crop-stage-specific rainfall alert can avoid significant loss compared to someone who receives the same advice late. This is where digital literacy, not just connectivity, becomes the decisive factor.

## AI Models are Reconfiguring Farm Level Decision Making

However, in the last five to seven years we have seen the emergence of digital systems such as satellite data, AI Based mobile applications, remote sensing, and digital platforms entering Indian agriculture. These technologies are filling the gaps left by traditional extension services by offering guidance that is real-time, hyperlocal, and responsive to rapidly changing climatic conditions.

AI systems trained on millions of real farmer queries are now capable of diagnosing crop stress, nutrient deficiencies, and pest symptoms through simple mobile photographs, often taken on low-end smartphones. Furthermore, Remote sensing tools integrate IMD forecasts, vegetation indices, microclimate readings, and soil moisture data to generate short-term, hyperlocal advisories.

As a result, Research by global institutions such as the FAO-led Digital Agriculture Profiles project indicate use of AI-based advisories can improve smallholder productivity by 10–15 percent, reduce input costs by 8–10 percent and lower weather-related economic losses by close to 20 percent when real-time alerts are followed.

These findings are not academic predictions. Field studies in states like Maharashtra, Andhra Pradesh, Odisha, and Karnataka reveal that farmers

using AI-supported advisories often irrigate with greater precision, adjust fertiliser dosage based on soil-data interpretation, and take preventive pest management measures instead of curative ones.

As a result, accessibility has expanded dramatically. Digital platforms now function in low-bandwidth environments; voice-based advisory is available in over a dozen Indian languages; and multimodal formats such as text, image, short video that not only allows farmers to get better guidance but also ease of understanding. Women, who frequently face social constraints in attending training sessions, are increasingly using voice-enabled advisory tools.

The most critical shift is hyperlocalisation. Many digital advisory systems now deliver guidance not just at the block level but at the village level, and in some instances, at the plot level. Soil parameters, crop stage, weather predictions, input history, and pest risk models are tied into a personalized digital advisory loop. For farmers, this precision often means preventing crop stress rather than responding to it.

Technology's role becomes even more vital during extreme weather. IMD-linked advisory platforms issue hyperlocal alerts during heavy rainfall, heatwaves, or cyclonic activity. Farmers receive advisories on measures such as draining stagnant water, covering vulnerable seedlings, postponing input application, or activating irrigation schedules ahead of dry spells. States that used these systems during cyclones and unseasonal rains have reported significantly lower crop losses.

## Digital Tools Are Expanding Women's Role in Agriculture

Digital transformation in rural India is not an automatic process. It is shaped by two factors: access and ability. While access is expanding rapidly, ability and digital literacy require deliberate investment. For women farmers, digital literacy is emerging as one of the strongest equalizers.

With voice-first interfaces, vernacular content, and simplified navigation, women can access training modules, market prices, pest alerts, and scheme information without depending on intermediaries. Agricultural universities and development institutions have observed that households where women use digital advisory platforms report better crop management, stronger budgeting decisions, and quicker adoption of climate-resilient practices.

However, human networks remain essential enablers of this transition. Farmer Producer Organisations (FPOs), Self-Help Groups (SHGs), and village-level resources form the last-mile bridge that ensure digital tools are not just downloaded but used effectively. They help interpret advisories, troubleshoot technology issues, demonstrate on-ground techniques, and build trust.

According to research by the National Institute of Agricultural Extension Management (MANAGE) digital adoption rates increase significantly in villages where FPOs or trained community resource persons are involved. This hybrid model-technology linked with human facilitation- is one of the most reliable pathways for sustained digital adoption across India's diverse rural landscape.

At the same time, digital literacy plays another crucial role in enabling resilience during climate shocks. When farmers understand how to read a rainfall deviation alert or act upon a heatwave warning, the impact is immediate. Case studies from coastal districts show that timely digital alerts can reduce flood-related crop damage by up to 30 percent, as reported by state disaster management departments. In these moments, digital literacy has become a safety net that protects income and sustenance.

## Digital Literacy is the need of the hour

The Government of India is building a national-scale digital agriculture framework anchored by the Digital Agriculture Mission and the Unified Farmer Service Interface (UFSI). The Ministry of Agriculture's 2024–

25 Annual Report highlights progress in integrating soil-health records, crop advisory systems, subsidy databases, land-holding digitisation, market intelligence, and weather alerts into a unified architecture.

