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Building a Purpose Driven Nutrition Brand

BETTER

BETTER NUTRITION





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A Resonance in Agriculture

From the Editor's Desk

Dear Readers,

This edition of Times of Agriculture Magazine holds great significance for the general public, especially in developing countries where malnutrition remains a major concern. In this context, biofortification technology is emerging as a groundbreaking solution. Scientists from the fields of agriculture and food science are continuously working on this technique, developing it in various forms and dedicating it to the welfare of society.

Through advanced breeding methods, agricultural scientists are enriching commonly consumed food crops with essential nutrients. This process of fortification ensures that staple crops can help meet nutritional requirements more effectively. As a result, many fortified products are now entering the market and directly reaching consumers.

In today's world, fortified foods are proving to be a boon, making their way from urban areas to rural communities. In this special edition, we have also featured an authored article by the well-known brand 'Better Nutrition', which you might recognize from Shark Tank.

Thank you very much, and enjoy reading!

Editor-In-Chief







AGRICULTURE UPDATES

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AGRICULTURE



Agronomist Dr. Mangi Lal Jat Appointed as Director General of ICAR

Dr. Mangi Lal Jat has officially taken charge as the Secretary of the Department of Agricultural Research and Education (DARE) and Director General of the Indian Council of Agricultural Research (ICAR), with a tenure of three years. His appointment, approved by the Appointments Committee of the Cabinet, follows the departure of Himanshu Pathak, who joined ICRISAT as its director general. Since Pathak's departure, Union agriculture secretary Devesh Chaturvedi had been holding the additional charge of secretary, DARE. Jat's appointment underscores the government's focus on sustainable agricultural practices, which he has championed throughout his career.

A well-recognized systems agronomist with over 25 years of experience, Dr. Jat's research areas include conservation agriculture, regenerative agriculture, farming systems, precision farming, and climate-smart agriculture. His extensive career has seen him serve at leading global research organizations, including CGIAR, where he worked for 13 years, and the International Maize and Wheat Improvement Centre (CIMMYT) for 12 years. He also worked at the International Rice Research Institute (IRRI) and served at ICAR for over a decade, specializing in systems agronomy and research strategy.

Jat's appointment at ICAR highlights the growing emphasis on integrating sustainable farming practices into India's agricultural research and development efforts. His leadership is expected to drive forward ICAR's mission of enhancing food security, combating climate change, and promoting sustainable land and water management practices. With his deep expertise in addressing global agricultural challenges, Dr. Jat is poised to make a significant impact on India's agricultural landscape.





Warangal Chapata Chilli Gets the GI Tag

The Warangal Chapata chilli, popularly known as *Tomato chilli*, has earned the prestigious Geographical Indication (GI) tag from the Government of India's GI Registry on March 28. This bright red, round-shaped chilli resembles a tomato in appearance, hence its local name. With this recognition, it becomes the 18th product from Telangana to receive a GI tag, enhancing its identity and market potential across India and beyond.

Cultivated for over **100 years by farming families** in the region, the Warangal Chapata chilli is prized for its **mild spiciness** and **rich red hue**, which comes from its high **capsicum oleoresin content**. "Though it's not very hot, it adds vibrant colour and deep flavour to dishes," says **Rajkumar Reddy**, a seasoned farmer from Thimmampet village who has been growing the crop for 45 years.

Historically, this variety has been under cultivation in Nagaram village of Jammikunta mandal for over 80 years, and it is believed to have originated in Nadikuda village. From there, it spread to neighboring regions through informal seed sharing, especially among the Velama community.

The GI application (No. 984), filed in 2022, was spearheaded by Thimmampet Chilli Farmer Producer Company Limited, Janna Reddy Venkat Reddy Horticultural Research Station (Malyal, Mahabubabad), and Sri Konda Laxman Telangana Horticultural University, with the support of GI expert Subhajit Saha.

The Warangal Chapata chilli comes in **three distinct types**: *single patti*, *double patti*, and *odalu*. Following the GI recognition, farmers are hopeful of a **substantial price increase**—from the current ₹300 per kg to around ₹550—bringing new economic opportunities to chilli-growing communities in the region.



Cabinet Approves Revised National Program for Dairy Development (NPDD)

The Union Cabinet, chaired by Prime Minister Shri Narendra Modi, has approved the Revised National Program for Dairy Development (NPDD), a Central Sector Scheme aimed at enhancing the dairy sector's infrastructure and capabilities. With an additional allocation of $\gtrless1,000$ crore, the revised scheme now has a total budget of $\gtrless2,790$ crore for the 15th Finance Commission period (2021–22 to 2025–26). This strategic move focuses on modernizing milk procurement, processing, and quality control systems to ensure sustained productivity and growth in the dairy industry.

The revised NPDD seeks to boost the sector by building robust infrastructure for milk collection and processing, improving quality standards, and facilitating better market access for farmers. By promoting value addition and streamlining the supply chain, the scheme aims to ensure fair pricing for dairy producers and increase rural incomes. So far, the program has positively impacted over 18.74 lakh farmers and generated more than 30,000 direct and indirect jobs. It has also led to a substantial increase in milk procurement capacity—by over 100.95 lakh liters per day—through the installation of 5,123 bulk milk coolers and the strengthening of more than 51,777 village-level milk testing laboratories.

Further, the Revised NPDD emphasizes the adoption of advanced technologies such as Fourier Transform Infrared (FTIR) milk analyzers for improved quality testing and adulteration detection. A total of 169 laboratories have been upgraded with FTIR systems, and 232 dairy plants now have modern adulteration detection setups. Looking ahead, the program plans to establish 10,000 new Dairy Cooperative Societies, particularly in the North Eastern Region, and support the formation of two new Milk Producer Companies (MPCs). These efforts are projected to create an additional 3.2 lakh job opportunities, significantly benefiting women, who make up about 70% of the dairy workforce.

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CSIR-CMERI Showcases E-Tractor and E-Tiller in Ludhiana

The Council of Scientific & Industrial Research – Central Mechanical Engineering Research Institute (CSIR-CMERI), based in Durgapur, West Bengal, has introduced groundbreaking electric vehicle technology to agriculture with the launch of its e-tractor and e-tiller. This innovation aims to demonstrate the feasibility and efficiency of using electric vehicles (EVs) in agriculture. The category 1N (narrow) e-tractor, for instance, produces a torque of 2,200 nm, matching the output of its diesel equivalent. With 26 horsepower—more than the 20 horsepower offered by traditional diesel tractors—this e-tractor is powered by a 72 V, 200 AH battery that can endure over 3,000 charging cycles, making it a durable and cost-effective alternative.

Although the e-tractor's price is projected to be 20-25% higher than that of a diesel tractor, it becomes more economical over time. After five years, even accounting for a battery replacement costing around ₹2.5 lakh, the total cost of the electric tractor would match that of a diesel tractor. On a single charge, the e-tractor consumes 16 units of electricity, and it offers two charging modes: a fast-charging option that takes just two hours, and a standard mode that requires over four hours but helps prolong battery life. The emphasis on standard mode ensures the longevity of the battery, offering a balanced approach for farmers.

The CSIR PRIMA ET11 e-tractor, an improvement over its 2024 version, and the newly introduced e-tiller are designed with small and marginal farmers in mind. These vehicles are characterized by low vibration, easy maintenance, and women-friendly ergonomics. They also produce zero emissions, making them not only cost-effective but environmentally friendly as well. These innovations are poised to revolutionize traditional farming practices by integrating high-performance, eco-friendly electric vehicle technology into agriculture, offering both economic and environmental benefits.



