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JUST AGRICULTURE®

Magazine

DRAGON FRUIT

NATURE'S SUPERFOOD AND THE SCIENCE BEHIND ITS CULTIVATION

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FROM THE FOUNDER & CEO's DESK

Dear Readers,

Welcome to the latest issue of Just Agriculture—a publication dedicated to empowering, informing and inspiring the agricultural community. The landscape of agriculture continues to evolve, we are witnessing significant advancements in technology, sustainability practices, and global trends that are reshaping the way we produce, consume, and think about food, from precision farming to the integration of AI in crop management, innovation is at the heart of the agricultural revolution.

However, alongside these opportunities, challenges like climate change, supply chain disruptions and labor shortages remain pressing concerns that require our collective action and resilience.

At Just Agriculture, we are committed to being a bridge between these emerging technologies and the farmers, agribusinesses and stakeholders who will shape the future of agriculture. In this issue, we delve into topics that matter most: sustainable farming practices, the rise of agri-tech and the crucial role of policy in ensuring a thriving agricultural ecosystem. We also highlight success stories from across the globe, demonstrating how

adaptability and innovation are driving positive change.

I believe that the future of agriculture is bright, but it requires all of us—farmers, scientists, policymakers and consumers—to work together toward a common goal: ensuring food security, environmental sustainability and the well-being of future generations.

Thank you for your continued support and for being a part of this incredible journey. I hope this issue inspires you as much as it has inspired us to bring it to you.

Dr. D.P.S. BADWAL
Founder & CEO,
Just Agriculture-the Magazine

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FROM THE

CHIEF EDITOR's DESK

Dear Readers,

Agriculture today stands at a decisive crossroads-where tradition meets technology and resilience is shaped by innovation. The current issue of Just Agriculture is thoughtfully curated to reflect this dynamic transition, bringing together field-tested technologies, academic reflections and emerging crop opportunities that collectively redefine the future of Indian agriculture.

We begin this issue with a powerful exploration of drone technology in Indian agriculture, where success stories from the field highlight how precision spraying, monitoring and data-driven decision-making are transforming farm productivity and sustainability. These narratives are not merely technological demonstrations; they are testimonies of how innovation, when made accessible, can empower farmers and optimize resource use.

Equally compelling is the discussion on academic harvest and professional drought, which urges us to rethink India's agri-education model. In an era demanding skilled agri-professionals, this article invites policymakers, educators and institutions to introspect and realign education with real-world agricultural challenges.

The spotlight on dragon fruit cultivation reflects the growing interest in high-value, climate-resilient crops. By blending nutritional science with cultivation practices, the article provides valuable insights for farmers looking to diversify income while meeting the rising demand for superfoods.

Further, the concept of a Crop Cafeteria as a tool for technology expansion presents an innovative extension approach—demonstrating how experiential learning can accelerate adoption of improved practices at the grassroots level.
Together, the articles in this issue reinforce a central message: the future of agriculture lies in integration of technology with tradition, education with practice and productivity with sustainability.

I extend my sincere appreciation to all authors and contributors for their scholarly rigor and practical insights. I also thank our readers for their continued trust and engagement. May this issue inspire dialogue, innovation and decisive action toward a resilient and progressive agricultural ecosystem.

Dr. Sushila
Chief Editor,
Just Agriculture-the Magazine

table of

contents

REVOLUTIONIZING INDIAN AGRICULTURE WITH DRONE TECHNOLOGY: SUCCESS STORIES FROM THE FIELD

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In recent years, drone technology has emerged as a game-changer in Indian agriculture, bringing precision, efficiency, and innovation to the hands of farmers. These unmanned aerial vehicles (UAVs) are transforming how crops are monitored, managed, and protected—ushering in a new era of "smart farming".

INTRODUCTION

The introduction of drone technology in agriculture has revolutionized crop protection practices. Unlike traditional knapsack sprayers, agricultural drones ensure precision spraying, uniform droplet distribution, and significant savings in both chemical usage and operational costs.

The Power of Drones in the Field

Agricultural drones are equipped with advanced sensors, cameras, and GPS systems that help farmers perform several critical tasks with remarkable accuracy. From crop health monitoring, pest and disease detection, and fertilizer and pesticide spraying, to mapping and yield estimation, drones drastically reduce manual labour, save time, and minimize input costs. One of the biggest advantages is uniform spraying of agrochemicals, which not only improves pest control efficiency but also reduces chemical exposure to farmers—ensuring safety and sustainability.

Government Push and Farmer Empowerment

Recognizing the potential of drones, the Government of India launched several initiatives under the Sub-Mission on Agricultural Mechanization (SMAM) to promote drone adoption. Farmers' cooperatives, FPOs, and Krishi Vigyan Kendra's (KVKs) are being equipped and trained to use drones effectively. Subsidies, training programs, and custom hiring centres are encouraging small and marginal farmers to benefit from this technology.

SUCCESS STORIES FROM THE GROUND

Telangana's Digital Fields:
In districts like Warangal and Khammam, KVKs have demonstrated drone-based pesticide spraying in paddy and cotton fields. Farmers reported a 25–30% reduction in chemical use and 40%-time savings compared to manual spraying. The uniform spray coverage led to healthier crops and improved yields.

Haryana's Precision Revolution:
In Karnal, progressive farmers adopted drones for nutrient management in rice and wheat fields. Using NDVI (Normalized Difference Vegetation Index) mapping, they could identify nutrient-deficient areas and apply fertilizers precisely. The result—10% increase in yield and significant savings on urea and water.

Maharashtra's Sugarcane Success:
Sugarcane farmers in Ahmednagar district, with the support of local FPOs, used drones for urea top dressing. The even distribution not only enhanced cane growth but also reduced lodging problems during heavy winds. Many farmers now prefer drones for all fertilizer applications.

KVK Bhadradri Kothagudem Demonstrations:
The Krishi Vigyan Kendra, Bhadradri Kothagudem, has been at the forefront of promoting drone-based spraying and monitoring in integrated farming systems. Demonstrations on paddy, maize, and horticultural crops have shown tremendous potential—saving labour, water, and ensuring effective pest control even in non-watershed areas.

A Glimpse into the Future

As drone regulations evolve and local manufacturing grows, costs are expected to decline, making drones more accessible. Integration with AI and IoT will further enable real-time crop diagnostics and predictive analytics. The future of Indian agriculture lies in data-driven decisions and precision farming, and drones are leading the way.

Comparison Between Drone Sprayer and Knapsack Sprayer

Parameter	Knapsack Sprayer	Drone Sprayer	Remarks
Chemical usage per acre	150–200 liters of spray solution	8–10 liters of spray solution	Up to 90–95% reduction in water and 20–30% reduction in chemicals
Pesticide consumption	100% baseline	70–80% of baseline	Drones use 20–30% less pesticide due to precision spraying
Operational cost per acre	₹500–₹700 (labor, water, fuel, etc.)	₹250–₹350 (battery, pilot cost, minimal water)	About 40–60% cost saving
Time required per acre	30–45 minutes	5–10 minutes	4–5 times faster operation
Labor requirement	2–3 persons	1 pilot/operator	Reduces labor dependency
Coverage efficiency	2–3 acres/day	20–25 acres/day	8–10× higher productivity
Droplet size control	Manual, uneven	Controlled (50–150 microns)	Ensures uniform coverage
Health & safety	Direct exposure to chemicals	No direct contact	Safer for workers

COST REDUCTION ANALYSIS

Component	Knapsack Sprayer (₹)	Drone Sprayer (₹)	Savings (%)
Labor cost	300	100	67%
Water usage cost	100	10	90%
Fuel/Battery	100	60	40%
Pesticide usage	700	500	28%
Total Cost per Acre	**₹1,200**	**₹670**	**≈44% reduction**

NOTE: Actual cost varies by crop type, chemical type, and local labour rates. Demonstrations in Telangana, Andhra Pradesh, and Gujarat under government-supported programs (e.g., DA&FW, ICAR-KVKs) have shown 30–50% total cost reduction using drones.

