



KAbcon 2025

Kerala Agrobiodiversity Conference 2025

KAbcon 2025

International Conference on Community
Agrobiodiversity management: in Kerala



December 2025
22-23



College of Agriculture
Vellayani

BOOK OF ABSTRACTS

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KERA
Kerala Climate Resilient
Agri-Value Chain Modernization





Kerala Agrobiodiversity Conference 2025

KAbCon 2025

**International Conference on Community
Agrobiodiversity Management: In Kerala**

Kerala Agrobiodiversity Policy Consultation

Book of Abstracts



**Kerala Agricultural University &
Kerala State Biodiversity Board**



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*The Organising Committee of **Kerala Agrobiodiversity Conference 2025 (KAbCon 2025)** – **International Conference on Community Agrobiodiversity Management: In Kerala** is privileged to present the Book of Abstracts, which compile abstracts of keynote addresses, lead lectures, and oral and poster presentations contributed by scientists, academicians, and students from India and abroad. The seminar is being hosted at the **Kerala Agricultural University**, College of Agriculture, Vellayani, Thiruvananthapuram, on **December 22-23 2025**.*

We were encouraged by the wide range of submissions received, which covered diverse sub-themes within the broad domain of biodiversity conservation and management. Each abstract was carefully reviewed for scientific merit and editorial quality by the Technical Committee and subject experts. We sincerely appreciate the diligence of the Technical Committee in evaluating and selecting the papers, and we extend our thanks to the Publicity Committee for their dedicated efforts in ensuring wide visibility and participation in the seminar.

*We gratefully acknowledge the financial assistance provided by the **Cochin International Airport Ltd. (CIAL)**, **Kerala State Pollution Control Board**, **National AYUSH Mission**, **Kerala Climate Resilient Agri-Value Chain Modernisation (KERA)** project, **Kerala State Council for Science Technology and Environment (KSCSTE)**, **Kerala agro industries Corporation**, **Union Bank of India**, **Canara Bank**, **Federal Bank**, **Oushadhi**, and all other supporting organisations.*

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*Our deepest gratitude goes to the **Honourable Chief Minister of Kerala** and **Honourable Minister for Agriculture, Government of Kerala**, for his inspiring leadership and continued encouragement of initiatives that promote agriculture, biodiversity conservation, and sustainability. We also record our sincere appreciation to **Dr B. Ashok, IAS, Vice-Chancellor, Kerala Agricultural University**, for his visionary guidance; **Dr Jacob John, Dean of Faculty of Agriculture**, for his academic leadership; and **Dr K. N. Anith, Director of Research**, along with **Dr Binoo P. Bonny, Director of Extension**, for their constant support in organising this seminar.*

*We place on record our special thanks to **Dr N. Anilkumar, Chairman of the Kerala State Biodiversity Board**, **Dr V Balakrishnan, Member Secretary**, and all esteemed members of the Board for their valuable insights, encouragement, and cooperation, which greatly enriched the deliberations and outcomes of the conference. Their active involvement and guidance provided a strong foundation for the success of KAbCon 2025.*

*A special note of appreciation is extended to **Major Dinesh Bhaskar, Additional Private Secretary to the Honourable Chief Minister of Kerala**, for his kind support and facilitation throughout the planning and execution of the event.*

We express our sincere thanks to all scientists, researchers, and students for their timely submissions and active participation. We also acknowledge the dedicated efforts of the Chairman, Convenor, Co-convenor and members of all committees and the enthusiastic involvement of postgraduate and graduate student volunteers.



GOVERNMENT OF KERALA

Pinarayi Vijayan

CHIEF MINISTER

No. 1297/Press/CMO/25

18 December, 2025.

MESSAGE

I am glad to note that the Kerala Agricultural University, in collaboration with the Kerala State Biodiversity Board, is organizing an International Conference on 'Agrobiodiversity for Resilient Food and Agriculture Systems' at the College of Agriculture, Vellayani.

Strengthening community-based seed conservation and protecting our local agro-ecological heritage are vital steps toward achieving the goal of Food Sovereignty. By bringing together global experts and local stakeholders, this conference will undoubtedly provide actionable insights for sustainable agricultural development. I congratulate the organizers for taking this initiative and wish the conference, as well as all the participants, every success in their endeavour to build a greener, self-reliant, and more resilient Kerala.

My best wishes.

Pinarayi Vijayan

The Dean of Faculty
KAU, E-mail : deanagri@kau.in



P. PRASAD
MINISTER FOR AGRICULTURE
GOVERNMENT OF KERALA

18/12/2025

Message

I am happy to extend my warm greetings to the participants of the International Conference on "Agrobiodiversity for Resilient Food and Agriculture Systems." This timely initiative, jointly organized by the Kerala Agricultural University and the Kerala State Biodiversity Board, gains added significance as it coincides with the Platinum Jubilee celebrations of the College of Agriculture, Vellayani.

Kerala recognizes agrobiodiversity as the cornerstone of sustainable agricultural systems. In the face of climate change and global food challenges, conserving our diverse crop varieties, livestock, and traditional practices is essential for ecological balance and the long-term security of our farming communities.

The Kerala Agricultural University continues to be a vital partner in our State's agricultural transformation. It is heartening to note that the Farmer's Seed Diversity Fair is a core highlight of this conference, as it rightly honours the invaluable contributions of Kerala's custodian farmers in preserving our natural heritage.

I commend the College of Agriculture, Vellayani, for organizing this significant international event. I wish the conference every success and trust that its deliberations will provide a roadmap for the sustainable and resilient development of Kerala's agricultural sector.

P.Prasad

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Message

The College of Agriculture, Vellayani, takes pride in hosting the International Conference on Agrobiodiversity for Resilient Food and Agriculture Systems on 22–23 December 2025, organized by Kerala Agricultural University in partnership with the Kerala State Biodiversity Board. This commendable effort reflects a shared commitment to advancing agrobiodiversity conservation and strengthening resilient and sustainable food systems at a time when these concerns have assumed critical importance.

The conservation and sustainable use of agrobiodiversity play a pivotal role in achieving the objectives of climate resilience, nutritional security, and sustainable agricultural development. Kerala, with its rich legacy of farmer-led conservation and diverse agro-ecological settings, offers valuable lessons for integrating scientific innovation with Indigenous and local knowledge. The theme of this conference is therefore both timely and highly relevant, providing an important platform for meaningful dialogue among researchers, policymakers, extension professionals, and farmers.

The conference brings together eminent national and international experts to deliberate on strategies for conserving crop genetic resources, improving crop quality and micronutrient content, and strengthening resilient food systems. The Farmer's Seed Diversity Fair, a key highlight of the event, celebrates the invaluable contributions of custodian farmers who continue to preserve traditional and climate-resilient crop varieties. In this context, I place on record my sincere appreciation for their diligent efforts in bringing these invaluable genetic resources to the forefront of public and scientific attention. The College of Agriculture, Vellayani, has been recognized with the Agrobiodiversity Award, which stands as a testament to its sustained institutional commitment to biodiversity conservation, farmer-centric initiatives, and community-based approaches to sustainable agriculture. Hosting this international conference further reinforces that commitment.

As the host institution, the College is honoured to facilitate this exchange of knowledge and experiences. I express my heartfelt appreciation to the Organising Committee for their meticulous planning and dedicated efforts in bringing this important event to fruition. Thank you for your outstanding contributions and commitment. The conference also holds special significance as part of the Platinum Jubilee celebrations of the College, reflecting its long-standing contribution to agricultural education, research, and outreach in Kerala. I am confident that the deliberations and outcomes will lead to meaningful insights and actionable pathways for strengthening agrobiodiversity conservation.

I wish you all the best, and may this event inspire enduring collaborations, innovative ideas, and sustained efforts towards resilient food and agricultural systems.

Dean
College of Agriculture, Vellayani



Message

The Kerala Agrobiodiversity Conference 2025 (KAbCon 2025), to be held at the College of Agriculture, Vellayani, on 22–23 December 2025, is conceived as a notable international gathering to advance community-based agrobiodiversity management. Jointly organised by the Kerala Agricultural University and Kerala State Biodiversity Board (KSBB), the Conference brings together policymakers, researchers, custodian farmers, indigenous leaders, development professionals, and sustainability managers to deliberate on integrating sustainable and wise use of genetic resources, traditional wisdom and modern science for climate-resilient food systems in the socio-economic context of the Western Ghats' agrobiodiversity hotspots.

The two day-Conference will bring together policymakers, scientists, custodians, farmers, youth innovators, and institutional leaders to deliberate on mainstreaming biodiversity into production sectors such as agriculture, animal husbandry, aquaculture, fisheries, and agroforestry. The Policy Makers' Meet at KAbCon 2025, led by senior government and academic leaders, will serve as a pivotal platform to set actionable resolutions and indicators, ranging from agrobiodiversity indices to smallholder well-being metrics, ensuring Kerala's diverse agroecological zones are harnessed for regenerative, circular-green economy models and biodiversity-friendly supply chains. The policy and implementation gaps in the state's Organic Farming Policy 2010, the State Agriculture Development Policy 2015 and the PPVFRA Act 2004 will be reviewed in the context of the emerging uncertainties from the new Seed Bill 2025.

Building on this foundation, the Conference's expected outcomes are envisioned as a comprehensive advancement of Kerala's agrobiodiversity agenda under the state's Sustainable Agricultural Framework. Central to this foundation is strengthening community seed systems, reinforcing farmer custodianship, and showcasing innovations in the management of crop and breed diversity. Equally, the Conference will emphasise empowering local governance institutions and the Biodiversity Management Committees to translate global biodiversity targets into local action, thereby fostering participatory and inclusive stewardship. Ultimately, KAbCon 2025 aims to deliver a state-level roadmap for community-led agrobiodiversity management that is firmly aligned with the Sustainable Development Goals and the Kunming–Montreal Global Biodiversity Framework, particularly Targets 4, 8, and 10, and the Kerala State Biodiversity Strategy and Action Plan 2025-2035, ensuring coherence between policy deliberations and practical outcomes.

I take this opportunity to thank the impressive line of eminent speakers and thought leaders in sustainable and resilient agriculture and food production who have kindly consented to speak at this conference. Also, gratefully acknowledge the role of the host team under the leadership of Dr Roy Stephan and Dr Beena of the College of Agriculture, Vellayani, for their tireless efforts in conducting this conference with such diverse expertise, but to discuss only one subject, the agrobiodiversity conservation and mainstreaming in the food and agricultural production of the state of Kerala.

Dr. N. Anil Kumar
Chairperson, Kerala State Biodiversity Board



Message

The Agricultural College, Vellayani, Thiruvananthapuram, and the Kerala State Biodiversity Board (KSBB) jointly organize the Kerala Agrobiodiversity Conference (KABcon 2025), conceptualized in the context of two flagship initiatives aimed at strengthening agrobiodiversity conservation in the State.

Agrobiodiversity, intricate tapestry of life sustaining our agricultural systems represents far more than a scientific concept. It embodies centuries of careful stewardship by farmers, traditional wisdom, and nature's resilience. In Kerala, positioned within the Western Ghats, Sri Lanka biodiversity hotspot, this living heritage has long been a source of sustenance, culture, and pride.

Yet agrobiodiversity faces an unprecedented crisis. While cyclones and landslides command immediate attention, genetic diversity erodes silently. The United Nations estimates that thousands of species face extinction, with thirty percent of farm animal breeds at high risk of disappearing forever. The devastating floods of 2018 and 2019 brought this vulnerability into sharp focus for Kerala, threatening genetic resources that generations of farmers had carefully preserved.

The Custodian Farmer Project, implemented by KSBB with support from the Rebuild Kerala Initiative, has reached 800 custodian farmers across eight districts, Pathanamthitta, Alappuzha, Idukki, Ernakulam, Thrissur, Palakkad, Malappuram, and Wayanad. The Vellayani Agroecosystem Project, supported by KSBB and the State Planning Board, has strengthened field level gene banks through community participation. These farmers have preserved thousands of crop varieties and diverse livestock, poultry, and fish species through documentation, farm schools, seed seed festivals, and knowledge sharing.

A dedicated policy workshop alongside the conference will bring together custodian farmers, policy experts, and representatives from Agriculture, Fisheries, Animal Husbandry, Forests, Local Self Government Institutions, and Tribal Development to develop a comprehensive State Policy on Agrobiodiversity Conservation.

This conference provides a valuable platform to exchange knowledge and deliberate on strategies for conservation, sustainable use, and equitable benefit sharing, contributing toward the Sustainable Development Goals, the Kunming-Montreal Global Biodiversity Framework, and climate resilient agricultural practices

extend my best wishes to all participants for the successful conduct of KABcon 2025 and for its best wishes to outcomes to lead towards a stronger policy framework and effective management plans for the conservation and sustainable use of Kerala's agroecosystems

A handwritten signature in blue ink, appearing to read 'Dr. V. Balakrishnan', written in a cursive style.

Dr. V. Balakrishnan

Member Secretary

Kerala State Biodiversity Board, Thiruvananthapuram



Message

Kerala Agricultural University, as the apex institution for agricultural education and research in the State, plays a critical role in addressing the emerging challenges faced by agricultural and food systems and the farming community. Through its research led and interdisciplinary approach, the KAU contributes to strengthening sustainable, climate-resilient agriculture, while supporting evidence-based policymaking and innovation.

Agrobiodiversity forms the biological foundation of resilient agri-food systems, and is essential for enhancing adaptive capacity, ecological stability, and nutritional security. The conservation and sustainable use of plant genetic resources are therefore of paramount scientific and societal importance. The sustained efforts of farmers, researchers, and R&D institutions in Kerala in conserving traditional and climate resilient crop varieties merit recognition, as they contribute significantly to safeguard agricultural heritage and food system resilience.

In alignment with its research mandate and its engagement with biodiversity conservation activities KAU promotes collaborative initiatives for agrobiodiversity conservation. In this context, the *Kerala Agrobiodiversity Conference 2025(KABCON-2025)* organized jointly with the Kerala State Biodiversity Board on **22–23 December 2025** at the **College of Agriculture, Vellayani**, assumes particular relevance. International academic conferences provide vital platforms for knowledge exchange, interdisciplinary dialogue, and research collaboration.

The inclusion of a Farmer's Seed exchange highlights the importance of community led conservation and the integration of scientific indigenous Traditional Knowledge systems. I am sure that the College of Agriculture, Vellayani, would be proud to host this conference as part of its Platinum Jubilee celebrations and to contribute to advancing agrobiodiversity research and policy discourse.

Director of Research
Kerala Agricultural University



Message

As the premier institution for agricultural advancement in Kerala, the Kerala Agricultural University (KAU) carries the vital mandate of ensuring that the frontiers of science meet the realities of the field. Our extension system serves as the bridge that transforms laboratory research into sustainable livelihoods for our farming communities.

In an era of shifting climates, the conservation of our rich agro-biodiversity is no longer optional, but a necessity for our survival. Farmers are the true custodians of our traditional seeds and genetic heritage. By empowering them through knowledge exchange and recognizing their role in community-based conservation, we secure our state's nutritional and environmental future.

KABCON 2025, organized on 22–23 December 2025, by Kerala Agricultural University in partnership with the Kerala State Biodiversity Board, is a milestone event designed to synchronize research with practice. Hosted at the historic College of Agriculture, Vellayani, this convention will serve as a crucible for new ideas, seed sovereignty discussions, and the formulation of a robust Biodiversity Policy for Kerala.

I invite all stakeholders to join us in this mission to celebrate, conserve, and cultivate a greener and more secure tomorrow. My best wishes for a transformative two days of insightful conversation and discovery at KABCON 2025.

18-12-2025

Vellanikkara

Director of Extension
Kerala Agricultural University

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THEME I

**AGROBIODIVERSITY
CONSERVATION AND COMMUNITY
SEED SYSTEMS**



SEEDS IN SYNERGY: BRIDGING FORMAL AND INFORMAL SEED SYSTEMS FOR RESILIENT AGRICULTURE

Sherry Rachel Jacob

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India's seed sector is characterized by the coexistence of two distinct yet complementary systems: the formal and the informal seed systems. The formal seed system comprises public and private sector institutions engaged in plant breeding, varietal release, seed certification, and large-scale commercial seed production. It plays a critical role in delivering high-yielding, input-responsive varieties with assured quality standards. However, its reach is often limited in marginal, rainfed, and remote regions, and it may not always capture the diverse, location-specific needs of smallholder farmers.

In contrast, the informal seed system—managed largely by farmers—accounts for a significant share of seed used in Indian agriculture. It includes farmer-saved seed, local exchange networks, traditional varieties, and landraces adapted to specific agro-ecologies. This system is rich in genetic diversity and resilience, particularly in stress-prone environments, but often lacks systematic quality assurance, access to improved traits, and long-term sustainability mechanisms.

Bridging these two systems is essential for building resilient and inclusive agricultural systems. Genebanks and community seed banks (CSBs) can serve as critical interfaces in this integration. National and regional genebanks conserve vast collections of plant genetic resources, including landraces, wild relatives, and stress-tolerant germplasm. Through targeted pre-breeding programmes led by public sector institutions, resilient genes from genebanks can be introgressed into desirable backgrounds, ensuring that genetic diversity translates into field-level impact.



Kabcon 2025

Lead Talk

Community seed banks, often managed by tribal cooperatives, women's self-help groups, and local farmer collectives, represent decentralized nodes of seed conservation and production. They can multiply, store, and distribute locally adapted varieties, strengthening seed access and local seed sovereignty. When linked with genebanks, CSBs gain access to diverse germplasm, technical support, and quality enhancement, ensuring their sustained functioning.

A synergistic model that connects genebanks, public breeding institutions, and community seed banks can bridge formal and informal seed systems. Such integration will promote decentralized seed production, accelerate last-mile delivery of resilient varieties, and empower farming communities, thereby strengthening India's capacity to respond to climate variability and future food security challenges.