Punjab Bans Sale of Hybrid Paddy Seeds

The Punjab government has recently **banned the sale of hybrid paddy seeds (non-Basmati varieties)** due to concerns over their high pricing and substandard milling output. These hybrid seeds, although widely cultivated and offered by companies such as Savannah, VNR, Corteva, and Bayer, have been found to result in **higher levels of broken rice** during the milling process. This makes them unsuitable as per the **Food Corporation of India's (FCI)** standards, which impacts the rice's overall quality and market value. Despite eight varieties being officially approved in Punjab, including Sava 127, Sava 134, Sava 7501, 27P22, and VNR 203, their acceptance has faced resistance from rice millers.

Many farmers in Punjab have supported these hybrid varieties because of their **early maturity, water-saving traits**, and **higher yield potential**. Farmers like Baldev Singh from Muktsar Sahib report **average yields of 35–36 quintals per acre**, earning up to $\gtrless13,000-\gtrless14,000$ more per acre compared to traditional varieties. Additionally, these hybrids produce **less stubble**, contributing to better environmental outcomes. Despite these benefits, the **lower Out Turn Ratio (OTR)** — ranging between 60% and 63% against the FCI's mandated 67% — has made them unpopular with millers who suffer financial losses due to the reduced milling recovery.

In the 2024–25 Kharif marketing season, millers across Punjab had refused to accept these hybrid varieties, leading to government intervention. This time, to prevent such a situation from recurring, the government has taken a proactive stance by **banning the sale of hybrid paddy seeds before the sowing season begins**. This decision aims to safeguard the interests of rice millers and ensure compliance with national quality standards, although it may challenge farmers relying on hybrids for better profits.

After the Success of Bharat Brand Fertilizer, Indian Govt to Introduce Bharat Beej Brand

The Ministry of Cooperation has established the Bhartiya Beej Sahkari Samiti Limited (BBSSL) under the Multi-State Cooperative Societies (MSCS) Act, 2002. The BBSSL is tasked with the production, procurement, and distribution of high-quality seeds under the single brand name 'Bharat Beej' through the cooperative network. This initiative aims to enhance crop yield by making quality seeds accessible to farmers. Currently, 19,674 cooperative societies are members of BBSSL, including 334 cooperatives from Jharkhand. The organization has also secured a seed license from the Government of Jharkhand, ensuring the efficient delivery of quality seeds, even in remote and rural areas of the state.

To further support farmers, the State Departments of Agriculture organize various programs such as training sessions, workshops, and demonstration schemes like Front-Line Demonstration (FLD) and Cluster Front-Line Demonstration (CFLD). These initiatives aim to increase farmers' awareness of using quality seeds. In addition to these efforts, BBSSL is focused on promoting the use of Bharat Beej-branded seeds, especially among small and marginal farmers, to ensure they benefit from improved seed quality and higher agricultural productivity.

The regulation of seed quality is governed by several legal frameworks, including the Seeds Act, 1966, the Seed Rules, 1968, and the Seeds (Control) Order, 1983, along with amendments. These legislations empower state governments to monitor seed quality and prevent the sale of sub-standard or spurious seeds. The Department of Agriculture & Farmer's Welfare, under the Ministry of Agriculture & Farmer's Welfare, allocates breeder seeds of various crops to state and private seed companies based on their annual breeder indents, facilitating the production of foundation and certified seeds for farmers' distribution.

IISR Develops Light-Coloured Turmeric-IISR Surya

The Indian Institute of Spices Research (IISR), Kozhikode, has introduced a new turmeric variety named **IISR Surya**, specially developed to meet the growing demands of the masala industry. This variety stands out due to its light-coloured rhizome, which is ideal for turmeric powder production, aligning with the preferences of modern spice processing industries. IISR Surya was developed after intensive research efforts and is expected to support the evolving needs of both domestic and export markets that previously relied on a limited number of local varieties.

IISR Surya not only addresses market shortages but also promises tangible benefits for turmeric farmers. It is a high-yielding variety that offers a 20% to 30% increase in yield compared to existing light-coloured types. The variety is capable of producing up to 41 tonnes per hectare, making it a highly productive option for cultivators. With a curcumin content of 2% to 3%, it maintains the standard quality expected from light-coloured turmeric while offering a pleasant aroma, adding to its appeal in spice formulations.

The variety was developed through clonal selection from accessions maintained in IISR's turmeric germplasm conservatory. It has been recommended for cultivation in Kerala, Telangana, Odisha, Jharkhand, and Arunachal Pradesh under the All India Coordinated Research Project on Spices. This strategic recommendation ensures its adoption in diverse agro-climatic zones, potentially leading to improved income for farmers and greater consistency in supply for spice industries.

ICAR-CTCRI Develops Orange-Fleshed Sweet Potato

The Orange-Fleshed Sweet Potato (SP-95/4), developed by the ICAR-Central Tuber Crops Research Institute (ICAR-CTCRI), is a nutritionally rich variety introduced to improve tribal food security in Kerala and other states. This pink-skinned, orangefleshed variety has passed final field trials in Odisha, West Bengal, Karnataka, and Kerala, showing great promise for wide-scale cultivation.

With 8 mg/100g of Beta-carotene, this sweet potato addresses Vitamin A deficiency, a chronic issue in many tribal communities. Its bright orange flesh and fusiform-shaped tubers weighing around 300 grams make it ideal not only for nutrition but also for processing industries.

The Attappady tribal region in Kerala recently witnessed a bumper yield, demonstrating the variety's potential. Its trial was conducted under a joint initiative of CTCRI's Rainbow Diet Programme and 'Punarjeevanam', a collaborative project between Kudumbashree and CTCRI.

"This is a highly promising variety," stated **S. Shanavas**, State Programme Officer (Farm Livelihoods). "The final trials were successful across **Purulia (West Bengal)**, **districts of Odisha, Belgaum (Karnataka), and Attappady (Kerala)**. The plan now is to expand cultivation to 100 acres in Attappady by the end of 2025."

This initiative reflects a significant step towards **nutritional self-sufficiency** and **sustainable livelihoods** for marginalized communities through scientific innovation and inter-institutional collaboration.



Building a Purpose Driven Nutrition Brand

About the Author

Mr. Prateek Rastogi Co-founder & CEO Better Nutrition

the world of 'n entrepreneurship, purpose is a word that gets thrown around a lot in spaces like health, food, and agriculture, it can't just be a marketing tagline. It must be the foundation. When you're dealing with something as important as what people put into their bodies, and as vital as how a nation nourishes its population, the intention behind your work has to be clear and deeply lived.

When we started our journey, we weren't chasing rapid scale or trying to "go viral." We were trying to understand a quiet but devastating public health issue hunger. It affects millions across India, especially children and women. These are people who may eat enough to fill their stomachs, but their diets lack essential nutrients like iron, zinc, or essential vitamins. The calories are there. The nourishment isn't. insight That one changed everything for us. We weren't just building products. We were building systems. And to fix what was broken, we knew we had to go back to the very beginning the soil.

The Nutrition Problem

India has long focused on food security in terms of calorie The sufficiency. public distribution system has done a commendable job of making sure people don't go hungry. But what's less visible and far more difficult to tackle is nutritional insecurity. As highlighted in the Economic Survey 2024-25, even though people consume staple foods like rice, wheat, and lentils daily, these often lack key nutrients. A meal might fill you up but still leave your body starved of what it truly needs.

Moreover, the problem is multidimensional. It's not just about access to nutrients it's also about awareness, affordability, and cultural acceptance. Many families are unaware of the longterm impact of micronutrient deficiencies. Others simply don't have access to diverse food groups. And even when better choices exist, they may not be palatable or familiar.

This is where the private sector, entrepreneurs, scientists, and communities need to come together. The government cannot bridge this gap alone. The scale of the challenge is too massive, and the nuances too many. The good news? The world is unjunking. Consumers today are no longer passive recipients of what's placed on retail shelves. They're curious. They ask questions. They want food that heals, not harms. They seek trust, not transactions.