EFFICIENCY AND QUALITY BENEFITS

- **Uniform Spray Distribution:** Drones ensure equal droplet size and distribution, improving pest and disease control efficiency.
- **Reduced Drift Loss:** GPS-guided flight ensures targeted application, minimizing wastage.
- **Precision Input Use:** Chemicals are sprayed only on required zones, avoiding over-application.
- **Environmental Safety:** Less runoff and contamination of soil and water resources.
- **Health Benefits:** No physical exposure of farmers to toxic chemicals.

EXAMPLE SUCCESS CASES

- **Krishi Vigyan Kendra's (KVKs):** Field trials in Telangana and Andhra Pradesh reported 30–35% pesticide saving and 50% reduction in water use.
- **ICAR-Central Institute of Agricultural Engineering (CIAE), Bhopal:** Demonstrated that drone spraying increased field efficiency by over 70% compared to manual methods.
- **Farmer Producer Organizations (FPOs):** Reported saving of ₹400–₹600 per acre and better pest control in cotton, paddy, and chili crops.

Summary of Key Advantages

Cost reduction: 40–60%
Chemical saving: 20–30%
Water saving: 90–95%
Time saving: 4–5× faster
Labor saving: 60–70%
Health safety: No exposure risk

CONCLUSION

Drone technology has proven to be a cost-effective and eco-friendly alternative to traditional knapsack sprayers. By reducing chemical and water use while increasing operational efficiency, it supports sustainable agriculture, enhances farmer income, and contributes to the Digital India and Smart Farming initiatives.

ACADEMIC HARVEST, PROFESSIONAL DROUGHT: RETHINKING INDIA'S AGRI-EDUCATION MODEL

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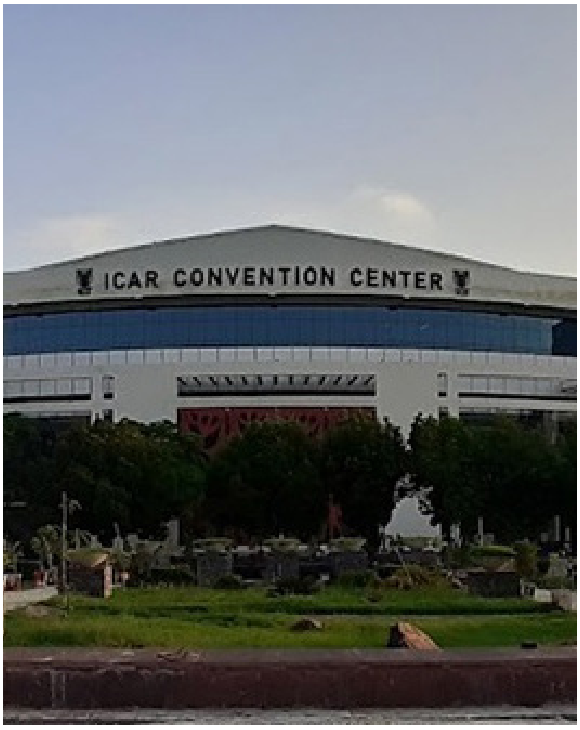
QUANTITATIVE STRENGTH AND SPECIALIZED REACH

The scale and structure of India's agricultural education system are unmatched globally. Anchoring this vast framework is the Indian Council of Agricultural Research (ICAR), which steers and supports a network of 63 State Agricultural Universities (SAUs), 3 Central Agricultural Universities (CAUs), quite a few deemed universities and numerous ICAR-accredited colleges in general universities. With a footprint across nearly every major state, the system ensures that education and research are both decentralized and tailored to regional agro-ecological contexts.



This expansive network offers a full spectrum of academic programs—undergraduate, postgraduate, and doctoral—across a wide array of specialized disciplines. These extend well beyond conventional plant sciences to encompass Agronomy, Soil Science, Horticulture, Agricultural Economics and Rural Sociology, Entomology, Plant Pathology, Agricultural Meteorology, Veterinary and Animal Sciences, Fisheries, Agricultural Engineering, Agricultural Biotechnology and Nanotechnology. Such deep specialization equips graduates not as generalists, but as domain-specific professionals trained to address complex, sector-specific challenges in India's agri-food systems.

MANDATORY PRACTICAL AND FIELD TESTED EXPERTISE

A defining strength of India's agricultural education system lies in its deep-rooted emphasis on applied, hands-on learning. Unlike conventional science courses that often remain confined to laboratory settings, agricultural degrees are inherently practice-oriented—comparable in rigor and structure to medical or engineering education.

At the heart of this experiential approach is the Rural Agricultural Work Experience (RAWE) program, a mandatory component of all undergraduate curricula. RAWE immerses students in the realities of rural India—through time spent on university research farms, in laboratories, and most importantly, within farmers' fields and villages. This intensive field exposure plays a transformative role, enabling students to:

- Integrate Theory with Practice: Apply classroom knowledge to real-world variables such as climate variability, pest dynamics, and soil heterogeneity.
- Develop Systemic Thinking: Understand how scientific interventions interact with economic, social, and market constraints in rural ecosystems.
- Build Extension and Communication Skills: Learn to effectively transfer knowledge and technologies to farming communities—a skill essential for bridging the lab-to-land gap and influencing on-ground adoption.

Through this structured field engagement, students are shaped not just as plant, animal or soil scientists, etc., but as holistic farm ecosystem experts—capable of navigating the complex interplay between science, policy, and rural livelihoods.

INTEGRATED TEACHING, RESEARCH AND OUTREACH

India's State Agricultural University (SAU) system operates on a robust tripartite mandate: Teaching, Research, and Extension. As enumerated below, this integrated model ensures that faculty members serve not only as educators but also as frontline researchers and extension professionals—bridging the gap between science and society.

- **Localized, Problem-Solving Research:** Faculty focuses on region-specific challenges, such as breeding flood-resilient varieties for the East or drought-tolerant crops for the arid West. This ensures that scientific innovations are contextually relevant and directly responsive to the needs of the local farming communities.
- **Dynamic Curriculum Integration:** Research insights feed directly into academic programs, creating a feedback loop that keeps the curriculum current, practical, and aligned with the evolving regional realities of agriculture.
- **Farmer-Centric Outreach:** Through their extension arms, universities ensure

timely transfer of innovations improved seed varieties, weather-based operations, pest and disease management strategies, conservation and post-harvest techniques to farmers. This two-way communication fosters not just dissemination but also grassroots' feedback for ongoing research.

India's agricultural education ecosystem is built to generate action-oriented professionals who can convert scientific knowledge into on-ground impact making it an indispensable engine for rural transformation and national development.

BROADENING THE GATES:
INCLUSION OF LIFE SCIENCE GRADUATES IN INDIA'S AGRI RESEARCH SYSTEM

A growing and contentious trend within India's agricultural science community is the progressive expansion of eligibility criteria for research and academic positions in the national system—particularly those administered by the Agricultural Scientists Recruitment Board (ASRB) under the Indian Council of Agricultural Research (ICAR).

Tradition vs. Transition

Historically, recruitment to the Agricultural Research Service (ARS) was firmly rooted in the specialized educational ecosystem of the SAUs, where degrees were tailored to the applied and contextual demands of Indian agriculture. Entry into research and academic roles was reserved for those trained professionals through this system, ensuring a strong linkage between education, field experience, and scientific specialization.