These platforms will support targeted policy design, improve transparency, and enhance service delivery for millions of farmers. They also align with India's ambition of Viksit Bharat 2047, where technology-enabled, climate-resilient agriculture is central to rural prosperity.

The FAO's Digital Agriculture report estimates that if digital tools achieve scale across the farm chain, they can raise national agricultural productivity by up to 15 percent by 2030 and expand market efficiency significantly. But the true multiplier effect will be unlocked only if farmers possess the digital literacy to use these tools meaningfully. With digital literacy, a farmer moves from guesswork to informed decision-making, from reactive responses to predictive planning, and from dependency on middlemen to greater market negotiation power.

Studies analysing 34 million farmer queries through AI-driven agricultural assistants show retrieval accuracy of over 97 percent and it is an indicator of when information is reliable and accessible, farmers develop trust and confidence in digital advisory systems. More than half of smallholder farmers adopt such tools once they understand clear economic benefits.

Thus, digital literacy becomes both an economic and psychological enabler. It expands access to structured markets, opens pathways to credit and insurance, and increases eligibility for government social security and scheme benefits that often remain unclaimed due to lack of information. It supports upward mobility for marginal farmers and offers a genuine transition from subsistence to enterprise.

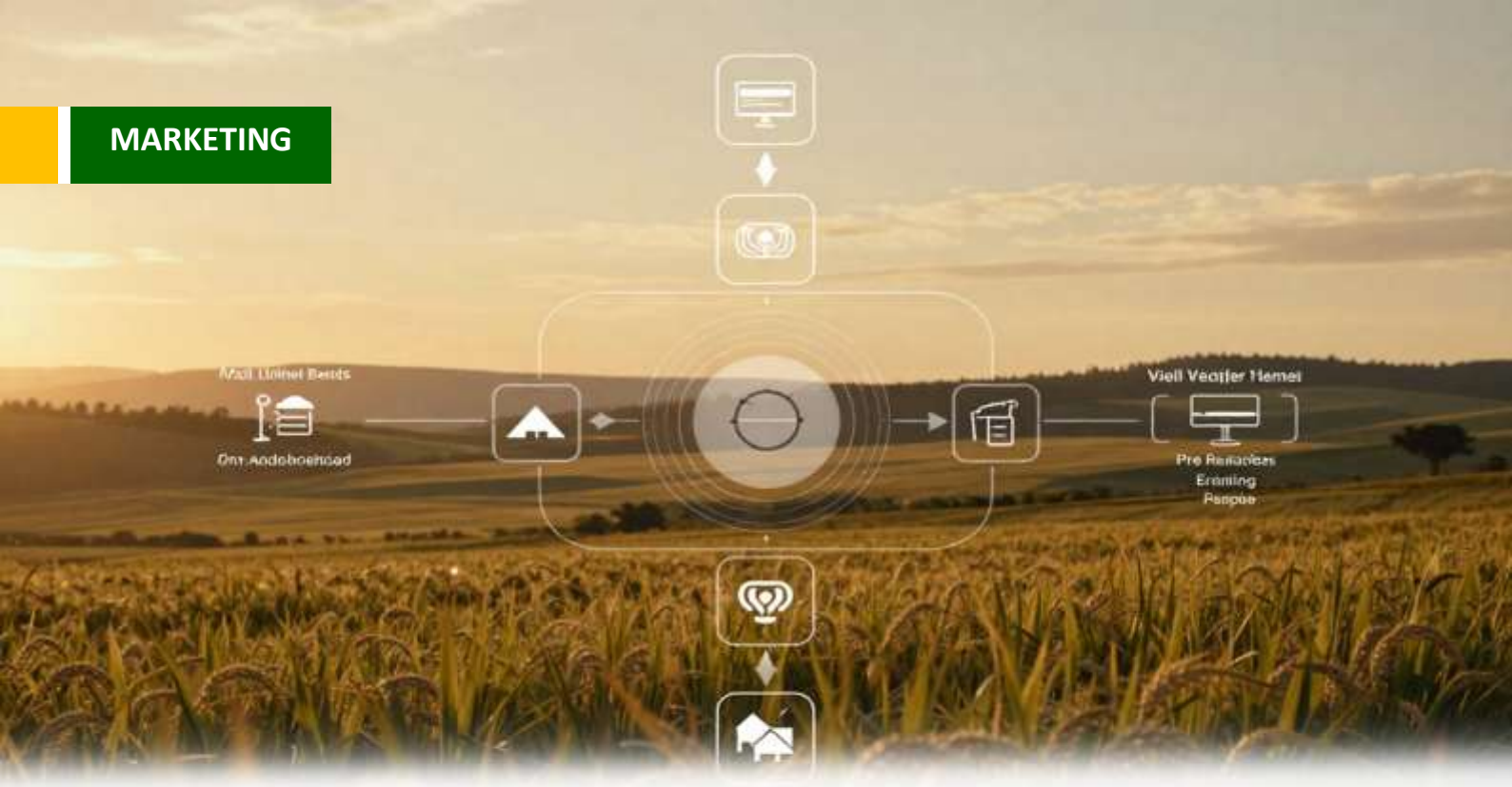
## Digital Literacy Strengthen Agriculture Ecosystem