This is the opportunity. Not just to create another line of supplements or superfoods, but to build a *purpose-driven brand* that reimagines how we think about food, how we grow it, and how we nourish our people.

Starting From the Ground

We realised early that solving the nutrition gap couldn't be achieved through pills, powders, or packaging alone. We had to start from the source - the crops, the seeds, the farmers, and the soil.

That's what led us to biofortification.

Defined by the World Health Organization, biofortification is the process of naturally increasing the nutrient density of crops through traditional breeding, improved agronomic practices, or biotech without modern sacrificing yield or taste. It's a deeply science-backed approach, but still underutilised in mainstream agriculture.

Why? Because it's not a quick win.

It takes time. Years, in fact. We invested more than five years in research, field trials, lab tests, and community partnerships. We worked directly with smallholder farmers to understand the constraints they face-irregular rainfall. lowresource inputs, and unpredictable markets. We didn't just want to build a high-tech product in isolation. We wanted to create something scientific but usable, scalable, and farmer-friendly.

Earlier this year, we filed a patent for an AI-modelled nutrient delivery system that uses beneficial microbes to improve the zinc, iron, and protein content in staple crops. At the same time, it restores soil health. It's our quiet revolution - one rooted in deeptech, but grown from lived realities.

Building Slow But Building Right

We live in a world that rewards speed. Funding cycles, media narratives, even consumer trends - everything points toward *faster*. But when you're working with food systems, and especially in public health, building trust takes time. We were often advised to "move fast," go heavy on marketing, or jump on trend cycles. But we knew our model needed time to mature. The reward? Strong consumer trust. Repeat usage. And more importantly, awareness - not just of our brand, but of the larger issue of nutrition equity in India.

In fact, this deliberate pace allowed us to focus on fundamentals - soil innovation, community farming models, traceability, and nutrient testing. What we've built may not go viral, but it's built to last.

And that's okay. Because some of the most transformational ideas didn't scale in five quarters. They scaled in five years. The work we're doing is laying the groundwork for a healthier India not just today, but for generations to come.

The Real Deeptech Challenge: Food, Not Just Software

There's a growing debate in India's startup space around whether we're building "deep enough"- especially in agriculture and nutrition. It's easy to build platforms. But building solutions that involve real- world constraints- weather patterns, soil types, biological variability is harder. Yet the impact, if done right, is generational.

Smallholder farmers don't need another flashy app. They need support systems that help them grow more nutritious crops, regenerate their land, and get better prices for what they produce. Consumers don't need more labels. They need food that quietly does what it promisesnourishment.

This is where we believe purpose-driven brands have a massive opportunity. To not just operate at the top of the pyramid but to redesign the whole pyramid itself.

A Purpose-Driven Brand for both: Rural & Urban!

India is not a monolith. Urban India, with its premium nutrition trends and wellness influencers, is one story. Rural India, where malnutrition still silently shapes childhoods, is another.

Purpose-driven brands must cater to both. Urban markets like Mumbai, Delhi, and Bengaluru are witnessing a spike in demand for functional foods, superfoods, and plant-based products. Consumers here are willing to pay more for cleanlabel, organic, or fortified food. This is where new-age brands can test innovation, drive early adoption, and build brand equity.

But the real impact lies in creating solutions that scale to Bharat. Fortified staples. Affordable nutrition-rich snacks. Micronutrient-dense crops that can enter mid-day meals and Anganwadi centres. It's possible to do both - premium positioning in urban markets and scalable models for public health programs.

The key is to bridge aspiration with access. And that requires thoughtful design, culturally sensitive communication, and long-term partnerships with public institutions.

Storytelling Builds Trust Not Just Sales

One of the most underestimated tools in building a purpose-driven brand is storytelling. Not advertising. Not marketing. *Storytelling*. When people know why a product exists, who it helps, and what problem it's solving, they care more. They trust more. They stay longer.

That's why transparency is non-negotiable. Every claim must be backed by evidence – whether it's nutrient content, sourcing origin, or impact on soil health. If your story is rooted in truth, it becomes your most powerful moat.

Engaging Stakeholders

In a truly purpose-driven business, your stakeholders are not just investors and consumers. They're your farmers, your field scientists, your lab technicians, your community partners.

Purpose is a team sport. And to make it work, everyone from your field officers to your R&D head - needs to buy into the "why." When they do, magic happens. Innovation becomes organic. Ownership becomes collective. Culture becomes your advantage.

What Matters, What do you stand for?

without Purpose accountability is just a wish. That's why it's crucial to define clear impact metrics - beyond revenue and margins. For us, it's the increase in nutrient density per 100g of food. It's the number transitioned of acres to biofortified crops. It's the count schoolchildren of accessing enriched meals through partner NGOs. It's farmer income uplift through better yields and traceability.

Track it. Improve it. Share it. The world doesn't just want to know what you sell - it wants to know what you stand for.

Why India Is Ready

India is at an inflection point. Lifestyle diseases are rising.

Preventive healthcare is gaining traction. Digital health platforms are pushing awareness. Millennials and Gen Z are more mindful of what they eat. Add to that a deepening gym culture, the rise of veganism, and increasing plant-based food adoption.

The nutraceutical market is booming. AI-led personalised nutrition is on the rise. Indigenous superfoods like millet, moringa, and amla are going global. It's the perfect storm for nutrition-first, mission-led brands to rise. And yet, amidst all this noise, the core remains the same - *purpose*. Not posturing.

A Closing Thought: The Bigger Picture of Nourishment

In the long run, food is more than fuel. It's a building block for a nation's productivity, health. and resilience. Poor nutrition is not just a health issue. It's an economic issue. It affects learning outcomes, workplace performance. and public healthcare wellcosts. A nourished population is a stronger population.

So when we think of building a nutrition brand, let's stop thinking of SKUs. Let's start thinking about systems. Let's ask: What if every crop could heal? What if every bite made someone's day better - not just taste-wise, but health-wise?

That's the future we believe in. And that's the brand we're trying to build.

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EDUCATION

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2021

Indian Agricultural Research Institute, New Delhi

DR. NUNAVATH ASHWINI A BRIGHT STAR OF INDIAN AGRICULTURE GONE TOO SOON



Banavath Rajesh B.Sc. (Hons) Agriculture College of Agriculture, Navsari Agricultural University, Waghai (Gujarat)

ndia's agricultural success depends not only on hardworking farmers but also on dedicated scientists who work behind the scenes to improve crop yields, fight diseases, and develop new varieties. One such brilliant young scientist was Dr. Nunavath Ashwini. She was a shining example of passion, commitment intelligence, and to agricultural research. Sadly, her promising life was cut short during the Telangana-AP floods in 2024. As a tribute to her work and dedication, the Indian Agricultural Research Institute (IARI) has named a high-yield chickpea variety after her - "Pusa Aswini." This article pays tribute to the life, education, achievements, and legacy of Dr.

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Ashwini - a true inspiration for the youth of India.

Early life and background

Dr. Ashwini was born in a small village called Gangaram Thanda, located in Karepally Mandal, Khammam district, in the state of Telangana. from a humble Coming tribal background, her journey from a village in Telangana to India's top agricultural research institutions shows her strong will and determination. She did her schooling in Karepally, her hometown area. Her early interest in science and agriculture began to grow during her school days, supported by her family and teachers. Her thirst for knowledge and hard work made her stand out among her peers.