However, in the recent years, the eligibility landscape has shifted. ASRB has opened the door to candidates holding postgraduate and doctoral degrees from general life science backgrounds. This structural shift, while reflective of interdisciplinary scientific trends, has sparked intense debate over the long-term implications for sectoral relevance, field orientation, and the future identity of agricultural research.

Mechanisms of Inclusion

The two principal channels through which this inclusion occurs are:

- National Eligibility Test (NET): A qualifying exam for appointment as Assistant Professor/Lecturer in SAUs and other Agricultural Universities.
- ARS Examination: A competitive exam for direct recruitment to entry-level scientist positions (Scientist 'B' and equivalent) within ICAR institutes.

In several scientific disciplines, the official notification of ASRB now allows, either explicitly or through interpretation, the eligibility of candidates without a foundational degree in agriculture (B.Sc. Agriculture or equivalent), provided their specialization aligns with the applied domain.

Examples of Broadened Eligibility

The trend is most pronounced in disciplines at the interface of basic sciences and agricultural applications:

- Plant Biotechnology / Molecular Biology & Biotechnology: Candidates with Master's degrees in Biotechnology, Molecular Biology, Genetic Engineering, Botany, or general Life Sciences are often considered eligible—if their focus areas align with plant systems.
- Plant Biochemistry: General science graduates with degrees in Biochemistry are now considered alongside those from agricultural biochemistry backgrounds.
- Plant Pathology, Entomology, and Nematology: While agricultural degrees remain preferred, candidates from Botany, Zoology, or Life Sciences may also qualify—particularly when their specialization includes relevant subfields (e.g., Mycology for Plant Pathology, Nematology, or Insect Science/Entomology).

Implications for Agricultural Research and Education

This inclusionary policy shift brings both opportunities and concerns:

- It aligns agricultural research with global interdisciplinary trends, inviting innovation and new perspectives from adjacent scientific domains.
- However, it also raises concerns about the dilution of field orientation, lack of contextual agricultural grounding, and the potential erosion of the applied ethos that has long characterized India's agricultural education system.

At its core, the debate revolves around a critical question: Can graduates trained without exposure to the complexities of Indian farming systems such as soil variability, climate risk, farmers' behavior, and rural livelihoods effectively drive innovations that are locally relevant and scalable?

As India modernizes its agricultural research infrastructure, this balance between scientific breadth and sectoral depth must be navigated with caution, foresight, and stakeholder dialogue.

INTEGRATED TEACHING, RESEARCH AND OUTREACH

The recent trend of expanding eligibility for ICAR/ASRB scientific positions to include graduates from general life sciences is often justified on two key grounds:

- **Harnessing Modern Science:** As agriculture increasingly intersects with cutting-edge domains such as genomics, proteomics, and other advanced molecular biology tools, there is a perceived need to integrate such tools, methodologies, and theoretical frameworks from basic sciences. General science universities, particularly those with trendy molecular and cellular biology programs, are seen as rich reservoirs of this expertise.
- **Expanding the Talent Pool:** In light of growing vacancies and specialization gaps, widening eligibility is also viewed as a strategy to draw from a broader pool of scientifically skilled individuals, ensuring the availability of qualified candidates for research in emerging and interdisciplinary areas.

However, this policy shift has sparked deep concern—especially among graduates and faculty of the SAU system, whose entire training is rooted in agricultural application and rural engagement.

Key Concerns Raised by the SAU Community

- **Erosion of Application Focus:** While general life science graduates may possess strong laboratory skills, they often lack the holistic, systems-based training that is central to agricultural education. This includes mandatory coursework in Agronomy, Plant Pathology, Agricultural Entomology, Horticulture, Fisheries, Soil Science, Farm machinery, Agricultural Economics, and Rural Extension, as well as intensive field immersion through programs like RAWE. The fear is that a lab-centric approach, disconnected from on-ground realities, could dilute the applied research orientation necessary for farm-level problem-solving.
- **Devaluation of Specialized Degrees:** By granting equal access to ICAR positions without requiring the rigorous, field-intensive curriculum of agricultural degrees, the policy risks undermining the credibility and value of SAU-based education. This has led to growing disillusionment among specialized graduates who view their targeted training as being sidelined in favor of more generalist qualifications in addition to creating the scare of unemployment.

A Delicate Balancing Act

This evolving policy represents a complex balancing act. On one side lies the imperative to infuse agricultural research with modern scientific rigor and interdisciplinary innovation. On the other is the equally critical need to preserve the application-driven, farmer-centric ethos that has long defined India's agricultural research and education system.

As India seeks to strengthen its agri-research architecture for the future, it must reconcile scientific advancement with sectoral relevance—ensuring that innovation remains firmly grounded in the needs of rural India.

A MISGUIDED SHIFT:
THE OVERREPRESENTATION OF GENERAL SCIENTISTS IN AGRICULTURAL GOVERNANCE

The growing practice of appointing experts from general sciences to high-level committees overseeing agricultural research, education, and policy—both at the national level (e.g., ICAR, DBT, DST, etc.) and within state systems—reflects a deeply flawed approach. While interdisciplinary perspectives can indeed enrich decision-making, the dominance of individuals without a background

in agricultural sciences threatens to erode the sector's foundational focus on applicability and rural relevance.

When non-agricultural graduates begin to steer or dictate the direction of these committees, there is a real risk of marginalizing the field-based, context-specific expertise that is essential for addressing India's complex farm-level challenges. In an agricultural landscape where evidence-based science must inform policy and policy must empower farmers, sidelining subject-matter experts is a strategic misstep that weakens national goals of food security and rural prosperity.

Why Agricultural Graduates Must Lead: Preserving the Integrity and Relevance of India's Agri-Governance

Graduates from India's specialized agricultural education system comprising the SAUs and ICAR institutes bring a unique, systems-oriented expertise that is irreplaceable in the governance of agricultural research, education, and policy. Their presence in key committees is not just desirable, it is essential.

- Systemic Problem Solving: Agricultural degrees are designed to integrate multiple dimensions into a unified understanding of farm systems. While a chemist may offer insights into molecular structures, they are ill-equipped to evaluate fertilizer policies in terms of suitability to multi- and/or inter-cropping, soil compatibility, economic viability or adoption by resource-poor smallholders. Only agricultural graduates are trained to assess these intersecting factors, ensuring that decisions are grounded in real-world applicability.
- Field-Level Insight through RAWE: The RAWE program provides graduates with direct exposure to farming realities—regional climate variability, credit constraints, market linkages, and socio-cultural dynamics. This lived understanding is vital in committees dealing with curriculum development, research funding, or policy formulation. Without this grounding, there's a risk that decisions will favor academic elegance over practical relevance—resulting in lab innovations that never reach the field.
- Safeguarding Accreditation Integrity: Committees responsible for curriculum design and academic accreditation must be led by those trained within the agricultural education system. They alone understand the pedagogical

philosophy that blends scientific rigor with hands-on exposure. Allowing general scientists to redefine standards threatens to dilute core components like field training and extension, reducing agricultural education to theoretical instruction and producing lab technicians instead of farm scientists. An association of the SAUs is the best agency to design and improve course curriculum and monitor the progress of its member universities.

- The interdisciplinary inputs are welcome, but agricultural governance must remain anchored in the expertise of those who are trained to understand agriculture not just as a science, but as a lived, field-bound system. The credibility and impact of India's agri-education and research depend on it.