Status and Future Direction for Exploration and Ex Situ Conservation of Plant Genetic Resources of Kerala

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The state of Kerala in India, a part of the Western Ghats-Sri Lanka biodiversity hotspot, is blessed with rich biodiversity, including agrobiodiversity. The state harbours 4,681 flowering species, which comprises of 26% of Indian flora in just 1.18% of land area. A total of 306 crop taxa (excluding medicinal & aromatic plants, ornamentals and forestry species) belonging to 290 species coming under 179 genera and 61 families, are being cultivated in different areas of this state. Richness in crop diversity is attributed to wide topographic and climatic niches, ethnic diversity, a long history of overseas contacts, a personal craving for experimenting with new crops, and the practice of high-density multi-species cropping systems. In fact, spice crops such as black pepper, small cardamom, and Malabar tamarind originated from here. Within each traditional crop, there exists a wide array of germplasm/landraces, differing in morphological and agronomic traits. Needless to say, the ex-situ conservation of crop genepool is crucial in the wake of rampant genetic erosion at the crop, variety, and allele levels, primarily orchestrated by anthropogenic factors and natural calamities that compromise our food security and nutrition. In this context, ICAR-National Bureau of Plant Genetic Resources, the nodal institution at the national level for management of plant genetic resources, has collected 10,578 germplasm samples (722 taxa) across the state. A total of 5,155 accessions in the form of seeds is conserved in the National Seed Genebank of ICAR-NBPGR from Kerala; predominant crops being rice (1911), cowpea and yard-long bean (245), okra (181), brinjal (160), bitter melon (151), horsegram (122) and finger millet (104). District-wise, collections from Palakkad (1049, including 454 Pattambi Rice Collections) predominate in the Seed Genebank, followed by Thrissur (986), Wayanad (352), and Idukki (269). As a significant proportion of



horticultural crops propagate vegetatively and/or exhibit recalcitrant seed storage behaviour, alternative conservation strategies, *viz.*, Field Genebanks (FGB), *in vitro*, and cryo-conservation, play a vital role in their conservation. Within the state, there are five field genebanks (for instance, NBPGR RS Thrissur – 2,338 acc.; CTCRI-5,234 acc. of tuber crops; IISR-6,745 acc. of spices; CPCRI-1,163 acc. of plantation crops), one seed genebank (NBPGR RS Thrissur-10,476 acc.), and one *in vitro* genebank (CTCRI-465 acc. of tuber crops) under the ICAR system, which caters to different crop groups. It should be noted that these genebanks with a national mandate also include a significant proportion of their collections from other parts of the country and abroad. Apart from these, agricultural colleges and research stations under KAU, as well as central government institutes (e.g., ICRI, Myladumpara), state government-run institutes/universities (e.g., JNTBGRI, KFRI, MBGIPS, University of Calicut for *Musa* and zingiberaceous germplasm), NGOs such as MSSRF maintain crop-specific collections. The exact number of crop- or species-specific accessions from this state maintained in genebanks remains obscure due to the lack of a unified database across stakeholders, which needs the intervention from Kerala State Biodiversity Board. Analysis of available data reveals that germplasm collections are incomplete for almost all the crops. However, the situation is much better for rice, sesame, cucurbitaceous vegetables, brinjal, mango, banana, tree spices, coconut, arecanut, tapioca, and sweet potato. In general, there is incomplete geographical and ecological coverage (e.g., Edamalakkudy Grama Panchayath in Idukki dt.; Protected Areas), as well as missing primitive cultivars/farmers' varieties/landraces. In the case of perennial crops, preference has been given to elite germplasm over genetic variability, due to constraints in land, manpower, and infrastructure. Significant gaps exist in minor fruits, ornamentals, and M&APs, as well as in crop wild relatives (including wild forms of crops). Profound gaps in the collected-to-conserved germplasm are experienced in perennial horticultural crops conserved other than through seeds. Collection-to-conservation gaps occur for numerous reasons, including small sample size, low viability, poor survival of vegetative propagules, poor adaptability, pest and disease incidence, wild animals damage, and a lack of regeneration plans and facilities. This gap can be significantly reduced through coordination, active monitoring and reporting systems, and strengthening regeneration facilities at the multiplication site, especially for cross-pollinated crops. Some emerging issues in PGR management that need attention include land shortage in FGBs to allow for accommodating more germplasm collections, disinclination among researchers for multiplication/regeneration/purification of germplasm of cross-pollinated crops, and apparently unregulated introduction of

ornamentals, fruit plants, and other economic species by gardeners and private nurseries without proper quarantine. Also, heritage fruit orchards and plantations, as well as FGBs owned by state governments and private owners, are often in peril. Suggested line of work that would strengthen the PGR management includes the need for a unified collection database (that would enable meaningful gap analysis), studies on improving storage conditions for vegetative propagules and live plants during transit from exploration sites; wide hybridization and graft compatibility studies involving wild relatives; and protocol standardisation for in vitro and pollen cryopreservation of non-traditional crops, minor fruits, and CWR spp. The effective use of GIS tools, species distribution models, the Focused Identification of Germplasm Strategy, and portable equipment/kits would maximise germplasm collection coverage and efficiency. Strong networking among all institutes working on PGR management and line departments such as Kerala Forest Department is essential. Considering the uncertainties associated with germplasm management, it is suggested to conserve a duplicate set for safe preservation either through alternative conservation strategies or at different sites. Raising awareness among the general public on the importance and necessity of germplasm conservation is another critical area. In this context, there exists a ray of hope in the on-farm conservation of specific crop/crop-group by hundreds of voluntary custodian farmers across the state.

Integrated Climate-Smart Technologies for Sustainable Banana Cultivation

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Banana (*Musa* spp.) is a vital global commodity, serving as a primary staple food and significant source of energy, minerals, and vitamins for millions, particularly in Africa and East Asia. Although India is the largest global producer, the concentration of production makes the sector highly susceptible to climate change vulnerability (CCV), posing a major food security threat. The primary CCV is the alteration of monsoon patterns, resulting in alternating periods of intense drought (soil moisture deficit stress) and severe flooding.



- **Drought:** Causes profound water stress and has emerged as the most significant abiotic constraint, being substantially pronounced in tropical and sub-tropical regions.
- **Flooding:** Leads to plant submergence, root damage, and accelerates the spread of devastating soil-borne diseases (e.g., *Fusarium* wilt).
- **Temperature Extremes:** Long-term rising temperatures and shifting seasonal patterns disrupt the crop's delicate phenological cycle. While modest warming may temporarily benefit some cooler, subtropical regions by shifting conditions closer to 26-27°C optimal mean annual temperature, this advantage is negated by the increased frequency of extreme heat events.
- **Wind Damage:** Coastal and low-lying areas are severely impacted by tropical cyclones and high wind velocities (>50 km/h) These events cause catastrophic short-term losses by destroying entire plantations.

Cultivated bananas are natural hybrid derivatives of *Musa acuminata* ('A' genome) and *Musa balbisiana* ('B' genome). The 'B' genome confers a critical advantage, making genotypes containing it (ABB) to abiotic stresses, including drought and extreme temperatures, compared to 'A' genome-only cultivars (e.g., Cavendish, AAA group). Research confirms that an increasing proportion of the 'B' genome reduces sensitivity to atmospheric dryness and enhances the instantaneous water use efficiency of the leaf. To alleviate negative climate change impacts, adaptation strategies are crucial. Without intervention, CCV is projected to significantly reduce the area suitable for banana production, with a potential 60% reduction in export-suitable areas in Latin America and the Caribbean by 2080. The following interventions are warranted:

- **Genetic Improvement:** Identifying and deploying superior banana (ABB) genotypes from existing genetic resources, and developing new climate-resilient varieties with higher 'B' genome contributions.
- **Precision Water Management:** Implementing advanced IoT-integrated systems for precision irrigation scheduling. This involves integrating soil moisture sensors, weather data, and AI/ML algorithms to determine the precise volume and timing of irrigation, moving away from resource-intensive flood irrigation.
- **Cultivation Shift:** Moving production to newly suitable regions (higher elevations/subtropical zones) and promoting a shift away from genetically uniform, pesticide-intensive monocultures towards more diverse and sustainable cropping systems.

These proactive research and deployment efforts are necessary to hasten the evolution of the banana crop to meet current and future environmental challenges.

Key Words: Bananas, Climate Change, ABB Genomes, Precise Irrigation Management

01 TOP 01

Safeguarding Millet Biodiversity of Kerala: Database Creation and Conservation Strategies

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ABSTRACT

Millets are naturally gluten free and are an excellent source of dietary fiber, protein, B-complex vitamins, and essential minerals. The crop is currently gaining importance due to its climate smartness. In Kerala, millets were once widely cultivated, particularly in tribal regions where diverse traditional varieties and indigenous landraces formed the staple food of local communities, but their cultivation has steadily declined. In this context, a project was implemented with financial support from KSBB, Thiruvananthapuram with the objectives of creating database of edible local cultivars/landraces/ cultivated varieties of millets of Kerala, assessing the nutritional value of selected species, developing value-added products, and establishing a conservatory. A systematic survey was undertaken across all districts of Kerala, covering 40 locations, including tribal settlements. A total of 75 landraces and local varieties representing eight millet crops; sorghum, bajra, ragi, foxtail millet, barnyard millet, little millet, proso millet, and kodo millet as well as two pseudo-millets, chia and *Amaranthus* spp., were collected mainly from Palakkad and Idukki districts. The highest genotypic variation was observed in ragi (18 accessions), followed by foxtail millet (8 accessions). Considerable variation was also recorded in sorghum, bajra, little millet, barnyard millet, and proso millet. The survey also revealed that millet cultivation in Kerala has declined primarily



due to the spread of high-yielding varieties of rice, other crops, and plantation crops, coupled with low procurement prices. Climatic uncertainties and frequent crop damage by wild animals have further aggravated the situation. Considerable variation in yield was observed among the collected millet germplasm. Based on these yield differences, selected varieties and landraces were subjected to nutritional analyses, which revealed significant variation. Traditional and fermented food items were also developed. To conserve the millet germplasm collected across Kerala, the Onattukara Regional Agricultural Research Station Kayamkulam established an *ex vitro* conservatory on its campus. Occupying 4.5 cents of land, it currently houses 45 genotypes representing eight millets as well as two pseudo millets and serves as a millet museum for farmers, students, and the public.

Key words: Millets, database, ex vitro conservatory

01 TOP 02 Phenotypic diversity of eggplant and its wild relatives from Kerala, India

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ABSTRACT

Eggplant is an important solanaceous crop with substantial economic value and important model for understanding crop domestication. Phenotypic diversity of 49 accessions, including cultivars and wild relatives was done based on IBPGR descriptors. A total of 28 characters (both qualitative and quantitative) were analyzed for variability and genetic parameters like GCV, PCV, heritability, GA and GAM. Morphological characterization showed significant difference in both vegetative and reproductive characters. Among vegetative characters plant branching, no. of prickles on petiole and leaf prickles showed high variability as per coefficient of variation (39.58%, 32.84% and 28.16% respectively). Low variability was observed in leaf length (11.45%) and stem circumference (12.96%). In quantitative reproductive characters fruit pedicel thickness (17.74%) and fruit calyx length (16.47%) showed high variability and fruit calyx prickles (6.28%)

showed low variability among the characters studied. Correlation analysis revealed significant positive correlation among characters. Leaf length and fruit pedicel thickness correlated with more number of characters (6) while the plant breadth and fruit breadth positively correlated with a single character (plant height and fruit pedicel thickness respectively). UPGMA tree supports the domestication pathway from wild forms to cultivated eggplant through primitive intermediates. *Solanum incanum* and *S.violaceum* share ancestral traits and *S. nigrum* and *S. macrocarpon* were out grouped. The primitive cultivars (green with violet strips, long and many prickles) bridge wild (*S. incanum*) and cultivated varieties. The later introduction of stripping was indicated by later branching off of stripped cultivars. Loss of prickles and increased fruit size were also result of human influence on selection. The Principle Component Analysis (PCA) separate wild relatives from cultivated and the first two components together explained 42.68 % of total variation. Morphological characterization provides valuable information into phenotypic variability and identifies important traits for crop improvement.

Key words: Phenotypic diversity, Eggplant, Correlation, Domestication

01 TOP 03

Diversity and ecology of halictid bees (*Hymenoptera: Halictidae*) in Kerala

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ABSTRACT

Halictidae is the second-largest bee family (Ascher and Pickering, 2017) and functions as a pollinator across ecosystems. They are small, slender and predominantly ground-nesting insects. Despite the diverse agroecosystems in Kerala, there is little information on the diversity and ecological functions of halictid bee fauna present in the state. The study identified halictid bee genera, namely *Halictus*, *Lasioglossum*, *Seladonia*, *Sphecodes*, *Nomia*, *Hoplonomia*, *Gnothonomia*, *Lipotriches*, and *Psuedapis* from Wayanad, Thrissur and Thiruvananthapuram



districts visiting flora like *Mimosa pudica*, *Mikania micrantha*, *Alternanthera sessilis*, *Wedelia chinensis*, *Tridax procumbens*, *Cleome viscosa*, *Cleome rutidospermum*, and *Leucas aspera*. *Lasioglossum* sp. was found to collect pollen from coconut. *Seladonia* nests were found on land slopes beneath the cover of *Mimosa pudica*. Textural analysis by the international pipette method (Robinson, 1922) and aggregate strength analysis using Yoder's apparatus (Yoder, 1936) identified the soil at the nest site of *Seladonia* as clay loam with a mean weight diameter of 6.193 mm, which classifies it as 'very stable' as per the general stability classification by Kemper and Rosenau (1986). Such soil likely enables *Seladonia* to construct nests resilient to heavy rainfall. *Lasioglossum* sp. preferred lateritic soil for nesting, suggesting its suitability for deliberate colonisation. From field observations, it can be concluded that undisturbed lands covered with vegetation provide suitable nesting habitats for halictid bees. The nest of *Seladonia* opened directly outside and, upon dissection, was found to comprise 0.4 cm wide elliptical branching tunnels that terminated as brood cells. The newly constructed nests of *Lasioglossum* had a simple, unbranched 0.3 cm wide elliptical tunnel that ended in a terminal cell. Halictid bees belonging to nine genera were documented in this study. Field borders, buffer zones, shelter belts, and such undisturbed lands with natural vegetation offer habitats for conserving the diversity of halictid bees present in Kerala.

01 TOP 04

Genetic diversity assessment of off-season jackfruit (*Artocarpus heterophyllus* Lam.)

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ABSTRACT

Jackfruit (*Artocarpus heterophyllus*) is native to the rainforests of India. It is a monoecious species with thick white latex in all parts of the plant. With its origin in Western Ghats, the fruit has remarkable genetic diversity in the area, possibly

due to cross pollination and seed propagation. Evaluations of these germplasms for molecular characterization serves as a fundamental tool in identifying superior genotypes. Characterization of off-season bearing jackfruit types will enhance the availability of the fruit during “no jackfruit” days and farmers will get chances to earn more because off- season yield fetches higher price in the market. In this context, a study was conducted at the Department of Fruit Science, College of Agriculture, Vellayani, in 2024, with the objective of molecular characterization to estimate the genetic variation in offseason jackfruit accessions from Northern Kerala using (Simple Sequence Repeats) SSR and (Inter-Simple Sequence Repeat) ISSR markers. 30 selected accessions of off-season jackfruit from Kannur, Kozhikode, and Malappuram, were analyzed for genetic diversity using 20 SSR and 10 ISSR markers. All 10 ISSR primers were polymorphic, with PIC value is in the range of 0-0.5 most amplicons had molecular size in the range from 500 to 800bp. Only 16 SSR primers were found to be polymorphic, and most amplicons ranged in molecular size from 350 to 500 bp. The dendrogram representation classified the population into 2 major clusters and 4 subclusters, with maximum proximity between accessions KNR 3 and KNR 7. The Principal Co-ordinate Analysis (PCoA) showed distinct populations in 2 districts. Furthermore, 2 major clusters and 4 subclusters with admixture was observed in the population structure analysis. Overall, the analysis indicates moderate levels of genetic differentiation and common ancestry, possibly due to limited genetic mixing and less seed dispersal rates in the close geographic locations selected for the study.

Keywords: Genetic diversity, molecular markers, jackfruit, SSR, ISSR

01 TOP 05

Role of controlled desiccation in enhancing cryosurvival of Oil Palm embryos for long-term cryogenic conservation

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ABSTRACT

Cryobanking represents a frontier technology in the long-term conservation of plant genetic resources, providing an efficient, secure, and cost-effective



method to conserve biodiversity at sub-zero temperatures. For crops like oil palm (*Elaeis guineensis* Jacq.), where conventional seed or field genebanks have limitations due to recalcitrant seed behavior, large space requirements, pest and disease outbreaks or climatic extremes, cryopreservation offers a sustainable alternative. Through the cryogenic storage of pollen, embryos, tissues, or somatic cells, cryobanking ensures the maintenance of genetic integrity and viability over extended periods, enabling their use in breeding and restoration programs when needed. Preliminary studies were conducted at ICAR-IIOPR, RC, Palode to study the effect of kernal desiccation and embryo desiccation on the embryo viability after cryopreservation. Results showed that desiccation duration of kernels had a highly significant ($p < 0.01$) effect on embryo viability, indicating that the degree of desiccation influenced the survival of embryos after kernel drying. Before cryopreservation, the highest embryo viability (99.2%) was observed in fresh (non-desiccated) kernels, which was significantly superior to longer desiccation durations (1-5 hrs). After cryopreservation, the mean viability was highest (80.8%) in the longest desiccation (5 hr). The non-desiccated treatment completely lost viability after liquid nitrogen exposure. Kernel desiccation (1-5 hours) followed by embryo desiccation also showed a similar trend where highest viability (97.2%) was reported under the shortest desiccation duration (0 hr) before cryopreservation. Whereas non-desiccated embryos did not survive liquid nitrogen exposure confirming that high internal moisture leads to lethal freezing injury. Partial desiccation of kernels (1-2 hrs) provided limited viability (53%), while moderate to longer desiccation treatments (3-5 hrs) resulted in markedly higher post-thaw viability (71–80%). The study revealed that desiccation plays a pivotal role in determining the survival and post-thaw recovery of oil palm embryos during cryopreservation.

Keywords: Oil Palm, cryopreservation, embryo, viability, desiccation

01 TOP 06

***In vitro* Multiplication for Conservation and Sustainable Utilization of *Coleus vettiveroides* : An Endangered South Indian Polychrest Medicinal Plant**

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ABSTRACT

C*oleus vettiveroides* K.C. Jacob (Syn. *Plectranthus vettiveroides*), a member of the family Lamiaceae, is an aromatic perennial herb of considerable ethnomedicinal, pharmaceutical, and industrial significance. Endemic to South India, the species is listed as endangered and extinct in the wild in the Red Data Book and is prioritized for research and conservation by the National Medicinal Plants Board (NMPB). The plant is morphologically characterized by succulent, quadrangular, dark purple stems, opposite decussate leaves with purplish petioles and midribs, and profuse branching. Interestingly, flowers and fruits have not been reported from its natural habitat, and identification is based solely on vegetative characters, which often complicates accurate taxonomic authentication. In traditional Ayurvedic and Siddha systems, *C. vettiveroides* is widely used as a polychrest for several diseases. It has been used for treating fever, diarrhea, skin diseases, and liver disorders. The root essential oil possesses antipyretic, diuretic, antimicrobial, hepatoprotective, antioxidant, and vasorelaxant properties and serves as a key ingredient in more than 75 commercial herbal formulations, including Anu Thailam, Brahmi Thailam, and Dasamoolarishtam. Despite its high therapeutic potential, natural propagation is limited to stem cuttings, and destructive root harvesting causes 30–40% root loss per cycle. The species demands a specific agro-climatic habitat with sandy or sandy loam soil, continuous irrigation, and open sunlight, further constraining large-scale cultivation. The present investigation aims to develop a reproducible and efficient *in vitro* multiplication and conservation protocol for *C. vettiveroides*. The study focuses on optimizing surface sterilization, culture media, and plant growth regulator combinations for multiple shoot induction, *in vitro* rooting, and *ex vitro* acclimatization. The established protocol is expected to facilitate mass



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propagation, ensure a consistent supply of disease-free, genetically stable planting material, and support *ex situ* conservation of this pharmaceutically valuable and ecologically threatened species.