India's agricultural future will be shaped heavily by the relationship between traditional wisdom and digital intelligence. Farmers will continue to rely on inherited knowledge, but their decisions will increasingly be validated by real-time data, predictive models, and AI-driven advisories. As rural India becomes more digitally connected, digital literacy emerges as the most powerful agricultural multiplier after water, seeds, and soil.

It strengthens resilience in the face of climate volatility, opens access to markets, reduces dependency on middlemen, empowers women, and expands opportunity for smallholders. In many ways, digital literacy is becoming the new fertilizer, quiet but transformative, enriching farmer capability, enhancing productivity, and enabling more confident, evidence-backed decision-making.

India's next agricultural growth story will be shaped not only by what grows in the soil, but by how farmers interact with their screens. The future of rural prosperity rests increasingly on the ability to equip farmers with the digital skills needed to thrive in a world where climate and markets shift at unprecedented speed.

■■■



# HARVESTING INSIGHTS

## HOW DATA AND AI ARE TRANSFORMING AGRIBUSINESS DECISION-MAKING

About Author

**Mandar Kulkarni**

**Vice President and General Manager-COE Findability Sciences**

Agribusiness has always been about making the best possible decisions under uncertainty: when to plant, what to grow, how much to invest, where to sell, and how to manage risk from weather, markets, and pests. For decades, these decisions relied heavily on experience, intuition, and relationships.

Today, that foundation is shifting. With the rise of digital technologies, sensors, satellites, and connected machinery, agribusinesses are awash with data. At the same time, advances in artificial intelligence (AI) and machine learning (ML) are turning that data into actionable insights. The result is a new operating model for agriculture, one where decisions are faster, sharper, and increasingly predictive rather than reactive.

### From gut feel to data-driven decisions

Most agribusiness leaders are not strangers to data. Yield maps, soil tests, procurement records, and market price feeds have been around for years. What's changed is:

- **Volume**: far more data from machines, sensors, and digital platforms
- **Variety:** structured data (transactions, inventories) plus unstructured data (images, text, weather grids)
- **Velocity**: information streaming in close to real time

AI thrives in this environment. Traditional analytics helps explain *what* happened. AI and ML help predict *what is likely to happen* and *what to do about it*.

Instead of looking in the rear-view mirror, agribusinesses can now:

- Anticipate demand and plan production accordingly.
- Predict yield and align supply contracts in advance.
- Detect early signs of disease or stress in crops.
- Optimize procurement, logistics, and inventory in near real time.

The shift is subtle but powerful: from opinion + experience to experience + evidence, where human expertise is augmented rather than replaced.

## The new data landscape in agribusiness

To understand how AI creates value, it helps to look at the underlying data sources that feed it. Across the value chain, some key categories stand out:

### 1. On-farm operational data

- Sensor readings (soil moisture, temperature, humidity).
- Weather and micro-climate information.
- Equipment telematics (tractor, harvester, irrigation system data).
- Crop health indices from drones and satellites (NDVI, canopy cover).