The Risks of Overrepresentation of Non-Agricultural Experts in Governance

When committees governing agricultural research, education, and policy are dominated by non-agricultural experts, the sector's relevance and effectiveness face serious threats:

- Flawed Policy Direction: Economists or policymakers lacking agricultural extension experience may craft subsidy or support policies that fail to address on-ground realities. Similarly, biologists without training in soil science or agronomy may set research priorities that overlook practical farm-level challenges. The result is policies misaligned with the needs of farmers and rural communities.
- Misallocation of Research Funds: In central grant committees (e.g. ICAR, DBT, DST), non-specialists may favor projects emphasizing abstract molecular or laboratory research at the expense of applied studies—such as improving water-use efficiency, pest management, or climate-resilient cropping practices. This undermines national mission to deliver tangible, farm-level solutions and impacts public investment efficiency.

- Compromising Recruitment: Panels dominated by non-agricultural experts risk selecting candidates with exceptional theoretical credentials but no field experience. This devalues the holistic training provided by the SAU/ ICAR system and weakens the capacity for applied research that addresses India's complex agro-ecosystem challenges.

The sidelining agricultural domain experts in decision-making jeopardizes the very purpose of India's agricultural education and research infrastructure: translating science into practical, sustainable benefits for farmers.

SAFEGUARDING AGRICULTURAL GOVERNANCE:
THE NEED FOR STRATEGIC REPRESENTATION IN DECISION-MAKING COMMITTEES

To preserve the integrity, field relevance, and transformative potential of India's agricultural governance architecture, the constitution of key committees must be governed by strategic mandates that prioritize domain expertise. Without such safeguards, there is a risk of disconnect between high-level decisions and on-ground agricultural realities.

Key Recommendations

- Mandating Predominant Representation of Agricultural Domain Experts: Committees responsible for shaping agricultural research, education, and policy—at both national (ICAR, ASRB, DBT) and state levels—must mandatorily include members holding specialized degrees in agriculture and allied fields. This ensures that decisions are driven by those with foundational, field-tested knowledge of farming systems.
- Clearly Define Interdisciplinary Roles: While interdisciplinary input is essential—whether from IT, trade, biotechnology, or economics—such members should serve in defined advisory roles that support, but do not override, the core agricultural mandate. Final decision-making authority must reside with professionals trained in the agricultural sciences.
- Prioritize Applied, Field-Based Experience: Beyond academic credentials and publication metrics, committee appointments must give due weight to real-world experience in agricultural extension, technology dissemination, policy implementation, and farmer engagement. These competencies—cultivated through the SAU/ICAR ecosystem—are crucial to ensure that policies and research investments translate into adoptable, scalable solutions for rural India.

Strategically restructuring committee composition around these principles is not exclusionary but it is essential. It aligns institutional decisions with the complex, field-bound realities of Indian agriculture. Only through such alignment can research investments, academic reforms, and policy frameworks translate into measurable and enduring gains for India's farmers and rural economy.

Prioritizing Agricultural Experts in Research Funding

Allocating public funds for agricultural research exclusively to specialized agricultural scientists—rather than to general or pure science specialists—is a strategic imperative. Such targeted funding ensures that investments generate practical, field-ready solutions that directly benefit farmers. This approach acknowledges a fundamental distinction: while basic scientific research advances knowledge, applied agricultural research demands a deep understanding of farm systems, regional constraints, and rural realities to translate innovation into tangible, adoptable outcomes.

The Limits of Pure Science Specialists in Applied Agricultural Research

Pure science specialists—such as general biologists, chemists, or molecular scientists without formal agricultural training—often lack the contextual knowledge necessary to direct research that is meaningful for Indian farms.

- Systemic Understanding: Effective agricultural research demands a holistic grasp of the farm ecosystem, integrating agronomy, soil science, entomology, agricultural engineering, and economics. While pure scientists may excel in a specific component (e.g., a gene or molecular pathway), they often lack the systems-level perspective required to assess whether a technology is feasible and beneficial in real-world farming conditions.
- Field Experience Gap: Agricultural degrees include mandatory programs like RAWE, which immerse students in farmer fields, exposing them to regional climate variability, soil limitations, resource constraints, and socio-economic realities. Pure science specialists, primarily lab-trained, may design projects that are scientifically interesting but disconnected from the practical realities faced by marginal farmers.
- Adoption Barrier: Technologies developed without consideration of extension and farmer constraints risk being too costly, complex, or incompatible with existing practices. Agricultural scientists, trained to integrate adoption potential from project inception, are uniquely

positioned to ensure that research outputs are both implementable and impactful.

The applied agricultural research requires a fusion of scientific rigor with field-grounded insight—something only trained agricultural specialists can reliably deliver.

Ensuring Impactful Agricultural Research through Specialist-Led Funding

- To maximize the practical and socio-economic impact of publicly funded agricultural research, central agencies including ICAR, and the agricultural programs of DBT, DST, etc. should implement mandatory provisions that prioritize agricultural specialists at every stage of project conception and evaluation.
- PI/Co-PI Mandate: Principal Investigators and Co-Principal Investigators must hold all degrees (UG, PG, and PhD) in relevant agricultural sciences. This ensures that project leadership possesses comprehensive field knowledge, applied expertise, and a deep understanding of farming systems.
- Field Component Requirement: All project proposals must incorporate a substantial, budgeted field-validation component, involving farmer engagement or multi-location, multi-season trials. Proposals that lack practical, farm-level relevance—often characteristic of lab-only and, pure science projects—should be deemed ineligible for funding.
- Expert Committee Filtering: Funding review committees and task forces must be composed of agricultural degree holders with demonstrated extension and field experience. This guarantees that project evaluation prioritizes economic viability, adoptability, and practical outcomes over purely molecular or theoretical novelty.

By mandating that leadership, evaluation, and execution of public agricultural research remain in the hands of specialized agricultural scientists, India can ensure that its investments generate tangible, farm-level solutions—strengthening productivity, resilience, and the overall agricultural economy.

SAFEGUARDING THE INTEGRITY OF AGRICULTURAL HONORS AND GOVERNANCE

The credibility and relevance of India's agricultural research system—from policy formulation to recognition of excellence—depend on ensuring that the highest honors and governance roles are reserved for those with mandated, specialized agricultural expertise. Disconnecting non-agricultural graduates from conferring fellowships and awards, particularly within the National Academy of Agricultural Sciences (NAAS) and similar scientific bodies, is critical for two overarching reasons: preserving the applied focus of agricultural science and validating the distinct value of specialized agricultural degrees.

- Preserving the Integrity of NAAS and Agricultural Awards: The NAAS was established to recognize and promote excellence in agricultural sciences and allied fields. Its fellowships and awards represent the highest form of recognition within the sector. To maintain their significance, evaluation and governance must remain rooted in the practical realities of agriculture.
- Mandate of Applicability: Agricultural science is fundamentally an applied discipline, focused on translating research into farm-level productivity, profitability, and food security. Contributions of a NAAS Fellow must be assessed not only on scientific rigor which non-agricultural experts can

evaluate but also on practical utility, adoption potential, and measurable field impact.

- Addressing the Expertise Deficit: While pure science specialists excel in their respective domains, they typically lack the systemic, field-based training including immersive programs necessary to evaluate the applicability of research across India's diverse agro-climatic zones. Allowing them to govern fellowships risks prioritizing lab bound, esoteric work over innovations that deliver tangible, on-farm benefits.
- Validating Specialized Agricultural Degrees: If the highest honors in agricultural science can be awarded by non-agricultural experts or to non-agricultural graduates, it undermines the value of the SAU/ICAR system's intensive, field-oriented education. To reinforce the credibility and distinctiveness of this pathway, NAAS/ICAR must ensure that:
  - Awardees/Fellows hold specialized agricultural degrees at all levels (UG, PG, PhD).
  - Award governance is restricted to agricultural specialists, capable of judging both scientific merit and real-world impact.