01 TPP 01

Assessment of Inter-Species Diversity in Sesame (*Sesamum* spp.) Germplasm Through Morphological Descriptors and D² Clustering

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ABSTRACT

Sesame (*Sesamum* spp.) is a crop of considerable economic and nutritional significance. It exhibits wide phenotypic and biochemical variability across its wild and cultivated relatives. The Onattukara region of Kerala harbours notable wild species diversity, including *S. malayanum*, *S. malabaricum* and *S. radiatum*, in addition to traditional and cultivated forms of *S. indicum*. The present study aimed to assess morphological and biochemical diversity among 27 sesame genotypes representing these four species. The field experiment was conducted during January 2022 in a randomized block design with three replications. Standard morphological descriptors, oil content, phenol content and lignan components were recorded, and genetic divergence was estimated using Mahalanobis D² statistics followed by Tocher's clustering. The genotypes were grouped into five distinct clusters, largely reflecting species-level differentiation. Cluster III exhibited the lowest intra-cluster distance (8.23), while the highest was observed in cluster II (14.46). Inter-cluster distances were markedly higher than intra-cluster values, indicating substantial divergence among species groups. Oil content emerged as the major contributor to total divergence, followed by phenol content, number of seeds per capsule and plant height, whereas number of nodes to first flower contributed least. Qualitative traits such as corolla colour, capsule hairiness and seed coat colour displayed clear species-specific patterns, strongly distinguishing wild species from cultivated types. A comparative inter-species evaluation revealed high phenol content and strong capsule hairiness in *S. radiatum*, higher sesamin

content in *S. malabaricum*, and superior 1000-seed weight, seed yield and oil recovery in cultivated *S. indicum*. The study highlights substantial morphological and biochemical diversity within Onattukara sesame resources, identifying clusters and species with desirable traits for future hybridization and sesame improvement programmes.

Keywords: Sesamum spp.; Genetic divergence; Mahalanobis D²; Morphological diversity; Biochemical traits

01 TPP 02

Characterisation of yield related Quantitative Traits in Grain Cowpea genotypes

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ABSTRACT

Cowpea (*Vigna unguiculata* (L.) Walp.) is a protein-rich legume widely valued for its adaptability, drought tolerance, and multipurpose use as a grain, vegetable, and fodder crop, making it integral to sustainable and diversified cropping systems. To evaluate the extent of variability in grain cowpea, a set of genotypes was assessed for thirteen yield-related traits, including days to 50% flowering, number of primary branches per plant, main stem length, number of pod clusters per plant, number of pods per cluster, number of pods per plant, pod weight, pod length, pod girth, number of seeds per pod, 100-seed weight, seed yield per plant, and crop duration. Data were subjected to analysis of variance to determine the significance of differences among genotypes. The results revealed substantial and statistically meaningful variability for all traits examined. Days to 50% flowering ranged from 30.66 to 60.66 days, and the number of primary branches varied from 2.78 to 6.15. Main stem length showed a wide range of 21.00-45.39 cm, while the number of pods per plant varied markedly from 8.03 to 21.87. Pod-related attributes, including pod length, pod weight, and number of seeds per pod,



exhibited considerable diversity, indicating differential genetic potential among the genotypes. The 100-seed weight ranged from 4.51 to 16.04 g, seed yield per plant varied from 11.07 to 32.91 g, and crop duration spanned 56.67 to 102.67 days. Overall, the study highlights significant variability in yield-related traits among the evaluated grain cowpea genotypes, offering a strong basis for identifying superior lines and contributing valuable information for breeding programmes aimed at enhancing yield potential and productivity in cowpea.

Keywords: Grain cowpea, Yield-related traits and Variability

01 TPP 03

Species Diversity and Genetic Resources of *Artocarpus*: Implications for Jackfruit Conservation and Crop Improvement

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ABSTRACT

The genus *Artocarpus* which belongs to family Moraceae, exhibits remarkable biodiversity, comprising both the cultivated jackfruit species and a wide range of wild and semi-domesticated relatives that contribute significantly to genetic, ecological, and agronomic resilience. The commonly cultivated jackfruit (*Artocarpus heterophyllus* Lam.) belongs to a diverse species complex that includes *A. integer* (chempedak), *A. hirsutus* (wild jack or 'aathi'), *A. altilis* (breadfruit), *A. lakoocha*, *A. nobilis*, and several lesser-known taxa distributed across South and Southeast Asia. These species display notable variation in fruit morphology, nutritional composition, phenology, stress tolerance, and adaptation to specific microclimates. Wild *Artocarpus* relatives represent a valuable reservoir of allelic diversity associated with disease resistance, abiotic stress tolerance, fruit quality traits, wood characteristics, ecological adaptability, and overall climate resilience. In regions such as the Western Ghats, a global biodiversity hotspot, the genetic

diversity of *Artocarpus* is particularly rich, with endemic species like *A. hirsutus* and *A. nobilis* playing essential roles in forest ecology and traditional agroforestry systems. Despite their ecological, nutritional, and breeding value, many wild *Artocarpus* species are increasingly threatened by habitat loss, fragmentation, overexploitation, and insufficient conservation measures. Strengthening their conservation through in situ protection, ex situ germplasm repositories, and molecular characterization is critical for safeguarding this genetic wealth. Exploring, documenting, and conserving the biodiversity of *Artocarpus* provides a strong foundation for jackfruit crop improvement programs, especially those aimed at enhancing climate resilience, broadening the genetic base of cultivated varieties, improving disease management, and supporting sustainable tropical food systems.

Keywords: *Artocarpus*, genetic diversity, germplasm conservation, crop improvement

01 TPP 04

Morpho-Biochemical Characterization of Pulasan (*Nephelium ramboutanake*(Labill.) Leenh.) Genotypes from Four Districts of Kerala

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ABSTRACT

Pulasan (*Nephelium ramboutan-ake*(Labill.)Leenh.), belonging to the Sapindaceae family, originally native to the Malay Peninsula, southern Thailand and parts of Borneo, has shown remarkable adaptability in Kerala. Over the past decades, it has become increasingly common in Kerala's homegardens, where the species performs vigorously under the state's humid tropical climate, indicating strong ecological compatibility and potential for wider cultivation. Despite its close cultural association with homestead systems and its high consumer appeal, scientific documentation of Pulasan diversity in Kerala remains limited. The present study aimed to assess the morpho-biochemical variability among Pulasan genotypes collected from four districts, namely Thiruvananthapuram, Kollam, Kottayam and



Pathanamthitta, to identify promising types for conservation and future utilization. A total of 30 genotypes were characterized for key fruit attributes, including fruit weight, dimensions, peel thickness, aril weight, edible portion, and seed traits. Biochemical parameters such as total soluble solids (TSS), titratable acidity, total sugars, reducing sugars, and ascorbic acid content were also quantified. Considerable diversity was observed across districts, with notable differences in sweetness (TSS), aril-to-peel ratio, and edible portion. Certain genotypes from Kottayam and Pathanamthitta exhibited superior consumer traits, including higher TSS and higher aril recovery. The study highlights the rich, yet undocumented, genetic diversity of Pulasan in Kerala's homestead ecosystems. Identifying elite genotypes provides a foundation for on-farm conservation, community nurseries and future crop improvement efforts, aligning with the goals of agrobiodiversity conservation and climate-resilient food systems.

Keywords: Pulasan, genetic variability, morpho-biochemical traits, underutilized fruit species

01 TPP 05

Assessment of morphological diversity and genome group association in *Musa* cultivars

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ABSTRACT

Banana (*Musa* spp.) is a crop of immense agricultural, nutritional, and cultural significance, especially in South India, where a wide range of traditional cultivars representing a valuable reservoir of genetic diversity, offering resilience against biotic and abiotic stresses. But the rich genetic resources are increasingly threatened by replacement of traditional cultivars with uniform, commercial varieties leading to genetic erosion and the gradual disappearance of locally adapted varieties. Documenting the morphological diversity of these cultivars is essential for their proper identification, conservation, and sustainable utilization. In the present study, fifty-seven banana cultivars representing different genome groups were analysed. The morphological characterization was based on IPGRI descriptors including both vegetative and reproductive characters. Considerable

variability was observed in both vegetative and reproductive traits viz., petiole margins, blotches, petiole canal, bunching pattern, male bud, male bract, flower, and fruit characteristics. Morphological traits clearly differentiated AA, AB, AAA, AAB, and ABB groups as revealed by the cluster analysis and principal coordinate analysis. The distinct phenotypic pattern recorded in this work highlight the rich genetic diversity across the cultivars and provide a scientific baseline for cultivar identification and conservation prioritization.

Keywords: banana, diversity, IPGRI descriptors, morphology

01 TPP 06

Reinforcing community seed systems through rootstock evaluation for sustainable conservation of the Kuttiattoor mango landrace

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ABSTRACT

Kuttiattoor mango, a GI-registered traditional landrace of North Kerala, represents a valuable reservoir of agrobiodiversity due to its distinctive flavour profile and characteristic orange-yellow pulp. Despite its cultural and nutritional significance, its conservation is constrained by biological limitations such as polyembryony, tall tree stature, prolonged juvenile period, and high susceptibility to mango nut weevil (*Sternochetus mangiferae*), making seed-based propagation inefficient and unsustainable. To promote long-term conservation and strengthen community-driven seed and planting material systems, the present study evaluated grafting performance on rootstocks with desirable traits such as dwarfing behaviour and abiotic stress tolerance. Four rootstocks - Vellaikolumban, Kurukkan, Kalapady and Kuttiattoor were tested under two propagation methods: softwood grafting



at 1, 2 and 3 months of rootstock age and epicotyl grafting at 7, 10 and 13 days of rootstock age. Results demonstrated that grafts with 3 months old Kuttiaattoor followed by Kalapady rootstocks recorded the highest graft success and graft growth parameters, whereas the lowest values was observed for grafts with 1 month old Vellaikolumban and Kurukkan rootstocks at 140 days after softwood grafting. The grafts with 7 days old Kalapady followed by Kuttiaattoor rootstocks recorded the highest graft success and graft growth parameters, whereas the lowest values were recorded in grafts with 13 days old Vellaikolumban followed by Kurukkan rootstocks at 90 days after epicotyl grafting. Histological studies validated the observed outcomes. The study underscores the potential of strategic rootstock selection to support the conservation and sustainable multiplication of the Kuttiaattoor landrace. By enhancing access to high-quality planting material, these findings contribute to strengthening community seed systems and safeguarding indigenous mango genetic resources for future farming generations.

Keywords : Kuttiaattoor, Vellaikolumban, Kurukkan, Kalapady, Softwood and epicotyl grafting

01 TPP 07

A Study on the Variability and Correlation in Okra [*Abelmoschus Esculentus* (L.) Moench] under different Fertilizer combinations

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Abstract

A statistically designed field experiment was conducted at the Experimental Plot of the Department of Botany, University of Calicut to study the variability and interrelationship of growth, yield and quality characters of okra (*Abelmoschus esculentus*) under different fertilizer applications. The variety taken for the study was Arka Anamika, and the data generated for this analysis were observations from different treatments such as control, organic, inorganic and a combination of both organic and inorganic fertilizers. A total of twenty eight quantitative characters were recorded and subjected to statistical analysis using descriptive statistics, analysis of variance, coefficient of variation and correlation analysis. Significant

differences were observed among all the treatments, indicating that fertilizer application induced considerable variability in okra. Leaf area exhibited the highest variability, while days to first flower showed the lowest, reflecting differences in trait responsiveness. Correlation studies revealed that characters such as plant height, leaf breadth and leaf area exhibited strong positive associations with several other traits, indicating the shared genetic influence and their suitability as selection indicators. These findings validate the statistical significance of the recorded data and highlight key characters that may play an important role in future breeding, fertilizer optimization and trait based selection studies.

Key words: *Abelmoschus*, okra, variability, ANOVA, correlation, fertilizer treatment

01 TPP 08

Safeguarding Wild Relatives of Crops from the Andaman & Nicobar Islands: The JNTBGRI Initiative

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ABSTRACT

Andaman & Nicobar (A&N) Islands situated in the Bay of Bengal is rich and diverse with 2314 angiosperm species. Geographic isolation, competition, limited gene pools and decreased outbreeding are characteristics of insular flora, which explains why 55% of all documented global extinctions have occurred on islands. The islands have exceptional plant genetic resources, including lesser-known wild relatives of major cultivars. Global island systems cover under 5% of terrestrial area yet host roughly a quarter of vascular plant endemics, supporting the livelihoods and cultures of islanders. This context underscores the urgency of *ex-situ* conservation. Jawaharlal Nehru Tropical Botanic Garden and Research Institute (JNTBGRI) initiated organized efforts since 1994 for the effective conservation of insular Wild Relatives of Crops (WRCs) outside the islands. Periodical explorations were conducted and the germplasm collected were introduced into JNTBGRI. Established plants were taxonomically evaluated and documented following flowering and fruiting. The FGB currently conserves over 190 insular taxa, with a



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Abstract

representation of 20 species of WRCs which includes fruits, spices, tuber crops, beverages etc. This *ex-situ* conservation strategy exemplified by JNTBGRI's FGB safeguards A&N Island's WRCs and preserves options for future livelihoods and cultural continuity. Scaling these efforts can fortify national agrobiodiversity security.

Keywords: Plant genetic resources, *Ex-situ* conservation, Agrobiodiversity, Spices, Medicinal and Aromatic Plants

01 TPP 09

Sustainable Mid-Storage Seed Treatment for Enhancing Seed Longevity in Rice (*Oryza sativa* L.)

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ABSTRACT

Seed quality tends to decline progressively with storage, which results in losses in viability, enzyme efficiency and the overall vigour, ultimately affecting field establishment and productivity. Mid-storage seed treatment has demonstrated effectiveness in countering the storage induced ageing by reducing early deterioration, enhancing germination and vigour, extending shelf life, and providing protection against pests and pathogens. The present study discusses the effectiveness of various mid-storage treatments on the seed quality parameters of five-month-old stored seeds of rice variety Manuratna. Stored seeds were subjected to six treatments – three single treatments namely hydration-dehydration(H-D), neem oil (NO), neem cake (NC), and three combination treatments namely hydration-dehydration plus neem oil(H-D+NO), hydration-dehydration plus neem cake (H-D+NC) and a neem oil and neem cake (NO+NC).The treated seeds were evaluated for seed quality and vigour were according to ISTA protocols.

All invigoration treatments demonstrated clear improvements in seed quality compared with the untreated control. Germination increased substantially after treatment, all maintaining germination above 94 per cent. Among the treatments H-D+NO recorded the highest germination per cent of 97.25 per cent which was an 2.91% increase from initial seed germination, followed by H-D and NO. Seedling vigour improved significantly, as reflected in higher SVI I and SVI II values in treated seeds. H-D+NO produced approximately 17% increase in SVI I and nearly 23% increase in SVI II over the control, while H-D+NC and NC alone also showed notable vigour improvements. Moisture content increased slightly in hydration-based treatments with H-D+NO and H-D reaching 11.12% and 11.11% respectively, compared to 10.89% in the control.

Keywords: Rice, Mid-storage seed treatment, Neem oil, Seed vigour

01 TPP 10

Biodiversity to Better Varieties: High-Performing Interspecific Capsicum Hybrids

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ABSTRACT

The conservation and strategic use of agrobiodiversity is central to strengthening community seed systems, particularly in crops like *Capsicum* that exhibit wide



species-level diversity. In this study, distinct genetic resources representing two key cultivated species—*Capsicum frutescens* accession IC208580 and five phenotypically diverse *C. annuum* genotypes (JNTBGRI 2, Unda chilli, AP-1, IC570376 and Pandalam local)—were identified, characterized, and utilized to generate interspecific F_1 hybrids. Harnessing this structured species diversity enabled the development of hybrid combinations with broadened genetic bases and improved agronomic potential. The F_1 hybrids demonstrated extensive phenotypic variability, validating the effectiveness of interspecific hybridization in mobilizing and expressing useful alleles from both species. IC208580 × Unda chilli (T_2) was the most vigorous hybrid, showing exceptional improvement in yield attributes with highest number of fruits per plant and greatest fruit yield per plant—far surpassing both parental means. IC208580 × AP-1 (T_3) also expressed strong heterosis, producing higher number of fruits per plant and superior fruit yield per plant. Trait-specific enrichment reflected successful introgression of species-specialized qualities: IC208580 × JNTBGRI 2 (T_1) accumulated the highest Vitamin A content along with high Vitamin C; IC208580 × IC570376 (T_4) expressed the maximum capsaicin and anthocyanin levels, showing strong potential for pungency-oriented improvement; and IC208580 × Pandalam local (T_5) recorded the highest carotenoid concentration, capturing desirable nutritional attributes. The clear differentiation among hybrids for yield, fruit quality, and bioactive compounds illustrates the powerful role of species identification and targeted use of *Capsicum* genetic resources. By effectively combining the unique strengths of *C. annuum* and *C. frutescens*, the study demonstrates how interspecific hybridization can operationalize agrobiodiversity into superior genetic materials. These high-performing F_1 hybrids offer valuable breeding stocks for future varietal development and serve as strong evidence that conserved agrobiodiversity, when strategically utilised, can reinforce resilient, diverse and farmer-empowered community seed systems.

Keywords: *Capsicum annuum*, *Capsicum frutescens*, species identification, agrobiodiversity, genetic resources, interspecific hybridisation, heterosis.

01 TPP 11

Effect of Natural Desiccants on Seed Longevity in Rice (*Oryza sativa* L.)

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ABSTRACT

Seed longevity plays an important role in agricultural productivity. Maintaining seed viability for extended durations is crucial for food security. Seeds deteriorate naturally over time as it gets affected by different factors such as temperature, humidity, and oxygen. A practical method to reduce this deterioration is by using desiccants, as these are hygroscopic materials which absorb moisture and create a favourable environment for storing seeds. Freshly harvested and dried paddy seeds of variety Jyothi were packed in polyethylene-lined gunny bags along with five desiccants such as charcoal, clay, pot pieces, saw dust and soil separately along with an untreated control. Seed quality parameters such as germination percent, seed moisture content, seedling vigour index I and II were recorded at first and third month of storage following the standard protocols (ISTA, 2009). Desiccant treated seeds showed better seed quality than untreated control. The treatment soil showed highest germination per cent of 93.66% at the end of storage with an increase of 3.66% from the initial month of storage. Moisture content decreased through the storage period and soil recorded the least (9.53%). Seeds stored with charcoal recorded high values for seedling vigour index I, at the end of third month, while seeds treated with soil recorded highest value for seedling vigour index II, with a 15.90% increase from the first to the third month of storage. Seed longevity improved by storing seeds with natural desiccants. Among the desiccants used in the study, charcoal and soil which are easily available to the farmers were found to



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A bstract

be the best options. Desiccants act by reducing moisture content of seeds during storage thus preventing seed infection, improve seed quality and longevity.