### 2. Production and input data

- Seed varieties, planting dates, and input application records
- Fertilizer, pesticide, and water usage
- Historical yield and quality data at field or even sub-field level

### 3. Market and commercial data

- Spot and futures prices.
- Demand signals from retailers, processors, and export markets.
- Promotions, sales patterns, and channel performance.

### 4. Supply chain and operations data

- Inventory levels, storage conditions, and spoilage.
- Transport routes, transit times, and logistics cost.
- Processing line performance and throughput.

### 5. Financial and risk data

- Cost structures, margins, and credit histories.
- Insurance claims and payouts.
- Historical weather extremes and climate risk indicators.

Individually, each data set is helpful. Combined and analyzed using AI, they become a rich fabric of insight for better decision-making at every level-from smallholder farm to global agribusiness conglomerates.

## Where AI is changing decisions in agribusiness

### 1. Precision agronomy: Doing the right thing, in the right place, at the right time

AI-powered agronomy tools are moving decisions away from field-level averages to sub-field precision:

- Variable-rate recommenddat-ions for seeds, fertilizer, and irrigation based on soil type, historical yield, and moisture patterns
- Disease and pest early-warning systems that analyze imagery and weather conditions to flag subtle stress signals before they're visible to the naked eye
- Dynamic irrigation scheduling that optimizes water usage while protecting yields.

For growers and input providers, this means higher productivity per hectare, more efficient use of inputs, and reduced environmental impact. Decisions that used to be made once per season can now be adjusted multiple times based on real-time insight.

### 2. Demand forecasting and production planning

For traders, processors, and food companies, one of the toughest questions has always been: How much will actually be produced, and when will it arrive? AI models can blend:

- Historical yield data.
- Current season weather patterns.
- Satellite-based crop monitoring.
- Market signals and policy news.

To generate more accurate yield and supply forecasts at regional or even field-level granularity. These forecasts feed into:

- Contracting and sourcing strategies.

- Capacity planning for processing plants.
- Inventory, storage, and distribution decisions.

The benefit is not only better efficiency but also reduced volatility and fewer last-minute surprises.

### 3. Smarter price, procurement, and sales decisions

AI can continuously analyse:

- Domestic and international price movements.
- Currency fluctuations.
- Logistics and freight costs.
- Consumption trends.

Using these signals, models can support:

- Optimal pricing strategies and quote recommendations.
- Procurement timing decisions (when to buy, in what quantity).
- Portfolio mix planning across regions, crops, and customer segments.

This is particularly important for agribusinesses that operate with thin margins and high exposure to commodity risk. Data-driven pricing doesn't eliminate risk, but it helps manage it more systematically.

### 4. Operational efficiency across the supply chain

In complex agribusiness supply chains, small inefficiencies multiply quickly. AI and advanced analytics help answer questions such as:

- How do we optimize transport routes to reduce cost and spoilage?
- Where are the bottlenecks in storage, grading, or processing?
- Which facilities or routes are most vulnerable to disruptions?

By analysing historical operations, sensor data, and external factors, AI can suggest:

- Route optimization and load consolidation opportunities.
- Ideal storage allocations based on quality and shelf life.
- Maintenance schedules for critical equipment (predictive maintenance).

Even modest percentage improvements in utilization and waste reduction can translate into significant financial gains.

### 5. Financial Services, Insurance, and Risk Management

Banks and insurers serving the agricultural sector are also embracing AI to:

- Assess credit risk based on farm performance, yield history, and payment behaviour.
- Design parametric insurance products triggered by measurable events (rainfall, temperature, drought indices).
- Detect fraud in claims using pattern recognition and anomaly detection.

By making risk assessment more granular and objective, AI can expand access to finance and insurance for farmers who were previously considered too risky or too opaque.

## What it takes to become an insight driven agribusiness ?

Adopting AI is not just a technology decision. It's an organizational journey that touches strategy, processes, people, and culture.

### 1. Get the data fundamentals right

AI is only as good as the data it learns from. Key steps include:

- **Data integration**: breaking silos between farm, operations, commercial, and finance systems
- **Data quality**: standardizing definitions, cleaning historical records, and validating sensor feeds
- **Data governance**: clear ownership, access policies, and compliance with regulations

Without this foundation, AI projects risk remaining pilots that never scale.

### 2. Start with clear business questions

The most successful initiatives don't begin with, "We need AI." They start with, "We need to improve X decision."