Education From journey: Telangana to international institutions

After school, she moved to Vijayawada in Andhra Pradesh for her intermediate education. Her academic brilliance continued to shine, and she later joined Professor Jayashankar Telangana State Agricultural University (PJTSAU) at Aswaraopet for her Bachelor's degree (B.Sc) in Agriculture. She not only completed her graduation successfully but also secured a gold medal, proving herself as one of the best

students of the university. Later, she pursued M.Sc in Agriculture with a specialization in Genetics and Plant Breeding at the prestigious Indian Agricultural Research Institute (IARI) in New Delhi - one of the most respected agricultural institutions in India. There too, her brilliance earned her another gold medal, continuing her streak of excellence. Her passion for research pushed her to do a Ph.D. at ICRISAT (International Crops Research Institute for the Semi-Arid Tropics), which is located in Hyderabad, Telangana. This world-class institute works on improving crops that are important in dry regions. Her work during her Ph.D. focused mainly on chickpea, one of the major crops in India, especially for small and marginal farmers.

Top performer in Agriculture **Research Service (ARS)**

Dr. Ashwini stood first in the Agriculture Research Service (ARS) national-level examination, а competitive exam for selecting agricultural scientists. This achievement is a big milestone in any agricultural scientist's career and shows how talented and hardworking she was.

Her research work on chickpea

During her research at ICRISAT, Dr. Ashwini focused on chickpea - an



important pulse crop that helps improve soil fertility and provides protein to millions of Indians. She was involved in the development of a new high-yielding chickpea variety, which would be later released by IARI/ICAR. This chickpea variety, named Pusa 4037 (Aswini), has a potential yield of 36 quintals per hectare, which is considered very high. According to IARI Director Dr. Cherukumalli Srinivasa Rao, the variety will be officially recognized by the through government gazette а notification.

Her career at ICAR NIBSM

After completing her Ph.D., she joined the Indian Council for Agricultural Research (ICAR) - the most prestigious agricultural research body in



India. She was posted at the National Institute of Biotic Stress Management (NIBSM) in Raipur, Chhattisgarh, as a scientist. There, she continued her work in the same area - chickpea research and improvement. She was one of the youngest and most promising scientists in the field. Colleagues and professors saw a bright future ahead for her, and many believed she would become one of the top researchers in India.

A tragic loss in the Telangana floods

Unfortunately, on September 1, 2024, tragedy struck. While traveling with her father N. Motilal in a car to Hyderabad, they were caught in the devastating floods caused by overflowing Akeru Vaagu near Purushottamgudem in Mahabubabad district. Telangana. The car was washed away in the floodwaters, and both lost their lives. She was only 26 years old. Her untimely shocked death the entire agricultural community, from students to top scientists, and left a void that will be hard to fill.

Tributes from professors and scientists

Her guide and mentor, Bharadwaj, Dr. principal scientist in plant breeding at IARI, expressed deep sorrow and called naming the variety "Ashwini" a "smallest tribute" they could offer. He described her as "the most sincere, bubbly

and intelligent student" and said she was like his own child. Many in the scientific community believe that the chickpea variety named after her will inspire future generations of researchers. especially young women from tribal and rural areas, to dream big and contribute to the field of agriculture.

Legacy through "Pusa Aswini" chickpea variety

The release of the "Pusa Aswini" chickpea variety is not just a scientific achievement - it is also a symbol of dedication, sacrifice, and hope. This variety will help farmers across India improve productivity, income, and soil health. It is a practical and living legacy of Dr. Ashwini's work. For years to come, every time a farmer sows seeds of "Pusa Aswini" in their field, it will be a silent tribute to a young scientist who devoted her life to agriculture.

Why her story matters

Dr. Ashwini's story is not just about personal success - it is about breaking barriers:

- She came from a tribal background in a remote village.
- She studied in government schools and colleges, proving that talent can shine from anywhere.



Tailored for machine harv Average yield: 2673 kg/ha Potential yield: 3646 kg/ha

- A very high Protein line with 24.8 % Resistant to Fusarium will disease, moder Root Rot, Collar rot and Stant diseases rately resistant to Dry

loped By: ICAR-Indian Agricultural Research Institute, New Delhi

- She earned top ranks and gold medals in India's most respected agricultural institutions.
- She stood first in the national-level ARS exam, beating thousands of candidates.
- She worked at top research institutes like IARI, ICRISAT, and ICAR.
- She remained humble and passionate about helping farmers till the very end.

Her story shows how education, dedication, and the right opportunities can transform lives and how women from rural India can lead in scientific fields

Conclusion: A life that continues to inspire

Dr. Ashwini may have left this world too early, but her impact will live on - through her research, her achievements, and especially through the "Pusa Aswini" chickpea variety. Her journey from a small village to India's top research institutions is a story of courage, excellence, and hope. She continues to inspire thousands of students and young scientists across India to dream big and work hard. She reminds us that with determination and passion, even a girl from a remote thanda can change the face of Indian agriculture. Let us remember Dr. Ashwini not with sadness, but with pride - for she was truly a daughter of the soil and a star of Indian Agriculture.



Times of Aariculture A Resonance in Agriculture

LIVESTOCK

INNOVATING FOR INCLUSION FINTECH SOLUTIONS FOR WOMEN IN LIVESTOCK FARMING

About Author

Bharath M. Research Scholar ICAR- Indian Veterinary **Research Institute Pragati Shukla** Consultant National Institute of Agricultural Extension Management (MANAGE)

he livestock sector, as part of agriculture and allied activities, contributes approximately 5.5 percent of the total Gross Domestic Product (GDP) of India and provides livelihood support for poor. marginalized, and landless farmers who may rely entirely on animal husbandry. This sector, termed as the "sunrise sector", supports approximately 30 million people, particularly marginalized and vulnerable communities, which includes rural women. The roles of livestock products in meeting the

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nutritional needs of these people cannot be overlooked.

Introducing emerging technologies and innovations can give an extra push that may lead to increased production and farmer welfare, especially for women farmers. According to the International Livestock Research Institute (ILRI), 69 per cent of the workforce engaged in livestock farming in India is contributed by women who often take a disproportionate burden of labour despite facing the lack of resources. By providing credit through Fintech, the enterprises that use technology to improve and automate financial services can solve issues like unequal access to institutional credit. NBARD reports that less than 50% of farmers are availing institutional credit.

With the widespread availability of mobile phones, fintech can make inroads into the rural economy due to better connectivity and can improve financial inclusion. They can also help in the transition from financial inclusion to digital financial inclusion aligned with the goal of the Government of India. This can be possible because of the ability of fintech to provide tailored solutions. For example, fintech like Dvarata provides services like digital bovine loans and digital dairy loans to the dairy farmers including women.

Gender and innovative financial technologies worldwide

FAO supports farmers across all the agricultural subsectors with innovative technologies and practices for crop, fisheries, livestock, and forest management. These technologies can significantly reduce work burden and food loss while improving efficiency. They can be instrumental in various stages of food production, from land preparation and harvesting to processing of animal products and distribution, which requires a lot of investment.

Digital technologies, such as mobile applications, GPS. and blockchains, are increasingly being used to support and connect different nodes of food and agricultural chains. However, technologies, if they are not inclusive, may also exacerbate existing inequalities and lead to job loss, particularly for women. through automation and mechanization. This requires designing



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gender inclusive technology and social innovation that can meet the needs of the women livestock farmers.

International frameworks, including 2030 the Agenda for Sustainable Development and the Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW), recognized the potential of technologies to empower women economically. Despite this, rural women's adoption of technologies remains low due to inadequate design, safety concerns, and limited access to key services. One of the ways to empower women through technological innovations to provide financial inclusion to those women engaged in farming.