Preserving the exclusivity of specialized expertise in recognition and governance safeguards not just institutional integrity, but also the applied relevance and societal value of India's agricultural research system.

ENSURING CONTEXTUAL EXPERTISE IN BROADER SCIENTIFIC ACADEMIES

Scientific academies such as the Indian National Science Academy (INSA), the National Academy of Sciences India (NASI), and the Indian Academy of Sciences (IAS) also confer fellowships and awards in dedicated "Agricultural Sciences" categories. Even within these broad, multidisciplinary institutions, the evaluation of candidates in agricultural disciplines must remain firmly rooted in domain-specific expertise.

- Need for Contextual Judgment:

Committees selecting fellows or awardees in agricultural sciences should be staffed exclusively by experts trained in agricultural sciences. Contextual knowledge ensures that evaluations prioritize real-world relevance. For instance, a general life science committee might favor a high-impact publication on a yeast gene, whereas an agricultural expert would rightly recognize a lower-impact study describing a drought-resistant crop variety successfully adopted by thousands of farmers.

- Preventing Misaligned Recognition: Mandating agricultural specialists in selection panels prevents the "Agricultural Sciences" category from becoming a default home for general life scientists whose work, while scientifically sound, may be only tangentially relevant to applied farming issues. Recognition must reward genuine contributions to agriculture, not just basic biological discovery.
- Preserving the Link Between Expertise and Impact: Restricting governance over agricultural honors to qualified agricultural experts ensures that national recognition systems remain aligned with the mission of serving India's agrarian economy. It reinforces the crucial connection between specialized training, field relevance, and societal impact, safeguarding the credibility of awards and fellowships in the agricultural domain.

THE PARADOX THREATENING INDIA'S AGRICULTURAL FUTURE

The integrity of India's agricultural future depends on the reciprocal relationship between the expertise cultivated by its educational institutions and the mandates of the bodies that utilize that expertise. The vast, specialized network of Agricultural Universities—an unparalleled national asset designed to address India's unique farm challenges—risks undermining its own purpose if it systematically excludes or marginalizes its graduates in recruitment, leadership, and recognition.

This creates a profound paradox: graduates, rigorously trained and field-immersed through programs are left to question the value of their specialization, while critical research, policy, and governance positions are increasingly occupied by generalists who lack systemic, contextual, and farm-level understanding. If the architects of India's agricultural talent are denied their rightful roles, the foundational infrastructure of the nation's agri-education system loses relevance, placing food security, rural livelihoods, and farmer welfare at serious risk.

DRAGON FRUIT : NATURE'S SUPERFOOD AND THE SCIENCE BEHIND ITS CULTIVATION

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INTRODUCTION

Consumer awareness about the health benefits of fruit offers great thrust for their regular consumption as part of a balanced diet. Worldwide, the demand of nutrient rich fruit has increased immensely in the recent past, not only for enhancing nutritional status, but also for their benefits to immune and metabolic health. Dragon fruit (*Hylocereus spp*.) popularly known as Pitaya or Kamalam a recently introduced super fruit in India, is considered to be a promising, remunerative fruit crop. It is a climbing cactus that belongs to Cactaceae family. Among its different species, *Hylocereus polyrhizus* (red dragon fruit or red pitaya) is highly nutritious, as it provides an array of bioactive components, including a wide range of antioxidants, phytonutrients, minerals and enzymes.

AREA AND PRODUCTION

The three major countries producing dragon fruit are Vietnam, Israel and China, which account for 93 per cent of global dragon fruit production. Vietnam is the largest producer and supplier of dragon fruit, accounting for 51 per cent of global production. In India, The dragon fruit was introduced in the late 1990s as a backyard crop. Later, the area under cultivation gradually increased from 4 to 400 ha during 2003-04. Initially, its cultivation was restricted to parts of Karnataka, Maharashtra, Gujarat and Andhra

Pradesh. Now, dragon fruit cultivation is gaining momentum in India. The Government of India, through various schemes, is giving greater impetus to push for its commercial cultivation in the climatically suitable regions of south, west and northeastern India, including the arid and semi-arid regions. Presently, its cultivation has extended to Madhya Pradesh, Haryana, Punjab, Uttar Pradesh and North Eastern (NE) states. As a result, the total area of dragon fruit cultivation in India has increased to 3084 ha, with an estimated total production of 12113 metric tonnes. The Mission for Integrated development of Horticulture (MIDH) under Ministry of Agriculture and Farmer's Welfare, Government of India has targeted to expand the area under dragon fruit cultivation to 50,000 ha in the country. MIDH also approved establishment of a Centre of Excellence (CoE) on kamalam (dragon fruit) at Horticultural Experimental Farm of ICAR-Indian Institute of Horticultural Research located at Tumukuru.

PROXIMATE COMPOSITION OF DRAGON FRUIT PULP

Red dragon fruit, with its striking appearance and delightful taste, is not only a visual treat but also rich in nutritional profile. The fruit pulp is composed of about 87.03 per cent moisture on Fresh weight basis (FW), offering a refreshing, hydrating quality. The total soluble solids (TSS) of the fruit are around 11.87 0Brix on FW. One of the interesting aspects of this fruit is its low acidity (0.4%) with a pH of 5.12, making it a friendly choice for those who may be sensitive to acidic foods. The fruit also provides around 6.40 per cent total sugars, along with a modest amount of fat at 0.48 per cent and a small protein content of 0.1 per cent on FW.

Moreover, red dragon fruit is notable for its antioxidant properties. The pulp contains significant amounts of total phenols and flavonoids - 90.48 mg GAE (Gallic Acid Equivalents) and 76.25 mg CE (Catechin Equivalents) per 100 grams FW, respectively. The fruit's total antioxidant activity stands at 38.13 mg AEAC (Ascorbic Acid Equivalents) per 100 grams FW, and radical scavenging activity of 69.42% is mainly due to the presence vibrant betalains, pigments measuring at 128.40 mg BCE (Betanin Equivalents) per 100 grams FW along with other phytochemicals.

HEALTH BENEFITS OF DRAGON FRUIT

Here are some key health benefits of red dragon fruit. The fruit is loaded with antioxidants, particularly vitamin C and betalains, which help combat oxidative stress, reduces inflammation in the body and also help strengthening the immune system, aiding the body in fighting off infections. In addition, antioxidants in red dragon fruit can also benefit the skin by reducing signs of aging and promoting a healthy complexion indicated that the fruit's anti-inflammatory and moisturizing properties can enhance skin health, making it a valuable ingredient in cosmetics.

Red dragon fruit is also a good source of dietary fiber, which promotes digestive health and regular bowel movements. Fiber is known to prevent constipation and support a healthy gut microbiome. Some of the recent studies were also indicated that red dragon fruit may help

lower blood sugar levels and improve insulin sensitivity, which is beneficial for people with diabetes.

Cultivation practices

Dragon fruit, a member of the Cactaceae family, has unique climatic requirements that set it apart from other cacti. Originating from tropical rainforests rather than arid deserts, this vibrant fruit thrives in regions with sufficient rainfall, ideally between 1,145 to 2,540 mm annually. In India, it flourishes in most areas, except those that experience low precipitation. The ideal climate for growing dragon fruit includes warm temperatures ranging from 20 to 29°C, though the plants can tolerate higher temperatures up to 38-40 °C. However, temperatures exceeding 40 °C can be detrimental, causing yellowing of the stems. Dragon fruit prefers well-drained soil types, particularly sandy loam enriched with organic matter and slightly acidic conditions. Propagation is through stem cuttings, typically measuring 20 to 25 cm in length. After preparing the cuttings, it's essential to allow the latex to dry and treat them with fungicides (Carbendazim 0.1 %) to prevent disease. Once planted in bags filled with a mixture of soil, farmyard manure, and sand, cuttings generally root within 5 to 6 months, requiring a shady spot and careful moisture management to avoid rot.