Keywords: Desiccants, rice storage, seed quality enhancement, seed longevity

01 TPP 12

Unlocking Conserved Diversity: Reproductive Barriers as Evolutionary Gatekeepers and Opportunities for Agrobiodiversity Use

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ABSTRACT

Reproductive barriers function as foundational evolutionary mechanisms that shape, maintain, and regulate agrobiodiversity across plant lineages. These intrinsic barriers, ranging from pollenpistil incompatibility and pollen tube arrest to endosperm imbalance, embryo abortion, hybrid sterility, and hybrid breakdown act as natural boundaries that prevent gene flow between divergent populations. By limiting hybridization, they promote species formation, ecological differentiation, and long-term genetic stability, thereby contributing to the structural richness of agrobiodiversity. However, the same mechanisms that protect species integrity also create significant constraints for agricultural systems that depend on broad, diverse, and resilient genetic resources. Many wild relatives conserved in gene banks or on-farm repositories carry valuable traits for abiotic and biotic stress tolerance, nutritional enhancement, and climate resilience, yet reproductive barriers restrict their effective introgression into cultivated crops. Understanding the genetic, cytological, and molecular bases of reproductive isolation is therefore essential for bridging the gap between biodiversity conservation and its practical utilization. Insights into self-incompatibility systems, gamete recognition pathways, endosperm balance dynamics, and sterility loci offer a scientific foundation for overcoming incompatibilities in a targeted and responsible manner. Classical breeding tools such as bud pollination, mentor pollen, mixed pollination, embryo

rescue, and chromosome doubling combined with modern innovations including omics-driven discovery and genome editing, now enable the strategic breakdown of reproductive barriers without compromising ecological or genetic integrity. These approaches transform conserved diversity into usable diversity, expanding crop gene pools, strengthening community seed systems, and contributing to long-term food and nutritional security. By framing reproductive barriers as both evolutionary gatekeepers and practical bottlenecks, this work highlights the importance of “conservation through use.” Responsible overcoming of incompatibility not only unlocks inaccessible genetic variation but also enhances the functional value of conserved germplasm, supporting more resilient agri-food systems in the face of global environmental change.

Keywords: Reproductive isolation, agrobiodiversity, conservation, intrinsic fertilization barriers, genetic resources, crop improvement.

01 TPP 13

Mapping the Morphological Diversity of Black Pepper (*Piper nigrum* L.) in Kerala: Insights for Breeding and Biodiversity Conservation

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ABSTRACT

The southern Western Ghats of India represent a primary centre of genetic diversity for black pepper (*Piper nigrum* L.), hosting diverse landraces and cultivars adapted to local agroecological niches. This key reservoir faces threats from habitat loss, changing land-use patterns, replacement by high-yielding varieties and recurrent drought stress. A comprehensive germplasm survey across Kerala's Agro-Ecological Units documented 62 genotypes, including landraces, cultivars and wild types, with peak diversity in Southern and Central Foothills and



Southern High Hills of Kerala. *In situ* IPGRI and DUS based characterization revealed marked morphological diversity in vine, leaf, spike and berry traits. Runner shoot tip colour varied from light green to light or dark purple, while lateral branch patterns were of three types-horizontal, semi-erect and hanging. Leaf lamina shapes spanned ovate, ovate-elliptic, ovate-lanceolate, cordate and elliptic-lanceolate forms, with leaf bases round, cordate or acute and margins even or wavy. Spikes exhibited straight or twisted forms with berry settings ranging from close to loose or medium-loose. Predominant traits included light purple shoot tips (62.90%), horizontal lateral branching (45.16%), short lateral branches (29.03%), few nodes per branch (50.00%), ovate-elliptic leaf lamina (40.32%), round leaf base (62.90%), even leaf margins (80.65%), short petioles (67.74%), medium leaf length (67.74%), medium leaf width (53.20%), straight spikes (83.87%), close berry setting (64.52%), medium-long peduncles (59.68%), short spikes (46.77%), many berries per spike (41.94%), many spikes per branch (46.77%), round berries (91.94%), medium berry size (61.29%), medium harvest maturity (72.58%) and medium bulk density (58.06%), from the plants surveyed. Hierarchical cluster analysis of 20 qualitative traits delineated four clusters, revealing inter- and intra-cluster variation. Distinct genotypes such as G-12, G-27 and G-60 showed unique morphological traits. The extensive diversity present in these genotypes highlights the urgency of conserving black pepper biodiversity and harnessing it effectively in breeding programmes.

01 TPP 14

Diversity of Solanaceae species in Kerala: morphological and biochemical insights

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ABSTRACT

The Solanaceae family comprises globally important vegetables, spices and medicinal crops such as tomato, brinjal, chilli, etc. Members of this family exhibit wide morphological, ecological and biochemical diversity, making them valuable for crop improvement and conservation. Kerala's diverse agro-climatic zones support several wild and cultivated Solanaceae family, yet systematic documentation of their diversity remains limited. A diversity survey was conducted across major

districts of Kerala, including Wayanad, Idukki, Palakkad, Thrissur, Malappuram, Kozhikode, Kannur, and Pathanamthitta. Thirteen species and landraces belonging to *Solanum* and *Capsicum* were collected and characterized for key morphological traits such as plant height, leaf and fruit morphology, and seed count. Preliminary biochemical parameters, including DPPH antioxidant assay, total phenol and flavanoid content were also assessed following standard protocols. The highest species richness was recorded in Wayanad, followed by Idukki and Palakkad. *S. torvum*, *S. violaceum*, and *S. viarum* were majorly found in Wayanad, while *C. annuum* and *C. frutescens* were widely distributed. Morphological characterization revealed broad variation in plant height (33.5–216.0 cm), fruit length (0.67–82.39 cm), and fruit weight (0.27–20.80 g). Leaf shapes ranged from ovate to strongly lobed, and flower colours varied from white to violet. *S. torvum* exhibited the tallest growth, whereas *S. macrocarpon* and Cheruvazhuthana recorded the highest seed numbers (>800 per fruit). Biochemical characterization showed considerable variation in total phenolics (1.25–6.80 mg GAE/g FW), flavonoids (0.45–3.92 mg QE/g FW), and ascorbic acid content (5.6–38.4 mg/100 g FW) among the accessions, reflecting their diverse nutritional potential. The study highlights the substantial inter- and intraspecific diversity within Solanaceae species in Kerala. The observed morphological and biochemical variability provides a strong foundation for future breeding, conservation, and utilization of these valuable genetic resources.

Keywords: *Solanum* sps., species diversity, biochemical characterisation, *Capsicum* sps.

01 TPP 15

Assessment of Morphological Diversity and Genetic Relationships among Cowpea Accessions from Kerala

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ABSTRACT

Agriculture plays a crucial role in ensuring food security and sustaining human life. Strengthening crop improvement programs is vital to meet the increasing food demand under changing climatic conditions. Developing elite, stress tolerant, and high-yielding genotypes can significantly enhance agricultural productivity, sustainability, and resilience. Cowpea (*Vigna unguiculata* (L.) Walp.), a protein-rich legume often referred to as the ‘poor man’s meat’, plays a vital role



in food and nutritional security owing to its ease of cultivation, adaptability to marginal environments, and high nutritive value. In the present study, a total of 44 cowpea accessions—including landraces, improved varieties, and wild *Vigna* species—were collected from diverse locations across Kerala. Ten replicates of each accession were raised in pots arranged in a Randomized Block Design (RBD) at the Calicut University Botanical Garden (CUBG). Comprehensive morphological characterization was performed by recording both vegetative and yield traits using IBPGR descriptors, and the resulting data were analyzed using appropriate statistical tools. Correlation analysis was used to assess relationships among traits, while cluster analysis and principal component analysis (PCA) revealed genetic relationships and grouping patterns among the accessions. The clustering pattern showed a clear separation between wild and cultivated groups. Analysis of variance (ANOVA) indicated significant variation among genotypes for most traits. Estimates of phenotypic variance, genotypic variance, and heritability demonstrated that seed length exhibited the highest heritability among the traits studied. Overall, the study revealed substantial genetic and morphological variability among the accessions. Accessions exhibiting desirable morphological traits may serve as valuable genetic resources for future cowpea improvement programs.

Key words: Cowpea, genetic variability, morphology, *Vigna unguiculata*

01 TPP 16

Effects of Salt Stress on Morphology and Nutritional Composition of (*Pennisetum glaucum* (L.) R. Br.) Microgreens

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ABSTRACT

Mitigating hunger in the face of a growing global population and accelerating climate change is a major challenge for agriculture. Climate-resilient crops such as millets are gaining importance for both sustainability and nutrition. Pearl millet (*Pennisetum glaucum* (L.) R. Br.), the sixth most important cereal after rice, wheat, maize, barley and sorghum, is a traditional staple in arid and semi-arid regions of Asia and Africa. The present study was undertaken with two main

objectives: first, to compare the nutritional profile of wild pearl millet grains with that of commercially available (market) grains; and second, to assess the salinity tolerance of the wild type by evaluating its germination, growth performance and microgreen nutritional responses under varying concentrations of NaCl. For this purpose, wild pearl millet seeds were treated with NaCl solutions of 20, 40, 60 and 80 mM, and germination percentage and seedling growth parameters (root length, shoot length and total seedling height) were recorded on the 7th, 14th and 21st days after germination. Under salinity, the nutritional composition and antioxidant activity of microgreens were analyzed, Comparison of the nutritional profiles of wild and market seeds revealed that wild pearl millet grains were superior to market grains in terms of total protein, phenols, flavonoids, antioxidants and proline content. Salinity stress experiments showed that germination percentage and growth parameters decreased with increasing salt concentration, although certain stress adaptations were evident at later growth stages. In microgreens, salinity stress led to a decline in protein content but significantly increased phenol, flavonoid, antioxidant and proline levels, indicating that salt stress triggers the synthesis of protective compounds and enhances stress tolerance. Overall, the findings highlight the potential benefits of pearl millet microgreens under mild to moderate salinity conditions and underscore the nutritional and functional advantages of wild pearl millet grains over commercially available grains.

Key words: Millets, Microgreens, Pearl millet, Salinity stress

01 TPP 17

Harnessing Native Diversity: Grain Trait Profiling of Wayanad Rice Landraces for Sustainable Breeding and Health Promotion

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ABSTRACT

Wayanad, a distinctive agro-ecological zone in the Western Ghats of Kerala, is a hotspot of rice genetic diversity, preserving numerous traditional landraces cultivated for generations. In this study, grain characteristic features of 75



Indigenous rice landraces were systematically evaluated to document the extent of diversity and to strengthen ongoing conservation and crop-improvement efforts. These landraces exhibit remarkable variability in grain length, width, colour, awn presence, and 100-grain dry weight, reflecting their long-term adaptation to diverse microclimates and farmer-selected traits. At the College of Agriculture, Vellayani, *ex situ* conservation and detailed grain-trait profiling revealed substantial differences among cultivars such as Chomala, Gandhakasala, Kalladiyaryan, Njavara, Japan Violet, Kanali, and several Basmati types. Grain lengths ranged from 0.5–1.4 cm, widths from 0.2–0.5 cm, and 100-grain dry weights from 1.10–3.32 g, demonstrating the wide morphological spectrum within the collection. This diversity serves as a critical genetic reservoir for breeding programs aimed at improving aroma, yield potential, resilience to biotic and abiotic stresses, and nutritional quality. Notably, many traditional landraces are rich in bioactive compounds, antioxidants, minerals, and dietary fibre, contributing to the prevention and management of lifestyle diseases such as diabetes, hypertension, cardiovascular disorders, and obesity. The preservation and utilization of these nutrient-dense varieties are therefore vital not only for genetic enhancement but also for promoting health-oriented diets. In the context of habitat loss, changing climate, and declining cultivation of traditional crops, the conservation of these 75 rice landraces is indispensable. The present grain-trait documentation highlights the immense genetic wealth embedded in Wayanad's rice heritage and underscores its significance for future breeding, nutritional security, and sustainable agriculture.

01 TPP 18

Exploring the diversity of underutilised bananas in Kerala for sustainable utilisation

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ABSTRACT

India is a major centre of banana biodiversity, with Kerala representing a key region rich in diverse edible cultivars. However, cultivation is largely dominated by the Nendran (AAB) cultivar, resulting in a monotypic situation that increases vulnerability to pests, diseases, and genetic erosion. Therefore, it is essential to broaden the genetic base of the crop and safeguard the existing genetic resources through the exploration, conservation, and utilization of the underutilized varieties. The present study focuses on the documentation, nutritional evaluation,

and value addition of underutilized banana varieties from different districts of Kerala. From August 2023 to November 2024, extensive field surveys were conducted across nine districts of Kerala. Farmers' fields were primarily visited to document native banana cultivars through semi-structured interviews with farmers and local informants, complemented by direct field observations. The districts covered included Wayanad, Malappuram, Kozhikode, Ernakulam, Thrissur, Kasaragod, Kannur, Palakkad, and Kollam. Data were generated on 57 native and 23 exotic cultivars. Morphological characterization of the documented cultivars was performed based on the minimum set of *Musa* descriptors developed by INIBAP (1996). A total of 31 qualitative traits, comprising 22 reproductive and 9 vegetative characters, were evaluated. Extensive morphological diversity was recorded among the banana cultivars in pseudostem height, colour, and blotching pattern, as well as in petiole canal shape and bunch orientation. Floral traits such as bract apex, tepal, anther, and stigma colour exhibited wide variation, while fruit shape and apex form also differed considerably, highlighting the rich phenotypic variability present among the studied cultivars. Nutritional profiling of 70 cultivars revealed considerable variation in total phenolic and flavonoid contents of both pulp and peel. Additionally, protocols were standardized for soap preparation using banana fruit extracts and paper production from pseudostem fibres, with quality evaluations confirming the standard and usability of the developed products.

Key words: Banana, diversity, Kerala, morphology, value addition

01 TPP 19

Evolving Methodologies in Seed Shape Quantification: Bridging Geometry and Machine Vision

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ABSTRACT

Seed shape is a key morphological trait essential for plant identification, classification, and understanding ecological adaptation. With increasing emphasis on precision agriculture and accurate species characterization, seed shape quantification has emerged as an important tool in seed science, taxonomy,



and plant breeding. Advances in this field range from simple geometrical modelling methods to sophisticated machine-vision and deep-learning techniques. Seed morphology, particularly seed shape, provides critical information for phenotypic characterization and taxonomic differentiation. Quantifying seed shape involves extracting measurable geometric or structural parameters to support species identification, distinguish closely related genotypes, evaluate environmental impacts on seed development, and ensure varietal purity. Early quantification methods used standard geometrical models such as cardioid, oval, ellipse, Fibonacci spiral, heart-shaped, and lens shapes to represent natural seed outlines. The J-index, which measures similarity between seed images and geometric models, enables standardized comparison across species. These simple, cost-effective methods have proven useful in diverse plant families and ecological studies. Modern machine vision systems have significantly improved accuracy and efficiency in seed shape analysis. By combining cameras, sensors, and image-processing software such as MATLAB, these systems extract morphological, colour, and textural features from digital images with minimal human intervention. They provide rapid, non-destructive assessment and reduce sampling errors, making them valuable for seed quality evaluation and varietal purity testing. SmartGrain, a specialized image-analysis tool, further automates parameter extraction such as seed length, width, area, perimeter, and shape ratios, enabling high-throughput phenotyping. Applications of seed shape quantification extend to seed purity testing, vigour assessment, germination studies, ecological strategy analysis, and environmental stress evaluation. Case studies highlight its usefulness in classifying paddy seeds, assessing Cucurbitaceous seed diversity, and heat-stress effects in wheat. Future advancements will likely integrate artificial intelligence, deep learning, and large-scale seed image databases to support automated seed identification and improved seed quality management.

Keywords: Seed shape, seed shape quantification, Software used for seed shape quantification

01 TPP 20

Biopriming-Induced Improvements in Seed Quality Attributes of Rice (*Oryza sativa* L.)

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ABSTRACT

Seed priming is an effective approach to improve physiological seed quality, germination efficiency, and early vigour. Biopriming with beneficial microbes enhances metabolic activity, speeds up germination, and promotes stronger seedling establishment. Assessing the response of rice cultivars to different priming agents is crucial for identifying economical options that boost overall seed performance. Freshly harvested Manuratna rice seeds were subjected to various priming treatments, including *Pseudomonas fluorescens*, coconut water, *P. fluorescens* + *Trichoderma viride* + coconut water, hydropriming, and untreated controls under both wet and dry conditions. Baseline seed quality was recorded before treatment. Post-priming, seed quality attributes including germination, root and shoot length, and seedling dry weight were assessed. Vigour indices (SVI-I and SVI-II), mean germination time, time to 50% germination, and speed of germination were subsequently calculated. Initial seed quality assessment indicated a germination of 91.50%, with corresponding vigour indices of 2452 (SVI-I) and 1647 (SVI-II). Post-treatment evaluation showed that the combination biopriming exhibited the most favourable response, achieving higher germination (93.50%), increased shoot (6.39 cm) and root length (12.40 cm), and an improved vigour index I compared with hydropriming. Dry treatment with *P. fluorescens* also enhanced germination (91.00%), total seedling length, dry matter accumulation, and vigour indices, in contrast, untreated control seeds recorded the lowest germination and exhibited delayed physiological activation. Regarding germination kinetics, *P. fluorescens* treatment markedly improved performance, reflected by a reduced mean germination time (2.90 days), quicker achievement of 50% germination, and the highest speed of germination relative to the control. The investigation revealed



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Abstract

that bio-priming markedly improved seed quality, vigour, and germination efficiency. Overall, seed priming exerted a positive influence on germination rate, metabolic activation, and subsequent seedling growth, underscoring its effectiveness as a practical, low-cost, and farmer-friendly strategy for enhancing seed performance in rice.

Keywords: Bio-priming, hydropriming, *Pseudomonas fluorescens*, *Trichoderma viride*

01 TPP 21

Biochemical diversity assessment of cochin ginger (*Zingiber officinale* Rosc.) genotypes

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ABSTRACT

Cochin ginger (*Zingiber officinale* Rosc.), a traded ginger variety known internationally is cultivated in central districts of Kerala, India. It is prized for its aromatic, lemony, and gently biting or pungent, with a rich, balanced heat that makes it versatile for culinary uses. An attempt was made to screen the cochin ginger genotypes from central zones of Kerala and analyse them for variability. Twenty eight ginger genotypes were analysed for their biochemical constituents, such as oleoresin and essential oil. Considerable variations were found among the genotypes for oleoresin and essential oil content. In the present study, genotypes CG 9, CG 28, CG 47 and CG 52 had oleoresin content ranging from 9.4 to 8.5 %, indicating high oleoresin content. The lowest oleoresin content was observed in CG 35 (4 %). The mean oleoresin content among the genotypes was 6.15 % with a standard deviation of 1.44. In the present study, essential oil content ranged from 2.9 % in CG9 to 1 % in CG 32. CG 13, CG 47 and CG 57 cultivars had high essential oil contents of 2.8 %, 2.7 % and 2.6 % respectively. In case of crude fibre content, lowest fibre content was found in CG 9 (3.1 %). Highest fibre content of 11.3 % was observed on CG 52. The mean fibre content among the genotypes was 6.25 %. Further evaluation using techniques like GC-MS will give more insights towards the

important active ingredients like zingiberene, sesquiphellandrene, citronellal *etc.*

Keywords: Diversity, essential oil, Fibre, Ginger, Oleoresin, Spices

01 TPP 22

Folk Rice of Kerala as Custodian Varieties: A Case Study on Nutritional and Industrial Trait Diversity

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ABSTRACT

Kerala's folk rice landraces constitute a critical reservoir of genetic variability, maintained through long-term community stewardship. This study characterizes a representative set of traditional varieties to quantify nutritional and industrial trait diversity relevant to value addition and germplasm utilization. Morphometric assessment combined with biochemical profiling revealed pronounced inter-genotypic variation in bran oil content, γ -oryzanol concentration, tocol fractions, and antioxidant potential. Several landraces exhibited superior nutraceutical attributes and elevated oilyield, underscoring their suitability as donor genotypes for functional food development and biochemical trait introgression. Multivariate and cluster analyses delineated distinct diversity groups, reaffirming the heterogeneity embedded in these farmer-preserved genetic resources. The results emphasize the role of Kerala's folk rice as "custodian varieties," harbouring adaptive, nutritional, and industrially significant alleles. Strengthening their conservation, characterization, and incorporation into breeding pipelines can enhance agrobiodiversity-based resilience, and support sustainable agri-food system transitions in biodiversity-rich regions. Strengthening the conservation, documentation and scientific utilization of Kerala's folk rice germplasm will enhance community agrobiodiversity management, promote farm-level value addition and contribute meaningfully to regional goals of food, nutrition and livelihood security within biodiversity-rich production landscapes.