Interventions to promote financial inclusion

Pradhan Mantri Jan Dhan Yojana (PMJDY) has provided bank accounts to more than 50 crore people, in which 55.2% account holders are women who are mainly from rural areas, a great leap forward toward financial inclusion. The Indian government has been instrumental in advancing the fintech sector through initiatives like Digital India and the development of India Stack, a comprehensive digital infrastructure. The JAM trinity-Jan Dhan, Aadhaar, and mobile internet connectivity-has enabled individuals, particularly women and underserved businesses, to access financial services through smartphones. Furthermore, the introduction of the Unified Payments Interface (UPI) has transformed India's digital payment landscape by facilitating seamless transactions through the linking of bank accounts to mobile phone numbers. To provide more inclusivity, it is high time to provide digital financial inclusion enabled by Fintech to reach excluded segments. For example, though the Livestock insurance penetration is low, it can be expanded through fintech. A lot of focus is needed innovations like index-based on livestock insurance through parameters like temperature and humidity index that are necessary to adapt to climate change.

Conclusion

As Fintech Innovations go beyond the traditional area of banking, a lot of time can be saved for women engaged in livestock farming as the visits to bank consume the day of work as well as empower them financially.



Fintech can enhance user experiences, along with financial inclusion, by providing access to mobile phones for farmers. Empowering women in livestock through fintech innovations is crucial for gender-inclusive growth. While there are challenges that need to be addressed, the benefits of fintech innovations for women in livestock are numerous. By providing women with systems, digital payment mobile banking, digital platforms, and data analytics, fintech innovations can increase their income, enhance their decision-making capabilities, improve their livelihoods, and empower them in livestock farming.



Top 15 Most Profitable Farming in India



IWISTED TUBERS HOOGHLY'S FARMERS STRUGGLE TO SELL ODD-SHAPED POTATOES

About Author 🚇...🖉

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armers in Arambagh, Hooghly, West Bengal, are facing an unprecedented challenge. The potato crops, which have been cultivated across nearly 150 bighas of land, have taken on peculiar shapes, deterring buyers from purchasing them. The oddly formed potatoes resemble ginger or clay dolls, making them unappealing for sale in the market.

Farmers in distress

seasoned Α farmer from Malaypur, expressed his deep concern over the situation and said that he have been farming for 45 years, but he have never seen potatoes like these. His entire 12-bigha harvest consists of this strange variety, and no one wants to buy them. The financial toll is severe, as he estimates a loss of nearly ₹4,00,000, considering that it costs around ₹35,000 to cultivate potatoes on just one bigha of land. Typically, a farmer produces 45-50 quintals of potatoes per bigha, meaning those cultivating across 10 bighas would yield nearly 500 quintals. However, with

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no buyers willing to take these misshapen potatoes, the farmers are left in despair.

Health concerns add to the woes

The distress is not limited to financial loss. Even the farmers themselves are hesitant to consume these potatoes due to their unusual appearance. They are afraid to eat them because they don't know if it could be harmful to their health as they have never encountered anything like this before.

The source to the problem

Several affected farmers had purchased potato seeds from a local trader who claimed they were of the high-yield Jyoti variety sourced from Punjab. However, after witnessing the unusual harvest, farmers confronted the local trader, demanding compensation. In response, he stated that he had contacted the supplier and that company officials from Punjab would soon visit Hooghly.

Investigations underway

Authorities in Hooghly have identified nearly 100 bighas of affected land and are continuing their survey to assess the total impact. A senior agriculture department official clarified that, while the government was not responsible for the issue, they had urged the trader to negotiate compensation for the farmers. At the same time, the office of the Deputy Director of Agriculture has sent samples of the potatoes to the State Agicultural University, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal to determine the cause of the irregular shapes.

Governments address to the concern

Bengal's Agriculture Marketing Minister, Becharam Manna, admitted to having no prior knowledge of the crisis but assured that he would investigate the matter. Meanwhile, local sources report that nearly 180 farmers are affected, though the agriculture department has yet to determine the full scale of the issue and the government is considering procuring the potatoes and selling them to food processing agencies, provided there are no quality issues. Many companies produce potato dust and processed potato products, if the food value is intact, they can purchase these potatoes which would be highly relief to the farmers.

Conclusion

Beyond this specific issue, potato farmers in the region are already struggling due to low wholesale prices. At just ₹900 per quintal, the existing market conditions are unfavorable. For those with the misshapen variety, the situation is even more dire, as there are no buyers at all. This crisis highlights the vulnerabilities of small farmers, emphasizing the need for better regulatory oversight on seed quality and swift government intervention in times of distress.









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THE USE OF STINK BEANS IN NAGALAND A CULINARY AND CULTURAL PERSPECTIVE

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Agaland, a state in Northeast India, is known for its rich biodiversity, diverse tribal culture and unique culinary traditions. One such ingredient that holds a special place in Naga cuisine is the stink bean, scientifically known as *Parkia speciosa*. Also referred to as the bitter bean or twisted cluster bean locally known as Yongchak, this plant belongs to the Fabaceae family and is widely valued for its nutritional benefits and distinctive aroma. While the strong smell of the

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bean may deter some, it remains a cherished ingredient among the Naga people, who incorporate it into a variety of traditional dishes. This article explores the significance of stink beans in Nagaland's cuisine, their health benefits and their cultural relevance.

Botanical and nutritional profile

Stink beans are characterized by long, flat pods containing bright green seeds that resemble plump almonds. They have a strong aroma, often compared to shiitake mushrooms or natural gas, which becomes more pronounced when cooked or chewed. Despite their pungency, stink beans are highly nutritious, rich in proteins, carbohydrates, fiber, vitamins, and essential minerals. They also contain antioxidants and plant compounds that contribute to their medicinal properties, including anti-inflammatory and



Stink bean pods growing on the tree: Nature's pungent delicacy

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antimicrobial effects. The high content of sulfur-containing compounds is responsible for their distinct odor but also provides detoxifying benefits to the body.

Culinary use in Nagaland

In Nagaland, where indigenous food traditions emphasize fresh, organic and locally sourced ingredients, stink beans are a valued component of various dishes. They are often used in the following ways:

- 1. Fermented and smoked dishes: Stink beans are frequently combined with smoked meats, such as pork or beef, to enhance the umami flavors. The smoky aroma of the meat complements the strong scent of the beans, creating a unique and savory dish.
- 2. Curries and stews: The beans are commonly cooked with local



Fresh stink bean pods and seeds: A nutrient-rich ingredient with a distinct aroma





Spicy Stink Bean Curry with **Chili Powder and Dry Meat: A Traditional Naga Delight**

spices, bamboo shoots and dried fish to make hearty stews. The combination of tangy bamboo shoots and the distinct bitterness of stink beans results in a robust and flavorful meal.

- 3. Chutneys and Condiments: Stink beans are also ground into chutneys along with chili peppers, garlic and tomatoes. This spicy accompaniment is eaten with rice, adding depth and pungency to an everyday meal.
- Stir-Fries: A simple yet popular 4. preparation involves stir-frying stink beans with wild herbs, garlic and ginger. This quick dish retains the natural crunch and flavor of the beans while blending well with the aromatic herbs.
- 5. Pickles: Some communities in Nagaland preserve stink beans by pickling them with mustard oil, chilies and local spices. These pickles serve as a side dish that can be enjoyed year-round.

Cultural and traditional importance

For the Naga people, food is more than sustenance; it is an expression

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of identity and heritage. The use of stink beans reflects the deep-rooted culinary practices passed down through generations. Many Naga tribes believe that eating local and naturally grown foods contributes to overall well-being. Stink beans are often prepared during family gatherings, festivals and celebrations, signifying their integral role in community bonding.

Additionally, the consumption of traditional ingredients like stink beans aligns with the indigenous practice of sustainable foraging. The beans are typically harvested from wild trees in the forests, ensuring minimal environmental impact while preserving the region's biodiversity.