**Examples:**

- How can we reduce input costs per tonne by 5–10% without sacrificing yield?
- How do we cut post-harvest losses by 20% in the next two years?

- How can we increase forecast accuracy for crop Y by 15 percentage points?

Once the business question is clear, the right data, models, and tools tend to follow more naturally.

### 3. Blend domain expertise with data science

Agriculture is complex and local. Off-the-shelf models rarely work perfectly out of the box. The best results come when:

- Agronomists, operations managers, and traders co-design models with data scientists.
- Local knowledge is integrated into features, rules, and model validation.
- AI recommendations are treated as decision support, not black-box orders.

This collaboration ensures that insights are realistic, trusted, and used.

### 4. Focus on change management and adoption

A technically sound model that no one uses creates zero value.

To drive adoption:

- Design simple interfaces—dashboards, alerts, mobile apps—that answer specific questions for users in the field or the office.
- Invest in training and communication, explaining "how this helps you" rather than "how clever the model is".
- Start with pilots that deliver quick wins, then scale step by step.

Over time, as people see consistent value, data-driven decision-making becomes the new normal.

## Responsible and Inclusive Use of Data and AI in Agriculture

As agribusiness becomes more data-driven, it's essential to use AI responsibly:

- **Data privacy and security**: Protect sensitive farm, customer, and partner data.
- **Fair value sharing**: When farmer data powers insights, ensure they share in the benefits, whether through better pricing, advisory services, or reduced risk.
- **Bias and transparency**: Monitor models for unintended bias (for example, in credit scoring) and provide understandable explanations for key decisions.
- **Sustainability alignment**: Use AI to support more efficient water, fertilizer, and land use, and to monitor environmental impact.

Done well, AI can support not just profitability, but also resilience and sustainability across the agricultural ecosystem.

## Conclusion: Turning Data into a Competitive Advantage

Agribusiness is entering an insight-driven era. Data and AI are not just buzzwords; they are becoming central to how we answer the most fundamental questions in agriculture: what to grow, how to grow it, how to move it, and how to make it profitable and sustainable.

Companies that embrace this shift by investing in data foundations, focusing on real business problems, and blending human expertise with AI will be better positioned to handle volatility, serve their stakeholders, and unlock new value.

■■■

# UNDERUTILISED FRUITS OF UTTARAKHAND

## FROM FORESTS TO FUTURE

**About Author**

**Pragti Negi**
Deptt. of Vegetable Science,
College of Horticulture,
V.C.S.G. Uttarakhand
University of Horticulture and
Forestry, Bharsar, Uttarakhand

**Swagat Ranjan Behera**
Deptt. of Vegetable Science,
College of Agriculture,
GBPUAT, Pantnagar,
Uttarakhand

Uttarakhand- The Land of Gods, is an epitome of the rich biodiversity of flora and fauna that exists in the zone of the North-Western Himalayas. It is a home to numerous wild edible fruits, which are rich in medicinal and nutritive values and are utilised by native communities not only as a food supplement but also as a means of income generation. The list includes various names like Kilmora, Kafal, Hisalu, and Timla, etc. These fruits, along with fulfilling the requirements of minerals and vitamins, also help to maintain the diversity in the food system, ensuring the livelihoods of the hilly people across the state. Despite this, fewer efforts are made for their domestication, conservation and exploitation. Some potential underutilised fruits from Uttarakhand are described below:

### 1) Kafal- The wild jewel of Uttarakhand

Known as *Myrica esculenta* Hook., is a beloved seasonal wild berry with a balanced sweet and sour flavour. Kafal trees can be found at high altitudes with a range between 1,500-2,100 m above sea level, and are said to have medicinal properties in their bark. A mature Kafal (Bayberry) fruit has a reddish-purple colour with an ellipsoid shape. Ripe fruits possess acidity, while unripe ones taste sour. Moreover, the fruits are also well-known for

their anti-asthmatic properties. This seasonal delight is harvested in the months of April-June, indicating the change of season.