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Abstract

Keywords:- Folk rice; Custodian varieties; Nutritional diversity; Bran oil; Genetic variability; Agrobiodiversity conservation.

01 TPP 23

Characterization of Transplanted Finger Millet using Morpho-Physiological Traits in Summer

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ABSTRACT

Finger millet (*Eleusine coracana* L.), commonly known as ragi, is a self-pollinated minor millet valued for its resilience and adaptability to diverse agro-ecologies across tropical and subtropical regions of Asia and Africa. The present study was carried out at the Small Millets Research Farm, Dr. RPCAU, Pusa, to assess the morphological and seed physiological variability in 144 locally collected genotypes along with three check varieties—RAU-1, GPU-67, and VL-376—during the summer seasons of 2022 (Season 1) and 2023 (Season 2). The experiment was conducted using an Augmented Block Design. Ten quantitative morphological traits and three seed physiological parameters were recorded. Significant variability was observed among the genotypes for all traits. Grain yield exhibited significant and positive correlations with days to 50% flowering, days to maturity, finger length, finger width, ear length, fingers per ear, plant height, number of basal tillers, productive tillers per plant, and 1000-grain weight across both seasons. Path analysis revealed that finger length, fingers per ear, number of basal tillers, and 1000-grain weight exerted positive direct effects on grain yield in both years. Seed physiological evaluation indicated that genotypes RAU-FM-Sheohar-2009-19 (987.0) and RAU-FM-Sheohar-2009-9 (964.9) recorded the highest seed vigour index I, while RAU-FM-83 (1.271), RAU-FM-Gopalganj-2009-5 (1.144), and RAU-FM-93 (0.960) exhibited superior vigour index II. Most genotypes showed 100% germination. RAU-FM-82 displayed a speed of germination comparable to the checks and also

performed well for plant height. RAU-FM-100 exhibited rapid germination as well as favourable values for days to 50% flowering and maturity. Although none of the genotypes surpassed the checks for grain yield, several outperformed them for other agronomic and physiological traits under summer conditions. These promising genotypes can be further evaluated across more summer seasons and utilized as donor parents in pre-breeding programs aimed at finger millet improvement.

Keywords: Finger millet, Morphological traits, Seed vigour, Correlation, Path analysis, summer season.

01 TPP 24

From traditional wisdom to modern practice: medicinal plant integration in Kerala's Agroforestry

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ABSTRACT

Homegardens, the dominant agroforestry practice in Kerala, integrate a dense, multi-strata mixture of agricultural crops, trees, and livestock, structurally mimicking a tropical rainforest. The system is subsistence-based and managed by family members. Given Kerala's immense floristic diversity (4,694 plant species, 1,170 with medicinal value), a study was undertaken to document the medicinal plant diversity and structure of these homegardens. Results revealed a remarkable diversity, recording 452 medicinal plant species across four growth forms: 144 herbs, 106 shrubs, 66 climbers, and 136 trees. This high diversity and multi-layered vegetation structure reflect a deep-rooted traditional knowledge system, interlinking health, nutrition, and ecological balance. Beyond providing essential household resources (food, fodder, fuelwood), these species ensure the availability of traditional remedies and strengthen local healthcare resilience. Therefore, documenting and promoting these homegarden systems is vital for sustaining medicinal plant diversity and supporting rural livelihoods in a changing socio-ecological context.

01 TPP 25

Genetic Safeguarding of Wild Fruit Species for Sustainable Horticultural SystemsNikitha Priya K. T.^{1*}, Simi. S.¹ and Manju. P. R.¹¹Department of Fruit Science, College of Agriculture, Vellayani, Thiruvananthapuram, Kerala, India

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ABSTRACT

Crop wild relatives (CWRs) of tropical fruits are vital sources of genetic diversity, supporting global food and nutritional security. Their adaptive traits ranging from tolerance to drought, salinity, flooding, heat, pests, and diseases make them essential for developing climate-resilient fruit varieties. Species such as *Psidium friedrichsthalianum*, *Vasconcellea quercifolia* and *Mangifera gedeba* provide valuable stress-tolerance genes and also serve as rootstocks offering dwarfing, salinity, flood tolerance and superior waterlogging resistance. However, rapid habitat loss, genetic erosion, and environmental change are driving many CWRs towards vulnerability or extinction, highlighting the urgent need for effective conservation measures. IUCN data indicate that over one-third of fruit wild relatives, including *Mangifera nicobarica* and *Musa argentea*, are threatened with extinction. Hence, both *in situ* and *ex situ* conservation strategies are vital for long-term conservation. *In situ* conservation through gene sanctuaries and biosphere reserves such as the Garo Hills (wild *Citrus*) and Great Nicobar (*Mangifera camptosperma* and *Musa sabuana*) protects species in their natural habitats. *Ex situ* methods, including field gene banks, cryobanks, and *in vitro* repositories, preserve species outside their habitats. ICAR-NBPGR conserves more than 13,000 fruit accessions, including many wild species, while advanced cryo-techniques support long-term storage of sensitive germplasm like *Artocarpus*, *Litchi*, and *Prunus*. Conserving wild relatives of fruit crops is essential for crop improvement and climate resilience. Integrated *in situ* and *ex situ* conservation, supported by inventories, biotechnology, and collaboration, is vital to safeguard the genetic resources for sustainable horticulture.

Keywords: Biodiversity, *in situ*, wild relatives, horticulture, conservation, fruits, sustainability

01 TPP 26

Physico-chemical characterisation of native mango (*Mangifera indica* L.) germplasm of southern Kerala: Implications for agrobiodiversity conservation and utilisation

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ABSTRACT

Kerala is endowed with a rich repository of traditional mango germplasm maintained largely in homestead ecosystems. These landraces contribute significantly to regional agrobiodiversity and nutritional resilience. Systematic characterisation of these landraces is essential for documentation of trait variability, conservation and utilisation for crop improvement and value addition. Attempts were made at the Department of Fruit Science, College of Agriculture, Vellayani to characterize the native mango germplasm in different parts of southern Kerala based on morphological characters as well as quality traits and to establish a field gene bank of superior types. The results of physico-chemical analysis of thirty native mango varieties/ accessions is presented here. Wide variability was observed in fruit morphological characters like fruit length, width, thickness and weight as well as in quality traits like TSS, total and reducing sugar, titrable acidity, total carotenoids, ascorbic acid and crude fibre content among the different landraces. Fruit length was the highest in Kulathoor konam Local (20cm) and the lowest in Pandalam Local-3 (5.44cm). Njettukuzhiyan excelled in fruit width (10.33cm) and thickness (7.91cm). Fruit weight varied between 30.52g (Shoolamkudi) and 597.42g (Kamaleswaram Local). TSS ranged from 9.0 in Nilakkal Local to 22 in Kamaleswaram



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Abstract

Local. Anchalumoodu Local recorded the highest total carotenoid content while Pandalam Local-1 recorded the highest ascorbic acid content. Among the accessions, the crude fibre content ranged from 0.859% (Kasthuri) to 2.68% (Thakaraparambu Local).

Keywords: Biodiversity, mango, *Mangifera indica*, landraces, conservation, field gene bank, physico-chemical, characterisation

THEME II

AGROECOLOGICAL TRANSITIONS AND SOIL HEALTH & CLIMATE RESILIENCE AND ECOSYSTEM RESTORATION IN AGRICULTURE

Genome Editing for Sustainable Management of Genetic Diversity for Climate Resilience, and Food and Nutrition Security

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Genetic diversity forms the foundation for developing climate-resilient crops and ensuring long-term food and nutrition security. Despite extensive conservation of crop diversity in the form of plant genetic resources (PGRs) in national and global gene banks, their sustainable and effective utilization in crop improvement remains a major challenge. These conserved germplasm collections harbour vast, largely untapped genetic variation, including genes and alleles conferring tolerance to drought, heat, salinity, pests, and diseases, as well as traits for enhanced nutritional quality. A transformative shift in the utilization of PGRs is essential to address emerging challenges posed by climate change and resource constraints. CRISPR-based genome editing has emerged as a powerful and precise tool to harness this genetic diversity by enabling targeted modification of key genes and precise introgression of favourable alleles without compromising the existing essential agronomic traits. When integrated with high-resolution genomic resources, including pangenomes and super-pangenomes derived from thousands of sequenced crop germplasm accessions, genome editing enables strategic improvement of complex traits such as water- and nitrogen-use efficiency, carbon sequestration potential, and overall climate resilience. Genome editing thus offers a robust pathway for the sustainable management and functional utilization of genetic diversity, creating new opportunities to enhance agricultural productivity, resilience, and nutritional quality. This integrated approach holds significant promise for ushering in an evergreen revolution aligned with global sustainability and food security goals.

Cultivating Carbon and Communities in Soil to Build Resilient Cropping Systems

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Soil organic carbon (SOC) and soil microorganisms are central to the functioning and resilience of agricultural ecosystems. Soils represent the largest terrestrial reservoir of organic carbon, and its stabilization is strongly governed by microbial processes that regulate carbon transformation, storage, and loss. Diverse and active microbial communities drive nutrient cycling and enhance plant–soil interactions that support crop productivity and stress tolerance. Management practices that increase carbon inputs such as reduced tillage, diversified crop rotations, cover cropping, and organic amendments can stimulate microbial diversity and activity, leading to improved carbon use efficiency and greater SOC formation and stability. In turn, microbially mediated carbon stabilization enhances soil structure, water holding capacity, and resistance to erosion, drought, and extreme weather events. However, in warm and humid agroecosystems, rapid residue decomposition can limit long-term carbon storage, underscoring the need to understand the best management practices that can support SOC storage over loss. Integrating knowledge of carbon–microbial diversity interactions into cropping system design offers a pathway to build resilient agroecosystems that maintain productivity while adapting to climatic variability.

Covering the Green Revolution’s Blind Spot: Ecological Intensification for Agroecosystem Stability

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The Green Revolution transformed Indian agriculture by substantially increasing food production through high-yielding varieties, mechanization, intensive tillage, and chemical inputs. While these interventions ensured food security,

Lead Talk



they reconfigured farming systems by displacing key ecological functions. As a consequence, intensively farmed systems have become increasingly dependent on external inputs to maintain stability. In the rice-wheat systems of northern India, this transformation has contributed to the widespread practice of crop residue burning, a time-saving response to mechanized harvesting and short cropping windows. Residue burning has emerged as one of the most damaging environmental legacies of post-Green Revolution intensification, causing severe air pollution, adverse human health impacts, soil nutrient depletion, and disruption of agroecosystem functioning. The paper presents a synthesis of global studies demonstrating that residue burning disrupts detrital energy pathways, suppresses decomposer and predator communities, alters pest regulation, and weakens soil biological processes essential to long-term productivity. Conservation agriculture (CA) has been promoted as a sustainable alternative, emphasizing reduced soil disturbance, residue retention, and crop diversification. It is expected to improve ecosystem health while maintaining yields. However, large-scale impacts of CA have remained limited in India, with adoption often partial and discontinuous. A global meta-analysis conducted by the author, synthesizing biodiversity responses across conservation tillage systems, shows that agrobiodiversity responses are generally positive but modest, highly context-dependent, and contingent on residue retention, long-term management, and climatic conditions. Zero tillage alone delivers weak or inconsistent ecological benefits, while the strongest gains occur when residues are retained and management continuity is maintained. These findings help explain why partial adoption of CA has failed to reverse the ecological damage associated with residue burning. Concerns regarding pest outbreaks during early adoption of zero tillage reflect the mismatch between short-term farmer risk horizons and the slower recovery of ecological processes. Technology-led approaches must be complemented by incentive mechanisms that explicitly value ecosystem services. Integrating agrobiodiversity into carbon market frameworks can reduce residue burning, compensate farmers for transition risks, and strengthen incentives for sustained adoption of conservation agriculture. Recognizing agrobiodiversity not as a co-benefit but as core ecological infrastructure is essential for addressing the unresolved environmental legacy of the Green Revolution in India.

02 TOP 01**Microbial diversity and its functional role in sustaining soil health of Kaipad coastal wetlands****Sanju Balan¹, P. P. Rajeshkumar², Chitra N.³, and T. Vanaja²**¹Pepper Research Station, Panniyur, Kerala-670142²Regional Agricultural Research Station, Pilicode, Kasaragode - 671310³College of Agriculture, Vellayani, Thiruvananthapuram- 695020

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ABSTRACT

The Kaipad region of North Kerala represents a unique salinity-prone coastal wetland system occurring as small patches along the coastal tracts of Kannur, Kozhikode, and Kasaragod districts. The Kaipad system of rice cultivation is an integrated organic farming practice that combines rice cultivation with aquaculture. It is influenced by a network of brackish waters and estuaries that permit seawater intrusion, resulting in seasonal salinity. This ecosystem supports rich biodiversity, including phytoplankton and marine microbial population, which play crucial roles in the decomposition of organic matter and nutrient recycling. Since microbial diversity is closely linked to nutrient and biogeochemical cycling, the present study was undertaken to investigate the microbial diversity in the rice-growing tracts of the Kaipad soil ecosystem located at Ezhome (12.0401° N, 75.2975° E) in Kannur District, Kerala. The findings provide valuable insights into the functional ecology and sustainability of the Kaipad ecosystem. Soil samples collected from Ezhome Kaipad were characterized to determine their physicochemical properties, and metagenomic analyses were performed to assess microbial diversity and associated metabolic pathways. The physicochemical analysis revealed that the soil pH was slightly acidic, ranging from 6.16 to 6.54, while electrical conductivity (EC) indicated moderately to strongly saline conditions (7.20–13.20 dS/m). The organic carbon content varied between 0.18% and 1.59%. Metagenomic analysis showed high bacterial richness, dominated by the phyla Proteobacteria, Firmicutes and Bacteroidetes. Diversity indices, including Simpson's, Shannon's (H'), and Chao1 richness estimators, revealed a highly diverse and functionally significant microbial community. KEGG functional gene annotation identified 41 distinct metabolic pathways, reflecting the broad functional diversity and metabolic potential of the Kaipad soil microbiome. Ecologically, these findings indicate that Kaipad soils

harbour a diverse and well-balanced bacterial community characterized by high richness and evenness attributes, that are vital for maintaining soil health and enhancing ecosystem stability and resilience to environmental fluctuations.

Key words: Kaipad, microbial diversity, metagenomic analyses, diversity indices, soil health

02 TOP 02

Multi-trait & multi-index assessment of diverse Pan-Indian rice germplasm reveals novel salt-tolerant landraces with distinct Saltol haplotypes and gene expression signatures

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ABSTRACT

Salinity stress imposes severe limitations on rice productivity, necessitating a mechanistic dissection of tolerance traits for robust identification of elite



donors. We collected an extensive array of 335 genotypes from inland and coastal saline tracts across India. The tolerance potential of this diverse germplasm was evaluated at the seedling stage under moderate (8 dS m⁻¹) and high (12 dS m⁻¹) salinity stresses. Systematic trait-based screening was conducted using 13 morpho-physiological and 7 ionic parameters under control and stress conditions. Salt tolerance indices (STI) derived from these traits were subjected to principal component analysis. Biomass-related traits clustered together and diverged from linear growth traits, across both stress levels. Using the principal component traits thus identified, mean membership function values (MMFV) and Multi-trait Genotype–Ideotype Distance Index (MGIDI) were employed for integrative tolerance ranking. Regression analyses identified root and shoot K⁺/Na⁺ ratios and shoot dry weight as the most robust predictors of salt tolerance. The developed ‘SalTol Reg’ model effectively predicted a comprehensive salt tolerance index such as MMFV. Integration of multiple indices led to the identification of four novel salt-tolerant landraces—Neta, Arjunsal, Chovvayan and Orthadiyan. The contrasting tolerant and sensitive genotypes were further subjected to physiological and biochemical characterization, to specifically examine the osmotic, ionic and oxidative modules. Haplotype analysis of the Saltol QTL using 14 tightly linked SSR markers revealed distinct polymorphisms in Neta and Orthadiyan. Expression profiling of key genes within and outside the Saltol region revealed genotype-specific and stage-dependent differential expression patterns. The identified tolerant landraces are currently being evaluated under a customized setup for reproductive-stage salinity tolerance, to unravel stage-specific mechanisms and thereby validate their potential as donors in breeding programs.

Keywords: Gene expression, Haplotype, Hierarchical clustering, Ion homeostasis, Mean membership function value, MGIDI, PCA, Salt tolerance index

02 TOP 03

IISR Navya: A promising high-yielding mutant variety against soft rot in Ginger

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ABSTRACT

Ginger (*Zingiber officinale* Rosc.) a spice, despite with its long history of domestication and global use, exhibits remarkably low genetic variability.

Cultivated ginger clones share a narrow genetic base, posing challenges for crop improvement. Among the challenges, loss due to soft rot incidence is around 70% which is managed mainly by fungicide application. Understanding and addressing this issue, a physical mutation study was initiated using gamma rays and identified five promising mutants R1.25, G1.00/4, HP0.5/15, HP0.5/2 and V 0.5/2 as a result of artificial screening against soft rot (*Pythium myriotylum*). Subsequently, multi-environment testing of these five entries along with three entries from ICAR-AICRPS centres were undertaken under ICAR-AICRPS centres (Barapani, Chintapalle, Gangtok, Kozhikode, Pottangi and Pundibari) and IISR Varada as a national check during 2021-2024 under RBD with three replications. Among the nine entries, HP0.5/2 (IISR Navya) was found to be high yielding with average yield of 15.3 t/ha, with the potential yield of 36 t/ha. It was also a stable genotype based on GGE biplot analysis which falls extreme left in the direction of AEC with minimum deviation as given by 'mean vs stability view'. The 'Which won where' view suggested the variety IISR Navya yielding better in Kozhikode, Barapani and Pundibari locations. The IISR Navya showed 9.7% increase over national check with 18.78% dry recovery. In addition to the yield, it has good quality attributes viz., essential oil (2.7%), oleoresin (6.65%), fibre (6.5%), zingiberene (20%) and beta.-sesquiphellandrene (10%). The variety is less susceptible to rhizome rot disease under field condition with PDI of 14.1 over the location. The identified variety is distinct from the closely related variety IISR Varada and Himachal cultivar. At molecular level, the SSR primer, GB-ZO-140 distinguished the variety HP 0.5/2 from IISR Varada by the presence of the polymorphic band at 350bp (GB-ZO-140350).