For optimal growth, dragon fruit plants need full sunlight and shouldn't be placed in shaded areas. A single post planting system, spaced at 3x3 meters, is typically used, with poles standing 1.5 to 2 meters tall to support the vines as they climb. Each pole can accommodate 2 to 4 plants (around 4000 to 4500 plants/Ha), depending on local weather conditions. Dragon fruit vines grow rapidly, producing dense branches in their early stages. Pruning is vital to direct growth and encourages lateral branching, which leads to the formation of impressive flowers. These beautiful nocturnal blooms, measuring 25 to 30 cm in length, are white inside and feature striking greenish-yellow exteriors with purple accents. Flower production occurs from May to August, with fruit ready for harvest 30 to 40 days after pollination.

Regular pruning helps maintain an open canopy, promoting new shoots for the next growing season. Proper irrigation practices, such as drip irrigation, ensure the plants receive adequate moisture without the risk of fungal diseases or excessive weed growth. During the dry season, providing 2 to 4 liters of water twice a week per plant is generally sufficient. With respect to fertilization, organic fertilizers such as cow dung and neem cake may be applied at the rate of 15–20 kg per pole, two to three times a year—once before and once after the production season.

Dragon fruit is relatively free from pests and diseases. However, the incidence of scale insects, ants, fruit flies, and nematodes has been observed in some parts of India and can be managed through the application of appropriate insecticides and pesticides. Similarly, diseases such as stem canker, anthracnose, brown spot, and stem rot can be controlled through early detection and timely application of fungicides and bactericides during the initial phase of establishment. Additionally, farmers incur about 5–8 per cent loss due to predators like rats and birds, which can be minimized by using protective netting

Dragon fruit plants typically begin to yield fruit about 12 to 15 months after planting. The optimal time for harvesting occurs when the fruit's outer skin changes color from green to red. The fruit is generally produced from June to September, with the potential for harvesting three to four times each month. Individual fruit weights range from 300 to 800 grams, and a three-year-old plant can yield approximately 30 to 35 kilograms of fruit. Currently, farm gate prices for dragon fruit vary between INR 80.00 to 120.00 per kilogram.

CONSTRAINTS IN DRAGON FRUIT CULTIVATION

- Lack of awareness and expertise regarding proper nursery production of dragon fruit.
- Supply of inferior quality planting materials by private nurseries.
- High cost and non-availability of quality planting materials.
- High initial investment required for orchard establishment.
- Selection of region-specific trellis design remains a major challenge.
- Scarcity of trellis materials to meet farmers' demand.
- Lack of skilled manpower for efficient orchard management.
- Absence of standardized cultivation protocols for diverse agro-climatic regions.
- Need for standardization of region-specific manuring and fertilization schedules.
- Poor flowering and flower/fruit drop due to excessive temperature and rainfall.

CONCLUSION

Dragon fruit, often celebrated as a "superfood," stands out not only for its exotic appeal and vibrant color but also for its immense nutritional and economic potential. Rich in antioxidants, vitamins, and dietary fiber, it contributes significantly to immune health, digestion, and overall well-being. Beyond its health benefits, dragon fruit cultivation offers a promising avenue for farmers across India due to its adaptability, high returns, and growing consumer demand for nutrient-dense fruits.

CROP CAFETERIA: A EFFECTIVE TOOL FOR TECHNOLOGY EXPANSION

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INTRODUCTION

Crop Cafeteria is playing very effective role in Krishi Vigyan Kendra for technology showcasing for enhancing its application and technology expansion among the farming community. It provides practical experiences based on 'Seeing is believing' and face to face views along with KVK experts for disseminating technical know-how to the farmers, rural youths and extension functionaries. Krishi Vigyan Kendra has planned to evaluate location specific varieties & technologies. Crop Cafeteria is a effective way for popularize the different varieties and technologies. In Krishi Vigyan Kendra Crop Cafeteria grown different varieties and technologies of Soybean, Maize, Paddy, Pigeon pea, Green gram, Black gram, Wheat, Chickpea, Mustard, Lentil, Linseed, Onion, Garlic, Pea etc crops.

The demonstration of high yielding varieties and improved technology of different crops with latest production technology in Crop Cafeteria, it was found that crop cafeteria proved very effective in changing attitude, skills and knowledge of farming communities of district. Further, in KVK crop cafeteria, technology integration was also demonstrated on Integrated Nutrient Management, Integrated Pest Management, Intercropping, System of Rice Intensification, System of Wheat Intensification, Dharwad method in pigeon pea. During the visit farmers are benefited to see latest varieties and also help in adoption of technologies.

Objectives- The main objective of crop cafeteria is to disseminate suitable and useful technologies for farming community, extension functionaries. The other objectives are-

- To collect feedback from farmers and other visitors.
- To use crop cafeteria as Training material.
- To increase adoption of technologies.
- To enhance input use efficiency.

Type of Crop Cafeteria :

As per the different climatic condition different type of Crop Cafeteria established in Krishi Vigyan Kendra.

- Field Crop Cafeteria
- Vegetable Crop Cafeteria
- Spices Crop Cafeteria
- Medicinal Crop Cafeteria
- Fodder Crop Cafeteria

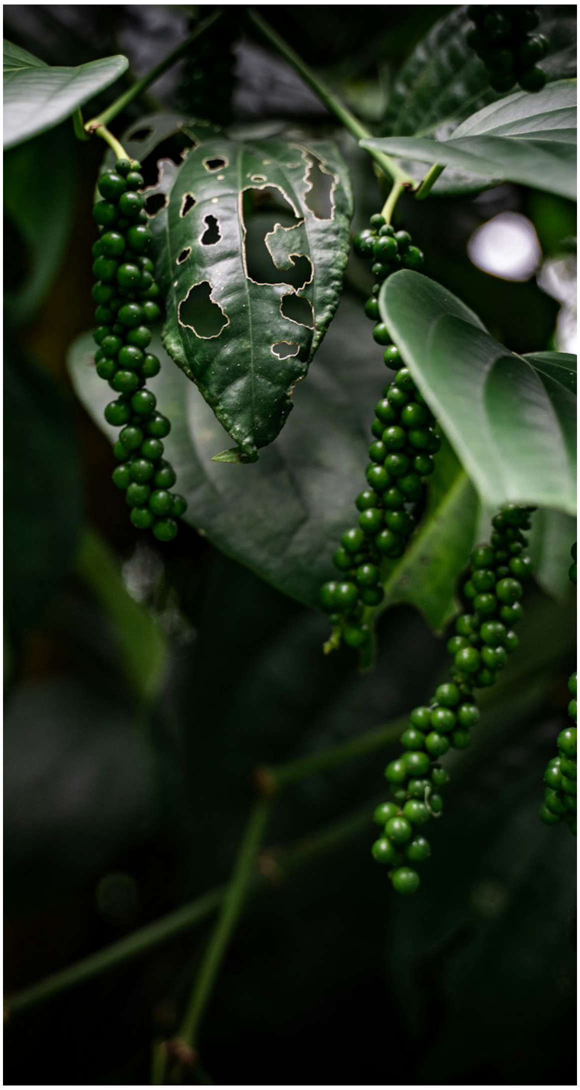
FIELD CROP CAFETERIA

In crop cafeteria, variety of different field crops are sown at proper spacing. The main aim of field crop cafeteria is to demonstrate number of varieties of a crop at one place. In this all crops are sown scientifically and technically. Filed crop cafeteria is demo units for farmers from which they are learn about different technology and techniques of crop growing.