### 2) Hisalu– The golden himalayan raspberry

Locally known as Aiselu (Nepali), ashilo or aisaylo, Hisalu (*Rubus ellpticus*) is typically a small, yellow coloured fruit that grows on a thorny shrub. It found its presence in the Garhwal and Kumaon regions of Uttarakhand (between 700 and 2000 meters),

indicating a rich natural heritage. This fruit has two varieties, viz., black and yellow. The former one is quite rare, while the latter is predominantly found. The sweet and sour fruits contain ample antioxidants, act as an immunity booster, provide relief from throat pain and reduce the risk of kidney damage.

### 3) Ghingaru- The wild medicinal fruit

Scientifically known as *Pyracantha crenulata*, Ghingaru (Indian Hawthorn/Nepalese Firethorn) is another important medicinal shrub that reaches up to a height of 1.5 to 3 meters. The plant is compact and upright in its growth pattern, forming a thick cluster of branches with glossy foliage. It possesses high nutritional values, cardiotonic

properties, and antioxidant compounds (Quercetin) that help to improve digestive health. The leaves are rich in phenols, flavonoids, glycosides, resin, polyphenols, alkaloids and coumarins.

### 4) Kilmora/ Kingoda- A Himalayan treasure

*Berberis aristata*, a major shrub found in Uttarakhand, is used in Ayurveda as a remedy for several conditions. The shrub attains a height of 3-6 meters with toothed leaves, and produces yellow flowers with bright red berries. The decoction obtained from the root bark has found its significance in reducing the nephrotoxic effects. The stems are used to cure rheumatism. Kilmora is a rich source of proteins (6.02%), carbohydrates (32.91%), condensed tannins (7.93 mg/g extract) and ascorbic acid (31.96 mg/g extract). Moreover, numerous phytochemicals, such as berberine, Berbamine, and Palmatine, are also present in considerable amounts, exhibiting anti-inflammatory and antimicrobial properties.

### 5) Timla- The Himalayan Wild Fig

The Roxburgh fig tree (*Ficus auriculata*) is found primarily in the Himalayan region of India, more specifically in the state of Uttarakhand. This significant wild fruit is renowned for its medicinal properties, high nutritional values, and leaves. The tree produces large, edible, brown to purple-coloured figs that grow in clusters on the trunk and

branches. It is recognised for its anti-oxidant and anti-inflammatory properties, and to maintain blood pressure.

### 6) Bhamora- The Himalayan strawberry tree

*Cornus capitata*, commonly known as Himalayan dogwood, is an edible, nutrient-rich wild fruit found in the higher altitudes of the Himalayan region, typically between 1500-2400 m above mean sea level. This evergreen

tree goes upto a height of 12 meters and has a smooth, greyish bark. The fruits are pinkish-red, globe-shaped in appearance, and possess an appealing sweetness with a taste of an over-ripe banana. Local people of Uttarakhand make "Jam" from these fruits, thereby also providing opportunities for income generation.

### Present status and the associated challenges

Despite having so much potential, the current scenario of these underutilised fruits is not encouraging in the state. These crops are mainly cultivated and harvested in small quantities by the farmers with small landholdings, which leads to issues in transportation, storage and post-harvest management. Hence, despite possessing so much diversity with a climate-resilient nature, these wild fruits remain unexplored. (Example- Kilmora, found mainly in the hilly regions of Almora, Champawat, Lohaghat and Devidhura). Uttarakhand is well-known for its wild fruits due to its challenging geography and climatic conditions. These wild fruits are an excellent source of proteins, carbohydrates, fats, vitamins and minerals, providing native people a nutritionally rich diet, a potential against numerous diseases, and an income source for livelihood.

There is a substantial opportunity in the consumption and value addition of these fruits, as they require fewer inputs compared to conventional crops. They are also capable of fetching higher market prices in contrast to traditional ones, owing to their unique nutritional and health-promoting properties. Hence, more focused research, development initiatives, policy support and market integration should be done to boost the growth of these multifold fruit species.

# Previous Issues


## Website Statistics (Dec. 2025)

| 142K | 25K | 3.7M |
|---|---|---|
| Monthly Pageview | Monthly Visitor | Monthly Impression |

## Social Stats

| 6.5K | 6.1K | 10.0K | 1.7K | 2.1K |
|---|---|---|---|---|

# Times of Agriculture

## A Resonance in Agriculture

## Monthly Agriculture e-Magazine

ISSN No. : 2582-6344


SCAN ME

Timesofagriculture.in