02 TOP 04

Bamboo Raft Culture of Seaweeds in Kovalam, Kerala: A Pilot-Scale Approach to Sustainable Coastal Aquaculture

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ABSTRACT

Seaweed culture plays a significant role in enhancing the agrobiodiversity of Kerala by diversifying coastal ecosystems and supporting sustainable livelihoods.



This practice reduces pressure on traditional land-based agriculture by offering an alternative source of income that does not require freshwater or arable land. Moreover, seaweed farming improves water quality by absorbing excess nutrients and carbon dioxide, helping maintain a healthier marine ecosystem. By encouraging the cultivation of native seaweed species, Kerala can conserve local genetic resources and avoid the spread of invasive species. Additionally, seaweed farming supports shoreline stabilization and coastal climate resilience. Overall, it strengthens ecological sustainability, economic security, and social well-being, making it a vital component of Kerala's agrobiodiversity strategy. In the present study, an in vivo bamboo raft method of seaweed cultivation was successfully implemented along the coastal waters of Kovalam, Kerala, during August to September 2025. Two ecologically significant species, *Ulva* spp. and *Sargassum* spp., were selected for cultivation owing to their high growth potential and economic value. The culture was initiated in August under optimal tidal and nutrient conditions, ensuring favourable growth throughout the cultivation period. After three months of sustained development, a remarkable 20-fold increase in biomass was recorded, highlighting the immense productivity of the raft culture system. The harvested biomass was further utilized for the preparation of seaweed-based value-added products, demonstrating its potential in biotechnological and commercial applications. This initiative also showcased the environmental sustainability of marine farming, with minimal ecological disturbance and high resource efficiency. The success of this pilot-scale endeavour underscores the promise of seaweed cultivation as a blue economy venture capable of empowering coastal communities. Ultimately, such innovations in marine agronomy contribute meaningfully to the vision of Navakerala, fostering ecological resilience and sustainable economic growth.

Key Words: Bamboo raft, Seaweed culture, value added products, *Ulva*, *Sargassum*

02 TOP 05

Soil Carbon Dynamics and Microbial Resilience in Miyawaki Forests of Kerala: A Nature-based Solution for Climate Mitigation

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ABSTRACT

The Miyawaki method of dense native forest establishment has gained widespread relevance in Kerala as a rapid ecological restoration strategy capable of enhancing biodiversity, improving soil health, and strengthening climate resilience in urban and peri-urban landscapes. However, scientific evidence on the below-ground ecological processes of these forests in the state remains limited. The present study investigates the depth-wise distribution and quantification of carbon, nitrogen, and soil microbiomes in five of the earliest established Miyawaki forests in Kerala, comparing them with adjacent undisturbed control sites. Composite soil samples from 0–15 cm and 15–30 cm depths were analyzed for physical, electrochemical, biological, and biochemical attributes. Multiple carbon fractions-SOC, TOC, labile carbon, particulate organic carbon, microbial biomass carbon and nitrogen pools were quantified. Soil organic carbon stock, carbon sequestration rate, C:N ratio, Carbon Pool Index, Lability Index, and Carbon Management Index were computed. Microbial abundance and diversity were assessed using culture-based enumeration and 16S rRNA metagenomic sequencing. Atmospheric temperature was measured to assess microclimate changes under Miyawaki canopies. Results revealed that Miyawaki forest soils had significantly higher SOC, TOC, labile carbon, MBC, and total nitrogen compared to control soils across both depths. Enhanced microbial abundance and diversity, along with higher dehydrogenase activity, indicated improved soil biological functioning. SOC stock and carbon sequestration rates demonstrated substantial carbon sink potential, aligning with India's climate commitments for additional carbon storage. Elevated CMI values confirmed accelerated soil restoration under the Miyawaki system. Miyawaki forests showed clear cooling benefits, with lower daytime temperatures under the canopy, helping reduce urban heat island effects. The study highlights



that Miyawaki forests in Kerala effectively enhance soil carbon dynamics, nutrient availability, and microbial diversity, thereby strengthening ecosystem resilience. These findings highlight native micro-forests as effective, scalable nature-based solutions for climate mitigation, urban heat reduction, and fast ecological recovery.

Keywords: Miyawaki forests, soil carbon, nitrogen dynamics, metagenomics, carbon sequestration, ecosystem restoration.

02 TOP 06

Carbon farming in rice-based cropping systems for climate stabilization in humid tropical agroecosystems

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ABSTRACT

Carbon farming strategies in the humid tropical agroecosystems of the West Coast Plains are central to advancing climate stabilization, particularly where rice-based cropping systems dominate and their carbon source–sink behaviour remains insufficiently understood. Identifying how diversified sequences influence soil carbon pools and sequestration is vital for designing resilient production systems. A field study was conducted at the Integrated Farming System Research Station, Karamana, to quantify carbon dynamics across eight rice-based cropping sequences developed for soil-health improvement, nutritional security, fodder supply and enhanced farm income. The traditional rice–fallow–fallow system functioned as the control. Soil samples were collected at 0–15, 15–30 and 30–45cm depths were analysed for total organic carbon (TOC), organic carbon fractions,

particulate organic carbon (POC), water-soluble carbon (WSC), labile and non-labile pools, and microbial biomass carbon (MBC). Seasonal residue incorporation was monitored to determine its role in soil carbon accrual. Climate stabilization potential was assessed using the carbon management index (CMI) and net greenhouse gas (GHG) balance. Carbon fractions consistently declined with increasing depth, reflecting reduced organic inputs and microbial activity. Among the cropping sequences, the soil-health-oriented T₃ (Rice–Bush cowpea–Groundnut + Daincha) recorded the highest TOC, organic carbon, and MBC, indicating superior soil enrichment. T₄ (Rice + Daincha–Rice + Daincha–Redgram + Groundnut) achieved the maximum WSC and POC due to continuous legume integration and biomass return. The income-driven sequence T₉ (Rice–Sweet potato–Cucumber) ranked second for most pools but attained the highest CMI and a strongly negative GHG balance, reflecting excellent carbon sequestration efficiency. Overall, diversified, residue-rich rice-based systems substantially improve soil carbon pools, enhance CMI, and lower GHG emissions, confirming carbon farming as an effective pathway for climate resilience and sustainable production in the West Coast Plains.

Keywords: Carbon dynamics, climate resilience, soil health, cropping sequence

02 TOP 07

Physiological and Nutritional Responses of Finger Millet to High Temperature and Elevated CO₂ × Drought Stress Conditions

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ABSTRACT:

Global climate change is intensifying stress on agriculture due to elevated CO₂, extreme temperatures, and erratic rainfall. Millets are climate-resilient crops. Finger millet [*Eleusine coracana* (L.)] holds great promise for food and nutritional security, particularly in semi-arid regions of Asia and Africa. It is valued for its high calcium and dietary fibre. The study was conducted at the Department of Plant Physiology, College of Agriculture, Vellayani (2022–2025) using an Open



Top Chamber (OTC) system. Three experiments were undertaken to evaluate the impact of elevated CO₂ on drought and high-temperature stress responses, nutrient homeostasis, and grain quality in finger millet. In the first experiment, twenty genotypes were screened under high-temperature stress. Heat stress increased plant height but significantly reduced yield attributes, photosynthetic rate, membrane stability, and nutrient quality. Enhanced catalase, phenol, and antioxidant activities indicated activation of oxidative defence mechanisms. Based on yield retention and physiological performance, GPU 28, ML 365, CoRa15, GPU66, GPU48 were identified as heat-tolerant genotypes. The second experiment assessed the interaction of elevated CO₂ x drought stress in six genotypes. Five tolerant and one susceptible genotype were selected from high temperature stressed plants. CO₂ enrichment improved tiller number, leaf production, and root-to-shoot ratio, while mitigating drought-induced declines in chlorophyll stability and water content. Proline accumulation and antioxidant enzyme activities increased markedly, supporting stress protection. Tolerant genotypes such as GPU 28 maintained higher photosynthetic efficiency, membrane stability, and yield. Elevated CO₂ under drought improved grain nutritional quality through reduced tannins and increased carbohydrate, protein, fibre, calcium, iron, and zinc contents. Expression analysis revealed the upregulation of nutrient transporter (*EcZIP1*, *CAMK1*) genes, facilitating enhanced nutrient translocation under elevated CO₂ x drought interaction. Elevated CO₂ improved remobilisation of calcium and zinc resulting in higher grain content of these minerals under the combined influence of elevated CO₂ x drought interaction.

Keywords: Elevated CO₂, heat stress, drought stress, Physiological response, Stress tolerance, *EcZIP1*, *CAMK1*.

02 TOP 08

Climate change prediction using Linear Regression, SVM and Random Forest Regression

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ABSTRACT

Some of the factors that play a crucial role in climate change are rising sea levels, unpredictable precipitation, humidity, CO₂ concentration, cloud cover,

solar irradiance, urbanization index, and rising temperature. Rise in temperature in turn expands sea water, causing the water level to rise in the seas. Machine learning algorithms were always a preferred one to predict climate change. Other experts have already predicted climate change but used the time series models for CO₂ concentrations and temperature anomalies. We use the Kaggle dataset and compare metrics based on Linear Regression and Random Forest Regression, the ML techniques for predicting climate change. A support vector regression, as a regression technique, like a support vector machine, can perform linear regression in high dimensions. We used Linear regression to read the dataset, train the model, and visualize actual vs. predicted climate change. The scatter plot based on that illustrates a linear regression model that fits the data very well, given that most predictions lie close to the perfect prediction line. Various machine learning algorithms accuracy will be compared. The low MAE and a high R² score suggest that Linear Regression fits the data well, indicating a strong correlation between actual and predicted climate changes. The findings indicate the need to use the appropriate model and for the balance between accuracy and interpretability to be able to develop a prediction model. This will ensure climatologist can detect and ensure early interventions to notify the communities of the unpredictable weather patterns.

Keywords: Machine Learning (ML), Linear Regression, Random Forest Regression, climate change prediction

02 TOP 09

Phytoremediation Potential of Invasive *Nymphaea rubra* Roxb. ex Andrews in the Kuttanad Agro-Ecosystem

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ABSTRACT

The phytoremediation potential of *Nymphaea rubra*, a recent invader in paddy fields associated with the Vembanad-Kol Ramsar site, was assessed to address the sustainable management of the species and mitigate ecological risks due to heavy metal contamination. The study found that the sediments of the agro-ecosystems contain the heavy metals Al, Mg, Fe, Mn, Cu, Zn, Pb, Ni and Cr,



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Abstract

probably contributed by agrochemicals, anthropogenic activities, and biological origin. The plant accumulated significant quantities of heavy metals from the sediments, especially Fe, followed by Al, Mn, and Zn. The highest accumulation of heavy metals was observed in the roots for all heavy metals, except Mn, which was highest in the leaves. This study demonstrates that *N. rubra* has a high potential to reduce the risk of heavy metal contamination in paddy fields, which can be effectively utilized as a management strategy for this invasive species.

Keywords: *Nymphaea rubra*., Kuttanad, Invasive species, Phytoremediation,

02 TPP 01

Physicochemical and Microbial Characteristics of Major Land Use Systems in Southern Laterites of Kerala

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ABSTRACT

A study was conducted across major land use systems (LUS) of the southern laterites of Kerala to assess soil physicochemical and microbial properties. Soil samples collected from banana, coconut, vegetable, and uncultivated fallow lands at 0–15 cm and 15–30 cm depths showed significant variation among the systems. The highest surface soil pH (5.91) was recorded in the coconut LUS. Electrical conductivity ranged from 0.16 dS m⁻¹ in uncultivated fallow to 0.21 dS m⁻¹ in vegetable LUS. The highest mean CEC (6.10 cmol(+) kg⁻¹) was observed in the vegetable LUS, while the lowest (3.74 cmol(+) kg⁻¹) occurred in the uncultivated fallow. Surface soils (5.05 cmol(+) kg⁻¹) generally exhibited higher CEC than sub-surface soils (4.66 cmol(+) kg⁻¹). Conversely, the highest AEC (0.740 cmol(-) kg⁻¹) was found in surface samples of the banana LUS. The coconut LUS recorded the highest dehydrogenase and alkaline phosphatase activities. Overall, both physicochemical and microbial parameters tended to decrease with soil depth across all land use systems.

Keywords- land use system, dehydrogenase, CEC, AEC

02 TPP 02

**Nanoparticle Toxicity and Risk Assessment
in Soil Ecosystem**

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ABSTRACT

Nanoparticles present within soil ecosystems exhibit a dual nature, manifesting both positive and negative impacts. While they may foster plant growth, their persistent presence in soils poses a noticeable hazard to crop productivity (Ahmed, 2021). Within soil matrices, nanoparticles, encompassing clay minerals and metal hydroxides, exhibit pronounced reactivity, thereby influencing the mobility and bioavailability of contaminants (Theng, 2008). Given their distinctive characteristics such as high specific surface area and mobility, nanoparticles have the potential to jeopardize soil health and consequently have indirect consequences on plant growth dynamics (Kumar, 2012). Metal-based nanoparticles have been observed to elicit detrimental impacts on essential soil microorganisms such as bacteria and fungi, pivotal for maintaining soil fertility and supporting plant growth (Ameen, 2021). It is crucial to recognize that the nature of nanoparticles and their concentrations play pivotal roles in influencing their toxicity towards soil microbial communities, with inorganic variants demonstrating heightened toxicity relative to organic counterparts (Simonin, 2015). Specifically, metal and metal oxide nanoparticles have been singled out for their pronounced toxicity towards soil microbial populations, thereby posing a potential threat to overall soil health and fertility (Parada, 2018). This paper aims to explore the multifaceted dimensions of nanoparticle toxicity and risk assessment within soil ecosystems. With a focus on nanoparticles and interactions with soil components and their environmental implications, the objectives encompass understanding the mechanisms underlying nanoparticle toxicity, elucidating their potential risks to soil microbial communities, and evaluating their impacts on soil health and fertility.

Key words: Nanoparticles, bioavailability, toxicity, soil health, fertility.

02 TPP 03

Soil Nitrogen and Carbon Dynamics under Different Production Systems with Varying Crops in Agro-Climatic Zones

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ABSTRACT

Soil nitrogen (N) and carbon (C) fractions under diverse production systems is crucial for developing sustainable soil fertility strategies in semi-arid regions. This study assessed the influence of natural, organic, integrated, and conventional farming systems on soil N and C fractions across three agro-climatic zones of the Kalyana Karnataka region, India. Surface (0-15 cm) and subsurface (15-30 cm) soil samples were analysed for ammoniacal, nitrate, organic, and total N, as well as organic, inorganic, total, and oxidizable C fractions. The results revealed significant differences among production systems and soil depths. Integrated and organic systems consistently exhibited higher concentrations of all N and C fractions compared with the conventional system. Ammonical and nitrate N were concentrated in the surface layers, whereas inorganic C was higher in the subsurface soil. The northeastern transitional zone recorded the highest N and C fractions, followed by the northeastern and northern dry zones. Enhanced organic inputs, biological activity, and residue recycling in integrated and organic systems contributed to improved soil fertility and nutrient retention. Overall, the study demonstrates that integrated farming system effectively enhance soil carbon storage and nitrogen availability, thereby promoting sustainable productivity and resilience in semi-arid tropical soils.

Keywords: farming systems, nitrogen fractions, carbon pools, agro-climatic zones, soil fertility

02 TPP 04

Integrating Traditional Practices with Modern Innovations

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ABSTRACT

Agroecological transitions are pivotal for ensuring long-term soil health and agricultural sustainability, especially amid changing climatic conditions and rising global food demand. Agroecology emphasises integrating ecological principles into agrarian practices, promoting biodiversity, enhancing soil fertility, and minimising the environmental footprint of farming. This paper examines how agroecological transitions can improve soil health by blending traditional farming practices with modern innovations. Traditional farming systems have long relied on organic fertilisers, crop rotation, agroforestry, and minimal tillage to maintain soil fertility and structure. These methods have been passed down through generations, contributing to the soil's resilience and health. However, modern agricultural practices, such as intensive monocropping and excessive use of synthetic chemicals, have led to soil degradation, loss of organic matter, and reduced microbial diversity. To address these challenges, agroecological transitions are necessary, combining time-tested traditional methods with contemporary scientific advancements. For example, the use of cover crops, green manures, and integrated pest management (IPM) can help restore soil organic matter and increase biodiversity. Furthermore, innovations such as precision farming and soil health monitoring technologies enable more efficient resource use and better soil health management. The integration of these practices within an agroecological framework can mitigate soil erosion, improve water retention, and reduce dependency on chemical inputs, fostering a sustainable, resilient agricultural system. This paper highlights the benefits of agroecological transitions for soil health and discusses the importance of policy support, farmer education, and research collaboration in driving these changes. By integrating traditional knowledge with modern innovations, we can



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create more sustainable and resilient agricultural system that ensures the long-term health of our soils and food security.

Keywords: Agroecology, soil health, traditional farming, modern innovations, sustainable agriculture.

02 TPP 05

Allelopathic Effect of *Panicum Sumatrense* Roth Stubbles on *Phyllanthus Amarus* Schumach. & Thonn.

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ABSTRACT

Panicum sumatrense Roth, (little millet), is a climate- resilient, nutrient rich minor millet widely cultivated in India and South east Asia. Allelopathy is the biological phenomenon where one plant exhibits positive or negative effects on the growth and development of the nearby plants. Phyllanthus amarus is a traditional medicinal plant widely accepted for its hepatoprotective, anti-inflammatory and antimicrobial properties. This study aims to assess the allelopathic interaction of stubbles of little millet on growth and development of Phyllanthus amarus Schumach. & Thonn. Laboratory bioassays and pot experiments were conducted using varying concentrations of stubbles amended into soils to simulate field conditions. Germination parameters such as germination percentage, mean germination time, radicle length, plumule length, and seedling vigour index were evaluated on 10th day. Pot experiments assessed germination, plant height, shoot length, and overall vigour. The results were statistically analysed using IBM SPSS statistics version 25 software, determined ANOVA ($p \leq 0.05$) with a mixed response in the laboratory assay. On the contrary, the treatment with stubbles showed concentration dependent increase on the germination and yield of P. amarus. This suggests that the soil-based pot environment supported better growth and development. Thus, the study shall be implied to avoid stubble burning, and paving way to the control of air pollution and effective waste management.