Medicinal and health benefits

Beyond their culinary appeal, stink beans are valued for their medicinal properties. Some of their health benefits include:

- **Detoxification:** The sulfur compounds present in stink beans help cleanse the kidneys and improve urinary health.
- Anti-diabetic properties: The beans contain natural compounds that help regulate blood sugar levels, making them beneficial for people with diabetes.
- **Digestive health:** The fiber content aids in digestion and promotes gut health, reducing issues like constipation and bloating.
- Anti-inflammatory effects: The antioxidants in stink beans contribute to reducing inflammation and oxidative stress in the body.
- Heart health: Regular consumption is linked to improved circulation and reduced risk of cardiovascular diseases.

Challenges and modern adaptations

Despite their benefits, stink beans face certain challenges in modern consumption. The strong odor can be off-putting to those unfamiliar with the ingredient, limiting its acceptance



Stink Bean Chutney (Left) and **Pickle (Right): Authentic Flavors** of Nagaland's Cuisine

outside of traditional communities. Additionally, as urbanization increases, there is a decline in foraging and traditional cooking practices, leading to a reduced reliance on indigenous ingredients like stink beans.

However, there is a growing interest in reviving and promoting local foods, with younger generations and culinary enthusiasts experimenting with innovative ways to incorporate stink beans into contemporary dishes. Some Naga chefs and food entrepreneurs are exploring fusion cuisines that blend traditional elements with modern cooking techniques, making these ingredients more accessible to a wider audience.

Conclusion

The stink bean, despite its pungent aroma, remains a cherished ingredient in Nagaland's culinary and cultural landscape. Its rich nutritional value, versatility in cooking, and deeprooted significance in traditional food practices make it an important part of the Naga diet. While modernization poses challenges to its widespread use, efforts to preserve indigenous food traditions continue to highlight the importance of stink beans. As interest in local and organic foods grows, stink beans may gain renewed recognition not just in Nagaland but beyond, as a unique and healthful ingredient worth embracing.





SOWING INNOVATION THE RISE OF AGRI-TECH STARTUPS IN INDIA

About Author

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n a country where nearly half of the workforce is engaged in agriculture, innovation in the farm sector is not just an opportunity-it is a necessity. Over the past decade, India has witnessed a quiet revolution in its agricultural landscape. No longer limited to ploughs and bullocks, today's farmers are tapping into mobile apps, artificial intelligence, drones, and blockchain technology. At the heart of this transformation are Agri-tech startups: young ventures with bold visions, aiming to solve age-old agricultural challenges with cutting-edge solutions.

Indian agriculture has long grappled with issues like fragmented

landholdings, low productivity, and poor market linkages. Traditional models often excluded small and marginal farmers from timely access to credit, weather forecasts, price information, and quality inputs. While government schemes have offered partial relief, a glaring gap persisted between policy intent and grassroots realities. This is where Agri-tech startups are stepping in—not to replace the existing system, but to reimagine and strengthen it with innovation, scalability, and efficiency.

The Agri-tech ecosystem: Growing fast and growing strong

India is now home to over 1,500 Agri-tech startups (NASSCOM 2019), making it one of the fastestgrowing Agri-tech markets globally. From pre-sowing to post-harvest and beyond, these startups are redefining every link in the agri-value chain by introducing efficiency, enhancing sustainability, and improving profitability for millions of farmers.

Pre-harvest and advisory: DeHaat offers a full-stack platform delivering inputs, personalized advisory, soil testing, credit access, and market linkage. It currently serves over 2 million farmers across 11 states through more than 11,000 centres and 500 FPOs. Similarly, *CropIn*'s AI-based platform, Cropin Cloud, helps digitize farms and improve traceability. It has impacted over 7 million farmers and 30 million acres of farmland.

- **On-field intelligence:** Fasal, founded in Bengaluru, deploys IoT sensors and AI to provide farmers real-time alerts on irrigation, pest control, and harvest timing in local languages, helping reduce costs and increase yield.
- Post-harvest & supply chain: Ninjacart, backed by Walmart and Flipkart, connects farmers directly with retailers, cutting out middlemen and reducing post-harvest losses. In the dairy sector, Stellapps uses sensor-based monitoring and blockchain to ensure milk quality and traceability.
- **Climate-smart** solutions: *Kheyti*'s 'Greenhouse-in-a-Box' shields crops from erratic weather while enhancing productivity affordably for smallholders.



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Figure 1. Agri-tech startup opportunities in Indian agriculture

These startups exemplify the transformative power of Agri-tech in tackling inefficiencies, reducing climate risks, and building a resilient agrieconomy.

Key Agri-tech opportunities driving indian agriculture

India's dynamic Agri-tech landscape is reshaping conventional farming through technology-enabled solutions. Key areas of opportunity include digital marketplaces, precision farming, financial inclusion through Agri-fintech, climate-resilient farming models, and real-time advisory services. These innovations are streamlining operations, minimizing post-harvest losses, and unlocking new avenues for farmer prosperity (Figure 1).

Challenges confronting agritech startups in India

Despite its momentum, India's Agri-tech sector faces several bottlenecks. A key issue is investor reluctance due to inherent sectoral risks and long gestation periods. Limited access to mainstream venture capital in rural areas worsens this funding gap.

Cultural resistance to tech adoption, coupled with unrealistic expectations, often leads to premature disengagement. Fragmented supply

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and poor pre-harvest chains data visibility limit scalability. Low rural connectivity and digital illiteracy further constrain adoption of advanced tools like AI and blockchain. Additionally, there's a shortage of experts who understand both agriculture and tech.

Other concerns include climate volatility, lagging policy implementation, monopolies by large agri-businesses, automation-linked job losses, and rising e-waste from outdated devices. These challenges underscore the need for an inclusive, innovative ecosystem that supports long-term Agritech sustainability.

A promising road ahead

With India aiming to double farmers' income and build a climateresilient agricultural sector, Agri-tech startups are emerging as key drivers of this transformation. Technologies like drone-based surveillance, precision farming, blockchain enabled traceability, and satellite-driven crop insurance are no longer futuristic concepts, they are actively being deployed across India.

This progress is powered by strong policy support and rising private investment. Initiatives like Startup India, Agri Infra Fund, and the Digital Agriculture Mission provide critical

funding and regulatory incentives. Institutions like NABARD and SFAC are promoting agri-entrepreneurship through grants and soft loans. Meanwhile, private investment continues to flow over \$1.4 billion was raised by Indian Agri-tech startups between 2020 and 2023, affirming faith in the sector's scalability and impact.

The next wave of innovation lies in AI-driven predictive analytics, farmer-first mobile platforms, and deeptech solutions tailored for smallholders. Government initiatives like the Open Network for Digital Commerce (ONDC) are also expected to unlock new ecommerce opportunities for farmers.

In this evolving ecosystem, Agri-tech startups are not just solving problems, they are reimagining Indian agriculture. By blending age-old wisdom with frontier technologies, these ventures are creating inclusive opportunities, attracting youth back to the land, and crafting a future where farming is not just viable, but vibrant. The seeds of innovation they are planting today may well spark the next agricultural renaissance.



EARLY DETECTION AND DIAGNOSIS OF PLANT DISEASES USING ARTIFICIAL INTELLIGENCE (AI)

D..... **About Author**

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he early detection and diagnosis of plant diseases play a pivotal role in agriculture, ensuring the protection of crop health, the enhancement of yields, and the minimization of pesticide use. The disease undiagnosed plant spread rapidly, causing severe yield losses and reducing both the quality and quantity of agricultural products. Moreover, expert manual inspection is a major component of traditional plant disease detection techniques, which is labour-intensive

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and error-prone, particularly in largescale farm sectors.

Recent advancements in machine learning (ML) and artificial intelligence (AI) have revolutionized the field of plant pathology. A new era of digital plant pathology has begun with the convergence of big data, advanced imaging technologies, potent and computing power. This era offers more accessible, accurate, and quick methods of identifying and treating plant diseases. This shift has marked the beginning of a new era in smart farming and precision agriculture, driven by AI and ML methodologies offering groundbreaking solutions to longstanding challenges.