VEGETABLE CROP CAFETERIA

In vegetable crop cafeteria vegetable of each and every growing season are grow at one place. In this the main focus is to develop a number of varieties of different seasonable vegetable crop. Crop cafeteria concept based upon the "seeing and believing" theory. In crop cafeteria farmer visit and discuss with expert so it is a mean of face to face interaction. Mostly we all have seen farmer only believe on practically thing so it is a better mean for extension of technology among the farmers.

SPICES CROP CAFETERIA



In spices crop cafeteria different spices are planted or sown in a small plots at one place. In this the focus are gives on the sowing technology, varietal demonstration, spacing, Insect Pest Management and Nutrient Management. In cafeteria the species are grown according to climatic condition of locality. The major species are grown in cafeteria are Cumin, Coriander, Cardomom, Chilli, Black pepper etc.

MEDICINAL CROP CAFETERIA

In medicinal crop cafeteria, the different medicinal plants and there species are grown at same place. In this focus are given on creation, conservation and domestication of technology among the farmers. It is a best mean for farmers "learning by seeing". The spices grown in this include Serpentine, Ashwagandha, Giloy, Nirgundi, Pattharchoor, Gudmar, Gulvakabli, kali moosli, van pyaz, jangli haldi, chitrak, mundakparni etc.

FODDER CROP CAFETERIA

A fodder cafeteria is simply display of several fodder varieties on a small patch of land. In this focus are given on to produce carbohydrate and protein rich fodder crops, mostly perennial. We very well know, farmer either do not have animal or if they have, they are not aware of the food that they need to feed them to get the required quantity and quality of milk. As we know, every animal needs at least 10% of its body weight as fodder every day. Ideally animal should be given three parts of roughage and one part of protein. The major fodder crops grown in cafeteria are as such napier grass, lucerene, Barseem, Maize, Sorghum, Bajara etc.

SEASON CROP CAFETERIA

In the year Krishi Vigyan Kendra generally three seasons Crop Cafeteria established i.e Kharif Crop Cafeteria, Rabi Crop Cafeteria

Kharif Crop Cafeteria : In Kharif Crop Cafeteria KVK Expert exhibited different crops Paddy, Pigean Pea, Maize, Soybean, Black gram, Green gram, Niger, Kodo, Kutaki, Sesam, Vegetables, Spices etc.

Rabi Crop Cafeteria : In Rabi Crop Cafeteria KVK Expert exhibited different crops Wheat, Chickpea, Lentil, Linseed, Maize, etc.

Summer Crop Cafeteria : In Summer Crop Cafeteria KVK Expert exhibited different crops Green gram, Ground nut, Bitter gourd, Bottle gourd, Spine gourd etc.

LATEST TECHNOLOGY EXHIBITED IN CROP CAFETERIA

Krishi Vigyan Kendra Expert exhibited suitable and latest technology in Crop Cafeteria. KVK Expert following technologies exhibited priority basis:

- Improved Varieties of Crops
- Integrated Pest Management
- Integrated Nutrient Management
- Integrated Weed Management
- System of Rice Intensification
- Intercropping System
- Seed Treatment
- Ridge and Furrow Method
- Broad Bed Furrow Method
- Dibbling Method
- Dharwad Method

OUT COME

The demonstration of high yielding varieties and improved technology of different crops with latest production technology in Krishi Vigyan Kendra Crop Cafeteria, it was found that crop cafeteria proved very effective in changing attitude, skills and knowledge of farming communities. The crop cafeteria was regularly visited by farmers, rural youth, extension functionaries, public representatives, Scientists and Administrative from various locations. It was found very easy to adopt the suitable varieties and other technologies for the farmers.

CONCLUSION

On the basis of our experiences & feedback from visitors it can be concluded that Crop Cafeteria is a very effective tool for transfer of technology. It is also observed that crop cafeteria is very much suitable tool for training and build up confidence of farmers towards adoption of technology.

SUPERGREENS: TINY LEAVES WITH MIGHTY POWER

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INTRODUCTION

In recent years, the term *superfoods* has become a buzzword in health and nutrition circles, and among them, *supergreens* stand out as one of the most celebrated categories. Supergreens refer to leafy vegetables and edible plants that are remarkably rich in vitamins, minerals, antioxidants and phytochemicals compared to their calorie content. Unlike fad health products that come and go, vegetable supergreens such as spinach, kale, moringa, fenugreek leaves and mustard greens have been part of traditional diets across cultures for centuries. What makes them "super" is not just their nutrient density but also their ability to support immunity, enhance digestion and reduce the risk of chronic diseases. As modern lifestyles often rely on processed foods with limited nutritional value, supergreens are regaining the spotlight as a natural way to meet dietary requirements. They are versatile, i.e., eaten fresh, cooked or in powdered form, and their benefits extend beyond nutrition to holistic well-being. With growing scientific evidence linking plant-based diets to better long-term health, supergreens are no longer just a passing health trend but a vital component of sustainable nutrition.

WHY SUPERGREENS MATTER?

Supergreens matter because they deliver concentrated nutrition in a way that few other foods can. In today's world, where diets are often dominated by refined grains, sugars and calorie-dense but nutrient-poor foods, deficiencies in

vitamins and minerals ae increasingly common. These "hidden hungers" rarely make headlines but can quietly deteriorate health over time, causing fatigue, lowered immunity and poor metabolic function. Supergreens like spinach and kale bridge this gap by providing iron, calcium and magnesium in forms that the body can readily absorb, along with vitamins A, C and K that play critical roles in immunity, vision and blood clotting.

Beyond supplying essential nutrients, supergreens also contain unique plant compounds that support the body's natural defenses. Lutein and zeaxanthin in kale and spinach, for example, protect the eyes from age-related degeneration, while glucosinolates in mustard greens help regulate detoxification pathways. Moringa leaves are especially valued for their balance of protein, antioxidants and minerals, making them a valuable food in regions battling malnutrition. Together, these proteins make supergreens powerful allies in preventing chronic diseases such as diabetes, cardiovascular conditions and even certain cancers.

Incorporating a variety of these greens into the diet ensures not only better nutrition but also diversity in phytochemicals. This diversity matters because each supergreen brings its own set of health-promoting compounds. By eating spinach one day, amaranth leaves the next and moringa powder in a smoothie, individuals can build a nutritional safety net that strengthens energy, immunity and overall well-being.