02 TPP 06

Mechanistic Insights into Potassium Dynamics and Microbial Solubilization in Coarse-Textured and Saline Hydromorphic Soils of Kerala

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ABSTRACT

Soil health in Kerala's agro-ecological landscape is shaped by strong contrasts in texture, salinity and nutrient retention, which significantly influence potassium (K) availability and crop performance. This study examined K dynamics in two representative soil systems—K-deficient coarse-textured sandy soils of AEU 2 and K-enriched saline hydromorphic Kaipad soils of AEU 7—to identify ecologically sustainable strategies for nutrient restoration. The sandy soils, dominated by >70% sand and clay contents generally below 10%, exhibited low available K (mean ≈ 70 kg ha⁻¹), high bulk density, and strongly acidic pH. In contrast, the hydromorphic soils, containing 20–45% clay and influenced by periodic salinity, maintained much higher available K levels (mean ≈ 1100 kg ha⁻¹) and elevated EC, indicating both abundant mineral K reserves and salinity-driven K desorption processes. Potassium-solubilizing bacteria (KSB) were evaluated through incubation and cowpea pot culture experiments to assess their potential to improve K availability in these contrasting soil environments. KSB inoculation enhanced the mobilization of non-exchangeable and mineral-bound K, increased water-soluble and exchangeable fractions, and significantly improved K uptake and biomass accumulation in cowpea. The microbial effect was particularly notable in the nutrient-poor sandy soils, where KSB-mediated solubilization compensated for limited native K supply and low cation-exchange capacity. In saline hydromorphic soils, KSB moderated competitive K–Na interactions in the rhizosphere and improved the effective K⁺/Na⁺ balance, supporting better nutrient acquisition under salinity stress. Overall, the study highlights that integrating KSB-based biofertilization with soil-type-specific understanding of K dynamics offers a strong agroecological pathway for



restoring soil health, improving nutrient-use efficiency, and reducing reliance on chemical K fertilizers. These findings support the development of resilient, site-specific nutrient management strategies for coastal and saline agroecosystems in Kerala.

Keywords: Potassium Dynamics, Soil Health Restoration, Potassium-Solubilizing Bacteria (KSB), Coastal Sandy Soils (AEU 2), Saline Hydromorphic Soils (AEU 7), Agroecological Nutrient Management, Soil–Microbe Interactions

02 TPP 07

Efficacy of *ayar* nutrient mix on improving soil health in northern coastal sandy soils

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ABSTRACT

In recent years, the rapid increase in human population has intensified concerns over global food security. Since soil is the primary medium supporting crop production, maintaining its health is essential for meeting rising food demands. However, continuous cropping has led to substantial depletion of critical soil nutrients, particularly secondary and micronutrients. Notably, nearly 35% of Indian soils exhibit zinc deficiency, and approximately 21% of coastal soils in Kerala show signs of declining soil health. Coastal soils also face additional challenges, including low organic matter levels, limited nutrient availability, considerable nutrient losses after application, and poor water-holding capacity, all of which restrict their agricultural productivity. This study was conducted to know the impact of *ayar*, a secondary and micronutrient mix containing calcium, magnesium, sulphur, zinc and boron in improving the properties of northern coastal soils of Kerala. Soil analysis demonstrated that the *ayar* nutrient mix significantly improved soil chemical fertility in coarse sandy soils of Kasaragod. Organic carbon (OC) content increased markedly, with the highest values recorded in T₂ and T₆ (1.34%), compared to the

minimum in T_4 (0.66%). Available nitrogen showed substantial variation among treatments, with T_5 recording the highest concentration (215.34 kg ha⁻¹), while T_2 exhibited the lowest (79.45 kg ha⁻¹). Available phosphorus was notably enhanced in T_6 (62.78 kg ha⁻¹) relative to the lowest value in T_1 (5.9 kg ha⁻¹). Potassium availability also improved under *ayar*-based treatments, peaking in T_5 (172.59 kg ha⁻¹) and declining to a minimum in T_8 (53.79 kg ha⁻¹). Overall, the results reveal that the *ayar* nutrient mix effectively enhances post-harvest soil nutrient status, particularly OC, N, P, and K, thereby improving soil health in nutrient-deficient sandy ecosystems.

02 TPP 08

Integrated nematode management in cardamom

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ABSTRACT

An experiment was conducted in farmers field located at Thoalapati, Idukki district, Kerala state, infested with *Meloidogyne incognita* with the following treatments T1 (mulching with *Gliricidia* @ 2 kg/plant + application *Purpureocillium lilacinum* @ 30g/plant one month after mulching, T2 (mulching with *Gliricidia* @ 2 kg /plant + application of *Pseudomonas fluorescens* @ 30g/plant one month after mulching, T3 (mulching with *Gliricidia* @ 2kg/plant + *Bacillus subtilis* @ 30g/plant) T4 (mulching with *Gliricidia* @ 2kg/ plant + application of neem cake @ 2kg/plant, T5 (mulching with *Gliricidia* @ 2kg/plant+ application of AMF @ 30g/plant) T6 (mulching along with *Gliricidia* @ 2kg/plant) T7 (Untreated check). The variety of cardamom used was Njallani and the experiment was laid out in RBD design. Perusal of data revealed that treatment involving T1 (mulching with *Gliricidia* @ 2 kg /plant + *P. lilacinum* @ 30 g/plant) was found to be statistically superior in increasing the yield (11 t/ha) of cardamom compared to all other treatments. The next best treatment was T2 (mulching with *Gliricidia* @ 2 kg/plant + *P. fluorescens* @ 30 g/plant) followed by, T4 (mulching with *Gliricidia* @ 2 kg/plant + neem cake @ 2 kg/plant) and T3 (mulching with *Gliricidia* @ 2 kg/plant + *B. subtilis* @ 30 g/plant). The lowest nematode population was recorded by T1 (mulching with *Gliricidia* @



2 kg/plant +*P. lilacinum* @ 30g/plant) in soil (6.9 J 2 /200cc soil) and roots (5.6 nematode/5g of roots) followed by T2(mulching with *Gliricidia* @ 2 kg/plant + *P. fluorescens* @ 30 g/plant) in soil (7.7 J 2 /200ccsoil) and roots (6.5 nematodes/ 5g of roots). Mulching with *Gliricidia* @ 2kg/plant +*P.lilacinum* @ 30 g/plant reduced the nematode population and increased yield in cardamom.

Keywords: *Gliricidia* sp, Mulching, Biocontrol agents, *Meloidogyne incognita*, *Purpureocillium lilacinum*, Kerala

02 TPP 09

Standardisation of in vitro PLB (protocorm-like bodies) regeneration in *Vanilla planifolia* H.C. Andrews to induce variability

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ABSTRACT

Vanilla planifolia H.C. Andrews, a tropical climbing orchid native to Mexico and the primary natural source of vanillin, is widely used across food, pharmaceutical, and cosmetic sectors. In India, its cultivation depends on a narrow clonal base introduced from Mexico, leading to very limited genetic variability and absence of natural seed germination. To overcome this constraint and to generate genetic diversity, flowers of *V. planifolia* H.C. Andrews at ICAR-Indian Institute of Spices Research, Kozhikode, Kerala were self pollinated, and the resulting seeds were cultured in vitro to optimize an efficient regeneration system via protocorm-like bodies (PLBs) for the development of seedling progenies. The seeds were extracted from fully matured yellowing beans, matured green beans, and physiologically mature (150-day-old) beans and cultured on different media compositions (MS, SH, Dendrobium, BM1 and Knudson). Maximum PLB induction was obtained from 150-day-old seeds cultured on BM-1 Orchid Medium supplemented with 2 mg L⁻¹ 2,4-D (2,4-dichlorophenoxyacetic acid) and charcoal under dark incubation. These PLBs differentiated into embryogenic callus and subsequently regenerated into shoot primordia on MS medium supplemented

with 3 mg L⁻¹BAP (6-benzylaminopurine) and 0.5 mg L⁻¹ NAA (naphthalene acetic acid) which displayed superior morphogenic capacity with successive subcultures. Rooting was most efficiently achieved using half-strength MS medium supplemented with 0.5 mg L⁻¹ NAA, resulting in the highest number of roots (4.16) and improved vegetative vigour. The in vitro seedlings upon hardening performed better in vermiculite and perlite (3:1) substrate indicating its suitability for ex vitro establishment of regenerated plantlets. The SSR and ISSR profile analysis of in vitro vanilla seedlings (16) revealed detectable polymorphism among seedlings, confirming genetic divergence generated through sexual recombination. This study demonstrates that in vitro seed regeneration is an effective approach to broaden the genetic base of *V. planifolia*, supporting future breeding initiatives.

Keywords: seed germination, physiologically mature (150-day-old) beans, media, BAP and NAA

02 TPP 10

Molecular Screening of Parental Polymorphism in rice for abiotic stress tolerance

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ABSTRACT

Abiotic stresses, mainly salinity and submergence, limit rice productivity. Developing multiparent populations from diverse parents with abiotic stress tolerance provides an opportunity to broaden the genetic base and identify favourable alleles for stress resilience. In the present study, eight genetically diverse rice genotypes were evaluated for molecular polymorphism using a panel of SSR markers linked to salinity and submergence tolerance. These parents were strategically selected for their contrasting adaptations and unique stress-resilience attributes, aiming to establish a genetically enriched multi-parent population for improving tolerance to abiotic stresses in rice. A high degree of polymorphism was observed among the eight genotypes, demonstrating substantial genetic diversity. Traditional Pokkali (salinity tolerant) and Swarna-Sub1 (submergence



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tolerant), both identified from preliminary germplasm screening, for salinity and submergence tolerance. Saltol-linked markers effectively differentiated Pokkali from the remaining genotypes, highlighting its strong salinity-tolerance signature. Sub1-linked SSR markers uniquely distinguished Swarna-Sub1, confirming its submergence-tolerance allele. Several markers showed moderate to high PIC values, indicating their suitability for detecting allele variation and for use in population development. The complementary diversity observed across all parents suggests the presence of distinct stress-responsive alleles that can enrich the recombination potential of a multi-parent population. Overall, the identified polymorphic SSR markers provide a robust molecular foundation for parent selection and population development. The results demonstrate that these eight elite genotypes possess substantial genetic variability and complementary stress-responsive alleles, making them excellent for establishing a multi-parent breeding population aimed at enhancing abiotic stress tolerance in rice.

Keywords: Rice, SSR marker, Salinity, Submergence

02 TPP 11

Organelle-Targeted Editing for Climate-Resilient Crops and Agroecosystem Sustainability

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ABSTRACT

Plant organelles encode key components of photosynthetic and respiratory machinery, as well as regulators of redox balance and retrograde signalling that shape whole-plant responses to heat, salinity, and drought. Unlike nuclear transgenes, plastid and mitochondrial edits show reduced pollen-mediated gene flow, supporting biosafety in sensitive landscapes undergoing ecological rehabilitation. Recent advances employ protein-based programmable nucleases and as editors mitoTALENs, organelle-targeted ZFNs, DddA-derived cytosine base editors

(DdCBEs), and TALE-linked adenine base editors (TALEDs) delivered via peptide targeting, biolistics, nanoparticles, or nuclear expression with transit peptides to achieve precise edits in coding and regulatory regions of organellar genomes. Homologous recombination and RNA-free base editing enable targeted knockouts and single-nucleotide substitutions without double-strand breaks, improving efficiency and limiting large-scale genomic rearrangements. Mitochondrial editing with mito TALENs has restored male fertility in cytoplasmic male sterile lines of rice, rapeseed, eggplant, and potato through disruption of CMS-associated open reading frames, thereby stabilizing hybrid seed production systems crucial for yield under climate stress. Chloroplast base editing of *psbA* and other photosynthetic genes has generated herbicide-tolerant and photosynthetically efficient plants without growth penalties. By stacking organellar edits that improve energy-use efficiency, abiotic stress resilience, and input-use efficiency, organellar genome engineering can underpin climate-smart cultivars that support reduced chemical loads, stable productivity, and functional biodiversity in restored agroecosystems. Integrating organellar genome editing with multi-omics, synthetic biology, and ecological breeding frameworks will accelerate the deployment of robust, low-leakage traits, aligning crop improvement with climate resilience and ecosystem restoration goals.

Keywords: organellar genome editing; climate-resilient agriculture; chloroplast and mitochondrial genomes;

02 TPP 12

Somatic Embryogenesis in Rice through Tissue Culture

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ABSTRACT

Somatic embryogenesis is a major advancement in plant biotechnology, enabling the regeneration of plants by producing embryos from somatic (non-reproductive) cells without the need for fertilisation. In rice (*Oryza sativa* L.). Somatic embryogenesis has become a crucial tool for genetic enhancement, acting



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as the main regeneration platform for genetic transformation, functional genomics research, and rapid breeding initiatives. To develop and optimise a reliable somatic embryogenesis protocol for the rice variety through tissue culture, enabling efficient callus induction, embryo formation, and complete plantlet regeneration. Mature seeds of the rice were subjected to surface sterilisation and cultured on a callus induction medium (Murashige and Skoog medium) enriched with auxins, primarily 2,4-dichlorophenoxyacetic acid (2,4-D) at optimised concentrations (2-3 mg/L), along with maltose (30g/L) and agar (8g/L). Mature somatic embryos were then transferred to a regeneration medium (MS + NAA (186µl/L) + BAP (788µl/L)) and subsequently moved to a rooting medium (MS + IBA (0.1 mg/L)), and complete plantlets underwent hardening through gradual acclimatisation prior to being transferred to greenhouse or field conditions. Callus development occurred within 5–28 days of inoculation, with a 54% callus induction rate. The regeneration frequency was 24%, and the root length observed was 4 cm after 30 days of inoculation in the rooting medium. An efficient and reproducible somatic embryogenesis protocol has been developed even for drought-resistant rice variety. This protocol serves as a solid foundation for large-scale propagation, germplasm conservation, and genetic transformation research aimed at integrating additional stress-tolerance traits. The effective regeneration system paves the way for expedited breeding programs, gene function investigations, and the creation of climate-resilient rice varieties.

Keywords: Somatic embryogenesis, tissue culture, callus induction, climate-resilient, genetic transformation

02 TPP 13

Identifying Drought-Resilient Sesame Genotypes Using Multivariate Tools

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ABSTRACT

Drought stress is a major constraint limiting sesame productivity, necessitating the identification of resilient genotypes with superior physiological and morphological adaptive traits. The present study was conducted at the College of

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Agriculture, Vellayani, Kerala Agricultural University during Rabi 2025, to evaluate drought tolerance in forty sesame genotypes using a Completely Randomized Design (CRD) with four replications, comprising one control and three drought-imposed treatments. A comprehensive set of nine traits associated with drought response—root length under drought (RLD), shoot length under drought (SLD), root diameter at drought (RDD), root dry weight at drought (RDR), proline content (PRO), phenol content (PHE), chlorophyll content (CHO), stress tolerance index (STI), and yield index (YEI)—were recorded to assess physiological and agronomic performance. Pearson's correlation analysis revealed significant positive associations among key drought-related traits, particularly between STI and RDR, and between RDD and SLD, indicating coordinated root–shoot adjustments under moisture stress. Traits such as proline and phenols showed negative to weak correlations with yield-related indices, reflecting their roles as biochemical stress markers rather than direct contributors to yield. Principal Component Analysis (PCA) captured major variability, with the first two components explaining substantial proportions of the total variation. Yield-associated indices (STI and YEI) clustered together, whereas biochemical traits (PRO and PHE) formed distinct vectors, highlighting contrasting mechanisms of stress adaptation across genotypes. The Multi-Trait Genotype–Ideotype Distance Index (MGIDI) effectively discriminated superior performers by simultaneously integrating all measured traits. Genotypes such as AVT 2, IC 204524, Thilothama, and VRI 3 showed the shortest distances from the ideotype, indicating balanced performance across physiological, biochemical, and yield parameters under drought conditions. The study demonstrates substantial genetic variability for drought-adaptive traits in sesame and identifies promising genotypes for use in breeding programs aimed at enhancing resilience under moisture-limited environments.

Keywords: Drought stress; Multivariate analysis; MGIDI; Sesame; Stress tolerance index

02 TPP 14

Moisture stress mitigation in *Gladiolus grandiflorus* L. using growth regulators

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ABSTRACT

An experiment was conducted at the Department of Floriculture and Landscaping, College of Agriculture, Vellayani, during September–March 2025 to evaluate the effects of melatonin and brassinolide on the floral parameters of *Gladiolus grandiflorus* L. under moisture stress. The study followed a factorial Completely Randomized Design with two varieties (Arka Amar and Arka Darshan), two moisture regimes (100% and 75% field capacity), and two growth regulator treatments (control, melatonin 100 μ M, brassinolide 0.03 mM). Moisture stress significantly delayed spike initiation and first floret opening and reduced spike length, rachis length, floret diameter, number of florets, spike weight, and spike longevity. Both melatonin and brassinolide mitigated these adverse effects, with melatonin exhibiting the strongest response across parameters. The plants treated with melatonin recorded the earliest spike initiation (85.37 days), earliest floret opening (96.17 days), maximum florets (13.97), longest spike (97.05 cm), longest rachis (52.57 cm), largest floret diameter (108.80 mm) and highest spike weight (43.83g). Brassinolide also improved floral traits compared to the untreated control, particularly enhancing spike length, floret diameter, and spike weight, though its effects were consistently lower than those of melatonin. Among varieties, Arka Amar showed superior floral performance under all treatments. The results demonstrate that both melatonin and brassinolide enhance flowering behaviour and spike quality in *gladiolus* under limited moisture, with melatonin being the more effective growth regulator for improving drought resilience and floral productivity.

Keywords: Climate resilience, Climate change, Growth regulators, Floriculture

02 TPP 15

Characterization, in vitro culturing and in vitro manipulation for enhanced production of secondary metabolites in medicinal orchids and Aloe vera (*Aloe vera L. barbadensis Mill.*)

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ABSTRACT

Characterization studies of medicinal orchid and Aloe vera collected from available sources was carried out and the best one ecotype from each of them were selected for the invitro studies. In vitro culturing protocols of medicinal orchid and Aloe vera were standardized. The best callus induction medium for the medicinal orchid, *Dendrobium nobile* was identified as MS medium supplemented with NAA (0.5 mg/l) and metatopolin (1 mg/l) and the nodal explants were found to respond well for callus induction. In Aloe vera, leaf base explants responded well for callus induction in MS medium supplemented with 2,4-D (2.5 mg/l) and BAP (2 mg/litre). However, callus induction rate in Aloe vera *L. (barbadensis Mill)* was found higher when adventitious bud was used as explant in MS medium supplemented with kinetin (0.5mg/l) and NAA (1.5 mg/litre). Also, the standardization of protocols for elicitation of secondary metabolites in callus cultures in both medicinal orchid (*Dendrobium nobile*) and Aloe vera were done.

Key words: Medicinal orchids - Aloe vera- in vitro studies-elicitation

02 TPP 16**Assessment of Pollinator Communities in Selected Agroecosystems of Kollam, Dindigul and Salem**Aswathy J.¹ and M. R. Srinivasan²¹Department of Entomology, COA, Kerala Agricultural University, Vellayani, Kerala, India²Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

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ABSTRACT

Pollinators constitute a critical component of biodiversity, ensuring the reproductive success of flowering plants and sustaining ecological balance in natural and agricultural systems. The present study investigated pollinator diversity across three distinct agroecosystems - Kollam (Kerala) and Dindigul and Salem (Tamil Nadu)—with the objective of documenting species richness, abundance, temporal patterns of visitation, and their contribution to pollination services. Systematic surveys were carried out in major crops such as brinjal, chilli, papaya, banana, marigold, jasmine, pomegranate and thulasi. Observations were made during morning, afternoon, and evening hours, and diversity was quantified using Shannon's and Simpson's indices to compare ecological variation among locations and crops. Across all sites, members of the order Hymenoptera were the predominant floral visitors, including stingless bees, Indian honey bees, ants, and various wasp species. Dipterans such as hoverflies and lepidopterans including butterflies formed an additional but less abundant component of the pollinator complex. Morning hours consistently supported the highest pollinator activity, largely due to optimal nectar availability and favourable temperature and humidity. In Kollam, stingless bees showed pronounced dominance across brinjal, chilli, marigold, and weed flora. In Dindigul, diverse Hymenopterans, particularly stingless bees, Indian bees, and ants, were highly active in papaya, brinjal, banana, and ornamental plants whereas in Salem ecosystem also exhibited similar trends, with stingless bees and ants being the major contributors to pollination across multiple crops. Diversity indices revealed substantial variation among districts and crop types, reflecting the influence of floral resources, habitat features, and local

microclimate on pollinator composition. The consistent presence and activity of stingless bees across all regions highlight their ecological importance as reliable and efficient pollinators. Overall, the study underscores the need to conserve diverse pollinator communities, which are essential for sustaining crop productivity, maintaining ecological resilience, and promoting long-term biodiversity stability in tropical agricultural landscapes.