Artificial (AI) intelligence technologies offer numerous benefits over conventional approaches in the management of plant diseases. Image recognition technologies can accurately diagnose diseases from plant photos, giving farmers real-time feedback. To enable prompt interventions, predictive analytics can predict disease outbreaks by analysing environmental data. By combining AI with mobile devices, farmers can now diagnose plant diseases in real time, further democratizing access to sophisticated diagnostic tools. Smallholder farmers can now access advanced diagnostics thanks to mobile applications with AI capabilities that can analyze crop photos and provide immediate diagnostic feedback. AIpowered precision agriculture methods minimize environmental hazards and use fewer chemical inputs by optimizing farming practices according to sitespecific conditions.

The adoption of AI and ML in plant disease identification offers great promise in this era of environmental sustainability and global food security issues. In addition to lowering the need for chemical pesticides, it promises to increase crop output and promote the prudent use of our agricultural resources. To shed light on the potential of AI and ML as game-changing instruments in the ongoing fight against plant diseases, the research presented here aims to address these important agricultural issues. In addition to discussing the challenges and opportunities that lie ahead, we will go the technological further into advancements that support this contemporary era of digital plant pathology, making sure that this area keeps developing and maturing in support of global food security.



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Applications of AI in plant disease diagnosis

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Image recognition and machine learning:

AI-driven technologies can precisely detect disease symptoms in images of plants. Convolutional neural networks, or CNNs, are especially good at differentiating between healthy and diseased plants. To identify particular disease signs, these algorithms can be trained on big datasets of labelled photos. In India, researchers at the Indian Council of Agricultural Research (ICAR) have successfully utilized CNNs to diagnose diseases in wheat crops, achieving impressive accuracy rates.

Predictive analytics

Predictive analytics utilises AI models to anticipate disease outbreaks through the analysis of diverse data sources, such as environmental data, weather patterns, and historical disease incidence.

Mobile diagnostics

Farmers can detect plant diseases in real time using smartphone applications equipped with AI technology. These applications allow smallholder farmers to utilise advanced diagnostics through image recognition, providing immediate feedback on plant health. The Plantix app, widely used in India, provides farmers with real-time disease diagnosis and management guidance.

Precision agriculture

Artificial intelligence and agricultural precision technology collaborate to assess crop health. AI analytics, in conjunction with drones and satellite imagery, can identify regions of disease and facilitate targeted interventions. The Indian Agricultural Research Institute (IARI) has played a pivotal role in the implementation of these technologies aimed at enhancing crop protection and yield.

Automated disease detection systems

These systems employ artificial intelligence and machine learning to

continuously monitor crops for indications of disease and to observe them in real time. These systems are applicable in fields, orchards, and greenhouses for the early identification of diseases, facilitating timely and precise treatments.

Example

AI-powered disease detection systems are indeed revolutionizing tea plantations in Assam. By integrating AI algorithms with IoT sensors, researchers have enabled the early detection of fungal infections and other diseases in tea plants. This strategic methodology has greatly improved disease management practices, mitigating crop losses and bolstering the overall vitality of tea plantations.

AI systems can analyze images of tea leaves to identify diseases even before visible symptoms appear. Additionally, drones equipped with AI technology are being used for the precision spraying of fertilizers and pesticides, ensuring targeted treatment without affecting surrounding plants. These advancements not only boost productivity but also promote sustainable farming practices by minimizing chemical usage.

Benefits

The application of AI and ML to plant disease detection could greatly lower crop losses, boost yields, and reduce the need for pesticides, all of which would be advantageous to farmers and the environment. It contributes to the maintenance of global food security as well.

- **1. Early detection:** AI algorithms can identify diseases in plants at an early stage, even before visible symptoms appear, enabling timely intervention and preventing the spread of diseases.
- **2. Precision agriculture:** By targeting specific areas affected by disease, AI helps in the precision spraying of pesticides or fertilizers, reducing the use of chemicals and promoting sustainable farming practices.

- **3. Reduced crop losses:** With early detection and precise interventions, farmers can minimize crop losses caused by diseases, ensuring better yields and economic stability.
- **4. Cost-effectiveness:** AI systems reduce the labour and costs associated with the manual monitoring of crops, making disease management more efficient and less resource-intensive.
- **5. Data-driven insights:** AI collects and analyses vast amounts of data about soil health, weather patterns, and plant conditions, helping farmers make informed decisions about their crops.
- **6. Scalability:** AI solutions can be implemented across large-scale farms and plantations, making them especially useful for high-yield crops like tea, rice, and wheat.
- **7. Environmental benefits:** By reducing excessive use of agrochemicals and focusing on targeted treatments, AI contributes to a healthier environment and biodiversity.

Conclusion

AI has the potential to revolutionise plant disease diagnostics and offer precise, practical, and scalable solutions to some of the most challenging issues confronting agriculture. Artificial intelligence has the potential to enhance crop yield, ensure food security, and promote sustainable farming practices by enabling the early identification and targeted management of plant diseases. But in order to realise its full potential, it is essential to overcome the challenges and ethical quandaries surrounding the use of AI. Empowering farmers to effectively leverage AI, fostering collaboration, and ensuring equitable access to this technology are vital as it progresses. Agriculture has the potential to pave the way for a more resilient, productive, and sustainable future through the implementation of AI-driven solutions.



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TECHNOLOGY

EXPLORING THE FRONTIERS OF AGRICULTURE THE PROMISE OF SPACE BREEDING

About Author

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pace breeding, the practice of growing plants in space environments, represents a bold frontier in agricultural science. As humanity ventures beyond Earth's atmosphere and seeks to establish longterm habitation on other planets or in space habitats, understanding how to grow food in these environments becomes crucial. Space breeding offers unique opportunities to study how plants adapt and evolve in microgravity and other space conditions, with potential implications for both space exploration and agriculture on Earth.

Understanding space breeding

In space, plants experience microgravity, altered light cycles, increased radiation exposure, and other environmental stresses not encountered on Earth. Space breeding involves studying how plants respond to these conditions and breeding new varieties that are better adapted to space environments. Researchers use specialized equipment, such as growth chambers aboard spacecraft or space stations, to conduct experiments on plant growth and development in space.

Historical perspective

The concept of space breeding has its roots in the early days of space exploration. In 1982, the first space shuttle mission carrying plants, STS-3, launched with a payload of two types of plants: *Arabidopsis thaliana*, a small flowering plant commonly used in scientific research, and rice. This marked the beginning of systematic research on plant growth in space and laid the foundation for future experiments in space agriculture.

Benefits of space breeding:

1. Improved crop varieties: Space breeding experiments have resulted in the development of new crop varieties with desirable traits. For example, researchers have bred wheat varieties with increased resistance to drought and disease by exposing seeds to space conditions.

- 2. Understanding plant biology: Studying how plants grow and adapt in space has provided valuable insights into fundamental aspects of plant biology. Researchers have gained a better understanding of how plants respond to gravity, light, and other environmental cues, which can inform agricultural practices on Earth.
- **3. Seed mutagenesis:** Exposure to space radiation can induce mutations in plant seeds, leading to the creation of novel genetic variations. This process, known as seed mutagenesis, has been used to generate new crop varieties with improved traits such as higher yield, disease resistance, and nutritional content.
- 4. Microgravity research: Conducting experiments in microgravity allows researchers to study plant growth in the absence of gravity's influence. This research has revealed how plants perceive and respond to gravity, including changes in root development, water uptake, and nutrient distribution.
- **5. Space farming technologies:** Advances in space farming technologies, such as plant growth chambers and hydroponic systems,



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Giant space pumpkin: 100-kg pumpkins from "space seeds"

have enabled sustainable food production in space habitats and on long-duration space missions. These technologies are essential for supporting future human exploration of the Moon, Mars, and beyond.