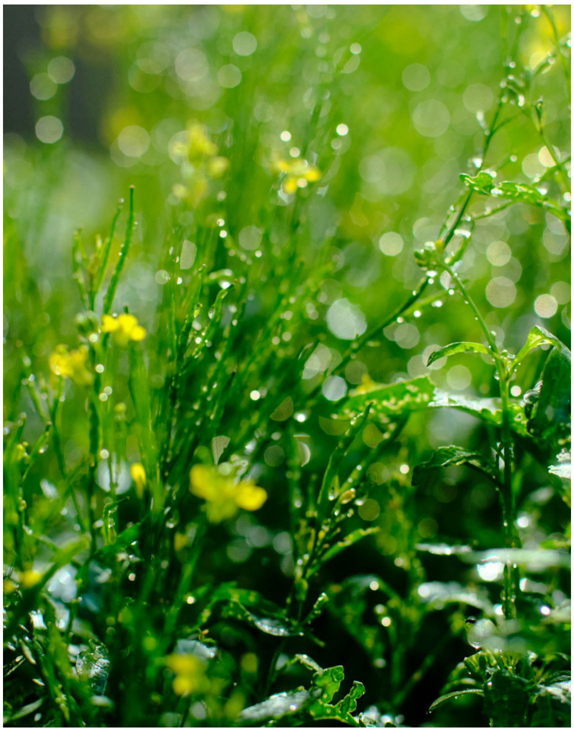

Table 1. Nutritional highlights of selected supergreens

Supergreen	Key nutrients	Health benefits	Common uses
Spinach	Iron, folate, vitamin C, magnesium	Supports energy, muscle function and immunity	Salads, smoothies, sautéed dishes
Kale	Vitamin K, calcium, lutein, β-carotene	Bone strength, eye health, antioxidant protection	Stir-fries, soups, baked as chips
Moringa leaves	Protein, vitamin A, iron, calcium	Enhances nutrition, fights anaemia, supports growth	Powders, teas, curries
Fenugreek leaves	Iron, vitamin C, dietary fibre	Helps in digestion, improves blood sugar regulation	Indian curries, flatbreads, soups
Mustard greens	Vitamin K, C, folate	Strengthens bones, boosts immunity	Stir-fries, pickles
Amaranth leaves	Calcium, vitamin A, potassium, antioxidants	Improves bone health, supports heart function	Stir-fries, dals, curries
Bathua	Vitamin A, calcium, phosphorus	Supports digestion, promotes bone strength	Seasonal curries, parathas
Wheatgrass	Chlorophyll, vitamin E, amino acids	Detoxification, improved metabolism	Fresh juice shots, smoothies
Beet greens	Magnesium, potassium, vitamin K	Improves circulation, supports heart health	Stir-fries, soups, salads, smoothies
Broccoli sprouts	Sulforaphane (10-100× higher than mature broccoli)	Supports detoxification	Salads, garnish, sandwiches, microgreen mixes

FRESH VS. POWDERED SUPERGREENS

A frequent question among health enthusiasts is whether fresh greens or powdered versions are more effective. The answer depends on context, lifestyle and nutritional goals. Fresh greens are unbeatable when it comes to providing fibre, hydration and a natural balance of nutrients. Eating leafy vegetables in whole form supports digestive health, regulates cholesterol and keeps one feeling full for longer. Many supergreens also contain compounds that become easier when lightly cooked, e.g., β-carotene in spinach and kale becomes easier for the body to use after steaming or sautéing. Whole greens also carry subtle phytonutrient interactions that powders cannot fully replicate.

Powdered greens, on the other hand, stand out in terms of convenience and concentrated nutrition. Made by

dehydrating and grinding leaves like moringa, amaranth or wheatgrass, they allow busy individuals to boost their nutrient intake without extensive preparation. They can be stored easily, added to smoothies, soups or energy bars, and especially useful in areas where fresh produce is seasonal or less accessible. However, the processing may reduce certain heat-sensitive nutrients and the absence of fibre means they should not completely replace vegetables. Quality also varies across brands, so sourcing from reputable suppliers is essential.

The best approach is to not choose one over the other but to use them complementarily. Fresh greens should remain the foundation of meals, while powders can serve as a backup or an enhancer. For example, a spinach-and-amaranth curry provides bulk nutrition and fibre, while a teaspoon of moringa powder in a morning smoothie adds a concentrated boost. This synergy allows individuals to enjoy both the wholesome qualities of fresh vegetables and the practicality of powdered supergreens.

CONCLUSION

Supergreens are far more than trendy foods; they are nature's nutrient powerhouses, rooted in tradition yet validated by modern science. They offer concentrated doses of vitamins, minerals, antioxidants and plant compounds that combat fatigue, protect organs and strengthen immunity. In a world where lifestyle-related illnesses are on the rise, supergreens serve as affordable, accessible and sustainable allies for better health. Choosing between fresh and powdered supergreens is not an either-or decision; both have unique advantages. Fresh greens provide fibre and hydration, while powders offer concentrated nutrition and convenience. By including a variety of these familiar and lesser-known supergreens, individuals can take simple yet powerful steps toward vibrant health and disease prevention. Ultimately, these leaves prove that the most effective medicine often comes straight from the garden.

BIOFABRICATED LEATHER

ALTERNATIVES (UTILIZING AGRICULTURAL BYPRODUCTS LIKE PINEAPPLE LEAVES (PIÑATEX) OR MYCELIUM FOR CRUELTY-FREE LEATHER IN FASHION DESIGN)"

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INTRODUCTION

The fashion industry's reliance on animal leather is under increasing scrutiny due to environmental pollution, ethical concerns, and the growing demand for sustainable materials. In response, new innovations in biofabrication have led to the development of leather alternatives derived from agricultural by-products and fungal mycelium. These materials replicate the aesthetic and functional properties of animal leather while minimizing ecological impact and avoiding animal cruelty. Traditional leather production, while prized for its durability and aesthetic, raises significant ethical and environmental concerns — from animal cruelty to high carbon emissions, toxic tanning processes, and excessive water consumption. As the world moves toward sustainability, biofabricated leather alternatives have emerged as revolutionary materials that blend science, nature, and design innovation.

AGRICULTURAL BY-PRODUCTS: PINEAPPLE-BASED LEATHER

Piñatex, developed by Ananas Anam, uses cellulose fibers extracted from pineapple leaves—an agricultural waste—to create a nonwoven mesh that mimics the texture of leather. Approximately 480 leaves are required to make one square meter of Piñatex. The production uses no extra land, water, or fertilizers, making it an eco-efficient process. However, while the base is plant-based, synthetic coatings such as polylactic acid (PLA) or polyurethane (PU) are sometimes used to enhance durability, reducing biodegradability.

MYECELIUM-BASED LEATHER

Mycelium leather is created by cultivating fungal networks under controlled conditions to form dense, leather-like sheets. Companies such as MycoWorks and Bolt Threads have pioneered this technology. Mycelium leather can be grown rapidly on organic waste substrates, requiring minimal resources and producing little waste. Its biodegradability and bio-based origin make it a leading innovation in sustainable fashion materials.

COMPARATIVE ADVANTAGES AND CHALLENGES

Both Piñatex and mycelium leathers present strong advantages in sustainability, as they utilize renewable or waste resources and eliminate the need for animal products. However, challenges remain: durability, scalability, and performance standards are ongoing concerns. Cost efficiency and consumer acceptance are also critical factors that influence mainstream adoption.

IMPLICATION FOR FASHION DESIGN AND ADOPTION

From a fashion-design perspective, these new materials open interesting opportunities: They allow designers to speak to sustainability and animal-free credentials, which is increasingly important for consumers.They enable new textures and aesthetics: for example, the non-woven mesh of a pineapple-leaf material has a distinct look compared to animal hide; mycelium materials can be designed for novel finishes.They support circular economy thinking: sourcing from waste streams, potentially designing for end-of-life biodegradation or recycling.

But designers must also work with material limitations: considerations of durability, finishing, cost, scalability, and supply reliability all matter. For example, if a bag made of pineapple-leaf leather suffers faster wear than expected, it may undermine the luxury positioning. Brands are already experimenting: e.g., major fashion houses have used Piñatex or mycelium-derived materials. In your case, as a fashion-design account or project, you might explore using these materials in accessories, up-cycled fashion pieces, or highlight the sustainability story as part of the design narrative.

CONCLUSION

Biofabricated leather alternatives such as Piñatex and mycelium leather represent promising innovations in the transition toward sustainable fashion. They offer cruelty-free, low-impact solutions that transform agricultural waste into valuable materials. Despite existing limitations in durability and cost, continuous research and technological advancement are expected to enhance their commercial viability. Integrating these materials into fashion design will not only reduce the industry's ecological footprint but also promote a more ethical and responsible future for fashion.

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