These achievements highlight the significant contributions of space breeding to agricultural science and its potential to address food security challenges both in s pace and on Earth.

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Challenges and future directions

While space breeding holds great promise, it also presents numerous challenges. Microgravity and other space conditions can affect plant growth in complex ways, and researchers must overcome technical and logistical hurdles to conduct experiments in space. Additionally, translating research from findings space to practical applications on Earth requires careful consideration of environmental differences and scalability.

Looking ahead, continued investment in space breeding research, collaboration between space agencies, academic institutions, and private companies, and advances in technology will be crucial for unlocking the full potential of space agriculture. By harnessing the power of space breeding, we can not only expand our understanding of plant biology but also pave the way for sustainable food production in space and on our home planet.

Applications of space breeding on earth

While space breeding is primarily focused on addressing the challenges of growing food in space, it also has applications for agriculture on Earth. By breeding plants for improved resilience to environmental stresses such as drought, heat, and disease, researchers can develop crop varieties that are better suited to the changing climate conditions. Space breeding techniques, such as mutagenesis and gene editing, can be applied to traditional breeding programs to accelerate the development of new crop varieties with desirable traits.

Conclusion

Space breeding represents a frontier of agricultural science with farreaching implications for space exploration and food security on Earth. By studying how plants grow and adapt in space environments, researchers are unlocking new opportunities to improve crop resilience, understand plant biology, and support long-term human habitation beyond Earth. As we continue to push the boundaries of space exploration, space breeding will play a vital role in shaping the future of agriculture and food production for generations to come.





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3D FOOD PRINTING A REVOLUTIONARY INNOVATION IN FOOD PROCESSING

About Author 🚇....க

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he advent of 3D food printing is reshaping the landscape of food technology by introducing customized, nutritious, and sustainable food production methods. This innovation in food processing involves layering edible materials to create intricate food designs, personalized meals, and innovative textures. With advancements in digital fabrication and food engineering, 3D food printing is the way for personalized paving nutrition, improved sustainability, and enhanced food security. As the demand for customized and functional foods grows, the potential applications of 3D food printing in healthcare, space missions, and gourmet cuisine continue to expand.

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Principles and working mechanism of 3D food printing

3D food printing operates on principles similar to additive manufacturing, where a computer-aided design (CAD) model guides the deposition of food materials layer by layer. This process uses various techniques such as extrusion-based printing, inkjet printing, binder jetting, and selective laser sintering.

- 1. Extrusion-based printing: The most common method, which involves extruding food pastes (such as chocolate, dough, or mashed potatoes) through a nozzle to create three-dimensional shapes.
- 2. Inkjet printing: Uses liquidbased food inks to create detailed patterns and flavors on substrates.
- 3. Binder jetting: Employs edible binders to fuse powdered ingredients together to form solid structures.
- 4. Selective laser sintering: Uses a laser to solidify powdered food materials into intricate designs, commonly used in sugar printing.

Applications of 3D food printing 1. Personalized nutrition and healthcare

3D food printing is revolutionizing personalized nutrition by enabling the

creation of customized meals tailored to specific dietary needs. For individuals with dietary restrictions (e.g., diabetics, gluten-intolerant individuals, or the elderly with chewing difficulties), food printers can produce nutrient-optimized meals with controlled textures and compositions. In the healthcare sector, fortified foods with precise nutrient compositions can be formulated to aid in and disease patient recovery management.

2. Sustainable food solutions

Sustainability is a growing concern in food production. 3D food printing enables the use of alternative protein sources, such as insect-based, plant-based, and lab-grown proteins, to reduce the environmental impact of traditional livestock farming. Additionally, food waste can be minimized by reprocessing surplus ingredients into printable food structures, thereby addressing global food security challenges.

3. Gourmet and artistic culinary creations

Chefs and food artists are leveraging 3D food printing to craft intricate and visually appealing culinary masterpieces that are otherwise impossible to achieve with conventional



methods. Custom-designed chocolates, artistic sugar decorations, and gourmet dishes with unique textures are now being created with precision and efficiency.

4. Space and military nutrition

NASA and defense organizations are exploring 3D food printing for space missions and military applications. Astronauts require long-shelf-life foods with high nutritional value, and 3D printing allows for on-demand meal preparation using stored food cartridges. Similarly, for military personnel in remote locations, 3D food printers can provide customized, energy-dense meals that improve endurance and efficiency.

Advantages of 3D food printing 1. Customization and personalization

One of the most significant benefits of 3D food printing is the ability to tailor foods to individual preferences and dietary requirements. Whether adjusting macronutrient compositions or designing aesthetic food structures, 3D printing enhances the personalization of food experiences.

2. Food safety and hygiene

Automated food printing reduces human contact with food, thereby minimizing contamination risks and ensuring higher standards of hygiene. Additionally, precise ingredient control can enhance food safety by preventing cross-contamination of allergens.

3. Reduction of food waste

3D food printing enables the reutilization of food by-products, reducing waste and promoting a circular economy in food processing. Ingredients such as vegetable peels, fruit pulp, and protein-rich leftovers can be converted into printable food pastes, contributing to sustainability.

4. Cost and resource efficiency

By optimizing ingredient usage, 3D food printing reduces the need for

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materials and lowers excess raw production costs. Smart food formulation can maximize nutritional value while minimizing ingredient wastage, making it a cost-effective solution in food engineering.

Challenges and limitations of 3D food printing

1. Limited ingredient compatibility

Not all food ingredients are suitable for 3D printing. The rheological properties (viscosity and texture) of food materials must be carefully controlled to ensure proper extrusion and structuring. Developing a wider range of printable food materials remains a challenge.

2. Processing time and scalability

3D food printing is relatively slow compared to traditional food production methods, limiting its application in mass food manufacturing. Researchers are working on multi-nozzle printing and high-speed processing techniques to improve efficiency.

3. Equipment and maintenance costs

The high cost of 3D food printers and the maintenance requirements of precision-controlled extruders and cartridges can be a barrier to widespread adoption, particularly for small-scale food businesses and households.

4. Consumer acceptance

Despite advantages, its consumer acceptance of printed foods a key challenge. remains Some consumers may perceive 3D-printed food as less natural or artificial compared to traditionally prepared meals. Educational initiatives and public awareness campaigns are essential to improve market adoption.

Future prospects of 3D food printing

The future of 3D food printing looks promising, with continuous

advancements in food material science, AI-driven customization, and smart kitchen integration. Several trends and innovations are expected to shape the next generation of 3D food printing:

- 1. Integration with AI and IoT-AI-powered food printers capable of analyzing dietary needs and creating optimized meal plans will enhance automation in meal preparation.
- 2. Nutritional enhancement-Researchers are exploring the use of functional ingredients (e.g., probiotics, plant-based proteins, and bioactive compounds) to improve the health benefits of printed foods.
- 3. Commercialization and mass production-Companies are working on high-speed 3D food printers for large-scale production, making the technology more accessible and affordable.
- 4. Expansion into consumer markets-With increasing affordability, home-based 3D food printers may become a common feature in modern kitchens, enabling households to create customized meals at home.

Conclusion

3D food printing represents a ground breaking advancement in food engineering, with applications ranging from personalized nutrition and sustainability to gourmet culinary arts and space exploration. While challenges such as processing speed, consumer perception, and ingredient compatibility continuous technological remain. advancements are expected to overcome these barriers. As food industries and researchers continue to explore its potential, 3D food printing has the power to revolutionize the way food is prepared, consumed, and experienced, ultimately shaping the future of food technology.



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