Keywords: Pollinator diversity; Stingless bees; Agroecosystems; Simpson's index; Shannon's index.

02 TPP 17

Best-fit non-linear models for biomass estimation in five bamboo species in the Southern Western Ghats

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ABSTRACT

This study examined above-ground biomass (AGB), carbon stocks, and soil properties of five different bamboo species: *Dendrocalamus brandisii*, *D. giganteus*, *Bambusabalcooa*, *Guadua angustifolia*, and *Dendrocalamus strictus*. It developed species-specific biomass equations. Using destructive sampling data, we rigorously tested nonlinear models (Logistic, Gompertz, Richards, Chapman-Richards, Allometric, and Monocular) to identify the best fit based on high R^2 values and low error metrics (RMSE, AIC, BIC). The results showed that Richards's model consistently provided the highest predictive accuracy across four of the five species, with R^2 values ranging from 0.9727 to 0.9926. This indicates that the Richards model effectively captures the sigmoid growth pattern of these bamboo species. The species-specific equations are valuable tools for local forest managers and researchers.

Keywords: Bamboo, Best-fit, Biomass, Culm, Non-linear.

02 TPP 18

Root physiological adaptations governing phosphorus uptake in bread wheat genotypes in response to low phosphorus stress

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ABSTRACT

Bread wheat genotypes were grown in a hydroponic system under contrasting phosphorus (P) regimes to investigate phosphorus acquisition traits and the underlying mechanisms contributing to P efficiency. A total of 89 diverse genotypes were evaluated for their responses to low (5 μ M) and sufficient (500 μ M) P concentrations, focusing on traits such as total biomass (TBM), total P uptake (TPU), acid phosphatase activity (APA), total organic acid content (TOC), and P acquisition efficiency (PAE). The total organic acid content included citric, pyruvic, succinic, malic, oxalic, lactic, and fumaric acids. Results indicated a significant reduction in total biomass, total organic acid content, and total P uptake per plant under low P conditions. Conversely, acid phosphatase activity showed a significant increase in response to P deficiency. Principal component analysis revealed that at sufficient P, PC1 and PC2 explained 56.5% of the total variation, whereas at low P, they accounted for 48.5%. Cluster analysis, based on relative values of TOC and APA, categorized the genotypes into four efficiency groups—efficient, moderately efficient, moderately inefficient, and inefficient. No significant differences were observed among these clusters for total biomass and total P uptake. However, the efficient and moderately efficient clusters exhibited higher TOC and APA under low P, while these traits declined in the inefficient cluster. Seven genotypes—DBW 39,

DBW 16, DBW 88, HD 2643, RAJ 3777, RAJ 3765, and GW 322 were consistently grouped as efficient across treatments. The overall findings suggest that root exudation physiology contributes only marginally to the mobilization of inorganic phosphorus in the rhizosphere and subsequent uptake by roots, as evidenced by the negative correlations between TOC and APA with total P uptake and biomass under low-P conditions.

Keywords: Hydroponics, Low phosphorus stress, Bread wheat, Total organic acid content, Acid phosphatase activity

02 TPP 19

Biochemical Mechanism Leading to Male Sterility in TGMS Line

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ABSTRACT

Thermosensitive genic male sterility system is a better option over CMS as it can be transferred to the progeny by crossing, since the trait is controlled by nuclear genes. With respect to Kerala conditions, TGMS system is more adoptable as we are having significant temperature variation between seasons and also between altitudes. While considering yield also, two line hybrids are having a yield advantage of 30 %. By understanding the biochemical changes in TGMS plants during sterility transformation influenced by environmental conditions will be helpful for utilizing the system in a desirable way. The line EC720903 which was imported from IRRI Philippines was maintained at sterility inducing and fertility inducing conditions at COA, Vellayani and RARS Ambalavayal respectively. Samples were taken at flowering for biochemical analysis. The work revealed that the total chlorophyll content in leaves of sterile plants were higher than in the fertile ones however content of chlorophyll b was lesser in sterile when compared to fertile plants. Higher content of proline, total free amino acids, mean protein, MDA, SOD, ascorbate, phenolic



compounds were accumulated by sterile plants than fertile ones. Observations from the present study thereby indicate a higher oxidative stress experienced by the sterile plants over fertile. The higher amount of MDA, SOD, ascorbate in sterile plants clearly indicate the presence of stress experienced by these plants. It indicates the higher need for an antioxidant for scavenging ROS formed as a result of higher stress, leading to male sterility. All these information pave ways to a better understanding on the biochemical changes during stress as well as towards male sterility. It helps us to positively manipulate the plants towards climate resilience and thus ensuring food security.

Key words: TGMS, Biochemical

02 TPP 20

From Niche Crop to Global Staple: The Role of Yam Bean Breeding.

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ABSTRACT

The yam bean (*Pachyrhizus* spp.) is an underutilized legume crop known for its substantial tuber yields, high nutritional value, and agronomic benefits, including nitrogen fixation and the production of the natural insecticide, rotenone. Its climatological resilience and adaptability make it a viable component for sustainable agriculture. However, broadening its genetic base is essential for future crop improvement. Mutation breeding using gamma irradiation was utilized to induce beneficial genetic variation in the RM1 variety of yam bean, addressing the need to broaden the crop and narrow genetic base and accelerate the development of superior, high-yielding cultivars. A preliminary radiosensitivity study was conducted to determine the 50% lethal dose (LD 50) by exposing seeds to 50, 100, 150, and 200 Gy. Subsequently, an M 1 generation trial was established in a Randomized Block Design (RBD), using treatments of 140, 160, 180, 200, and 220

Gy. The preliminary study revealed a clear dose-dependent negative correlation, where increasing radiation progressively reduced seed germination and vigour, suppressed plumule development, and decreased seedling length. Probit analysis of the seed vigour index established the LD 50, indicating an optimal mutagenic range between 150 and 200 Gy. The M₁ generation experiment successfully generated observable phenotypic variations, including morphological changes in leaf structure, altered stem pigmentation, and the presence of chimeras and chlorophyll anomalies. These results validate gamma irradiation as an efficacious tool for creating genetic diversity in *Pachyrhizus*, significantly accelerating breeding efforts for the development of superior cultivars.

Keywords: *Pachyrhizus* spp., 50% lethal dose (LD 50), gamma radiation (Gy), RM1

02 TPP 21

Multivariate Principal Component Analysis of Rice Varieties for Enhanced Nitrogen Use Efficiency under Drought Stress

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ABSTRACT

Rice (*Oryza sativa*) is a major global cereal and the staple food for much of Asia. The two resources that greatly influence crop productivity are water and nitrogen (N). With water scarcity, plant access to N fertilizers will be further constrained, threatening yield. Past genetic studies focused on maximizing productivity through heavy nutrient inputs; however, rising environmental degradation and climate impacts now demand improved nutrient use efficiency (NUE) for sustainable cultivation. Enhancing NUE under water-limited conditions is therefore a priority for future rice breeding. 11 rice varieties, including traditional types (Karuthamodan, Thekkenchera, Mattathriveni, Annapoorna, Manuratna, Pournami, Jyothi, Harsha, Swarnaprabha, CO53 and PMK3), were evaluated for NUE under drought at two



N levels (recommended dose and 50% dose). The experiment was conducted at the Department of Plant Breeding & Genetics, College of Agriculture, Vellanikkara. Drought was induced by withholding water for five days before panicle initiation and relieved when leaf rolling appeared. Data were subjected to Principal Component Analysis (PCA) to assess genetic diversity in yield-related traits across treatments, using GRAPES software of KAU. Leaf-rolling symptoms generally appeared after six days of water withdrawal. PMK 3 and Manuratna showed the least rolling (score 1), indicating strong tolerance. Pournami, Swarnaprabha and CO53 showed mild rolling (score 3). Harsha was most susceptible (score 9). PCA separated total variation into eleven components, where PC1 showed 51% of variations. PC1, PC2 and PC3 had eigenvalues of 5.575, 1.529 & 1.187 respectively. PC1 showed strong positive loadings for grain yield, dry matter, panicle length, grains/panicle, productive tillers and NUE, representing “Yield–NUE performance” axis. Biplot analysis highlighted Pournami, PMK3 and CO53 as superior for NUE under drought. Correlation circles showed a tight cluster of yield and NUE, indicating strong contribution to total variation. PCA effectively differentiated trait groups and identified high-performing genotypes under drought–nitrogen stress.

Key words: Diversity, Rice, Traditional, Drought, Nitrogen use efficiency

02 TPP 22

Biological Management of Taro Leaf Blight Using Plant Growth Promoting Rhizobacteria

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ABSTRACT

Taro (*Colocasia esculenta* L. Schott) is an important tropical tuber crop severely affected by taro leaf blight (TLB) caused by *Phytophthora colocasiae*, resulting in significant yield losses under warm and humid conditions. Dependence on chemical fungicides for disease management is limited by environmental concerns, high cost and inconsistent field performance. Plant growth promoting rhizobacteria (PGPR) offer an eco-friendly alternative by suppressing pathogens and inducing

host defence responses. The present study aimed to identify efficient PGPR isolates and evaluate their potential in controlling TLB. Bacterial isolates maintained at the microbial repository of ICAR–CTCRI were screened for antagonistic activity against *Phytophthora colocasiae* using dual culture, diffusible metabolite and volatile metabolite assays. Selected isolates were evaluated for plant growth promoting traits including indole acetic acid production. Pot experiments were conducted in taro using susceptible (Sree Kiran) and tolerant (Muktakeshi) varieties to assess disease suppression and induction of defence-related enzymes following PGPR application and pathogen challenge. Molecular identification of potent isolates was performed using 16S rDNA sequencing and BLAST analysis. Several isolates exhibited strong antagonistic activity against *P. colocasiae* under in vitro conditions through multiple modes of action. Selected PGPR significantly reduced taro leaf blight incidence in pot culture experiments. Enhanced activities of defence-related enzymes such as chitinase, β -1,3-glucanase, peroxidase, phenylalanine ammonia lyase and total phenols were observed, indicating the induction of systemic resistance in taro plants. Molecular analysis identified the effective isolates mainly as *Bacillus* and *Pseudomonas* species. The study demonstrates the potential of PGPR-based biological approaches in managing taro leaf blight through pathogen suppression and activation of plant defence mechanisms, providing a sustainable alternative to chemical disease management in taro cultivation.

Keywords: Taro leaf blight, *Phytophthora colocasiae*, PGPR, biocontrol, induced resistance, PR proteins

02 TPP 23

Impact of climatic factors on the occurrence and severity of finger millet blast disease in Kerala agroecosystems

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ABSTRACT

Finger millet is a climate resilient and highly nutritious crop grown in marginal and rainfed regions. Despite its hardy nature, the crop is severely affected by



blast disease caused by *Pyricularia grisea*. Considering the frequent blast outbreaks reported in Kerala and the absence of comprehensive region specific studies, a purposive survey was conducted across six agro ecological units (AEUs) of Kerala viz., AEU 3, AEU 8, AEU 11, AEU 15, AEU 16, and AEU 18 during 2023-2025 to assess the field distribution of blast disease and evaluate its association with local microclimatic conditions. Disease incidence (DI) and Percent Disease Index (PDI) were recorded from symptomatic fields and corresponding climatic variables were analysed. The survey revealed notable differences in disease intensity across locations, with DI ranging from 20.67% to 56.33% and PDI from 17.76% to 52.60%. The highest disease severity was observed in Santhanpara (56.33%), followed by Vellayani and Pudur, all of which experienced high relative humidity (>88%), cooler minimum temperatures (17-19°C) and moderate rainfall conditions which were highly conducive to infection. In contrast, Pullur Periyé and Mavelikkara, characterized by maximum temperatures exceeding 30°C and comparatively lower humidity, exhibited the least disease levels. Relative humidity showed the strongest positive correlation with DI and PDI, with minimum temperature also promoting disease. Maximum temperature was negatively associated with blast intensity indicating a suppressive effect on pathogen activity. Although rainfall did not show statistical significance, moderate rainfall generally supported higher disease expression. The study highlights that high humidity, adequate moisture, and cooler nights form the most favourable microclimatic regime for blast development. These insights emphasize the need for microclimate based forecasting and location specific, climate responsive strategies to strengthen blast management and enhance resilience in finger millet ecosystems.

Keywords: Finger millet, Blast disease, *Pyricularia grisea*, Disease severity, Climatic factors

02 TPP 24

Management of rice blast disease using endophytic bacteria and bioagents in Kuttanad

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ABSTRACT

Rice (*Oryza sativa* L.) is a major staple for billions worldwide, and its productivity is crucial for food security in regions such as Kerala. Rice blast remains a major

constraint in wetland ecosystems like Kuttanad, where fluctuating microclimatic conditions favour rapid disease development. A survey across 21 rice-growing locations in the Kuttanad Agro-Ecological Unit (AEU-04) showed wide variation in blast incidence and severity in the variety Manuratna. Typical leaf and panicle blast symptoms were recorded, with the highest incidence (66.42%) and percent disease index (64.41%) at Kaduthuruthy and the lowest at Kadapra. Disease intensity displayed a positive correlation with relative humidity and a negative correlation with maximum temperature, highlighting the strong influence of local weather on blast epidemics. The pathogen was isolated, purified and confirmed as *Pyricularia oryzae* through pathogenicity tests, morphology and molecular characterization. From healthy leaves, 78 endophytic bacteria were isolated, of which 16 showed antagonism in dual culture. Two isolates, B23 and B64, exhibited the highest inhibition (82.22% and 84.91%) and were mutually compatible. Molecular identification revealed B23 as *Bacillus altitudinis* (PX496090) and B64 as *Bacillus subtilis* (PX496089). Both produced cell-wall-degrading enzymes, volatile antifungal compounds and several plant-growth-promoting traits, demonstrating their potential as biocontrol agents and bio-stimulants. *In vivo* evaluation showed that the combined application of B23 and B64 (54.93% disease reduction) performed comparably to the fungicide Trifloxystrobin + Tebuconazole (56.63%) while also improving yield attributes. The study indicates that native endophytic *Bacillus* spp., applied through seed treatment, soil drenching and foliar spray, can effectively suppress blast and enhance crop performance. These results support microbe-based strategies as practical, environmentally compatible alternatives to chemical fungicides for sustainable blast management in the lowland rice ecosystems of Kuttanad.

Keywords: Rice blast, Endophytic bacteria, *Pyricularia oryzae*, Climatic factors

02 TPP 25 Effect of insecticidal hormesis in insect diversity

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ABSTRACT

Insecticidal hormesis describes biphasic dose–response patterns in which low, sublethal doses of insecticides stimulate rather than suppress insect performance, with important consequences for insect diversity in agroecosystems. At low doses, many synthetic insecticides and Bt toxins can enhance reproduction, longevity, development rate, stress tolerance, and detoxification capacity in both pest and beneficial insects, while higher doses remain inhibitory or lethal. These stimulatory responses vary with insecticide class, environmental context (notably temperature), developmental stage, and species traits, thereby reshaping community structure and functional diversity across trophic levels. In pest species such as *Myzus persicae* and *Spodoptera frugiperda*, sublethal exposures to pyrethroids, neonicotinoids, organophosphates, and Bt toxins have been shown to increase fecundity, extend longevity, and upregulate detoxification genes over multiple generations, promoting pest resurgence, resistance evolution, and potential shifts in dominance within herbivore guilds. Similar hormetic stimulation has been documented under low-dose exposure to heavy metals, radiation, and thermal stress, further amplifying diversity responses under variable field conditions. Conversely, in natural enemies such as *Podisus distinctus*, *Bracon hebetor*, and *Chrysoperla zastrowi sillemi*, carefully calibrated sublethal doses of diamides, pyrethroids, and other selective insecticides can enhance survival and reproductive rates, potentially strengthening biological control but also altering predator–prey and parasitoid–host networks. Mechanistically, insecticidal hormesis arises from over compensatory homeostatic regulation, shifts in physiological resource allocation, and receptor-level interactions that produce non-monotonic (J- or U-shaped) dose–response curves. At the community scale, these processes can increase functional diversity by differentially favouring tolerant, resistant, or hormesis-prone taxa, while simultaneously risking loss of sensitive species that lack compensatory capacity. For integrated pest management, recognizing and managing insecticidal hormesis is therefore critical: inappropriate low or declining field doses can unintentionally enhance pest fitness

and disrupt community balance, whereas informed dose selection and timing may allow hormetic stimulation of beneficials while minimizing adverse diversity and resistance outcomes.

02 TPP 26

Assessing Drought for Ecosystem Restoration Using Agrometeorological and Remote Sensing Techniques in Kerala

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ABSTRACT

Kerala's ecosystems face escalating threats from climate induced droughts, which disrupt hydrological cycles, impede vegetation recovery, and undermine restoration efforts amid intensifying monsoon variability. Understanding how drought affects restored landscapes is essential for designing resilient, climate smart restoration strategies. This study addresses the need by examining drought patterns, ecosystem responses, and adaptive measures that can strengthen long term ecological resilience in Kerala. Using long-term meteorological datasets, satellite derived vegetation indices, drought indicators such as the Standardized Precipitation Index (SPI) and Vegetation Condition Index (VCI), and land use change information, drought sensitive zones and restoration vulnerability hotspots were identified. Results demonstrate distinct spatial variations in drought severity and highlight the importance of vegetation diversity and microclimatic regulation in improving drought resilience. The study proposes a climate smart restoration framework incorporating drought tolerant native species, soil moisture conservation practices, agroforestry integration, and continuous agrometeorological monitoring. Strengthening these adaptive measures can significantly enhance the long-term stability and recovery potential of restored ecosystems in Kerala under future drought scenarios.

Keywords: Drought assessment, Ecosystem restoration, Restoration planning, Standardized Precipitation Index, Vegetation Condition Index

02 TPP 27

Genotypic Variability in Phytic Acid Accumulation and Mineral Bioavailability Under High Temperature Stress in Rice

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ABSTRACT

Climate-induced high temperature stress has emerged as a major threat to rice production, affecting both yield and grain nutritional quality. Phytic acid, the primary storage form of phosphorus in rice grains, binds essential minerals such as iron and zinc, reducing their bioavailability. Understanding heat-induced alterations in phytic acid accumulation and associated mineral dynamics is critical for developing climate-resilient and nutritionally efficient rice genotypes. Eleven rice genotypes were evaluated under ambient and high temperature regimes using a polyhouse system. Morpho-physiological parameters, grain quality traits, phytic acid concentration, total and bioavailable iron and zinc were quantified. Seed germination and vigour indices were assessed to understand the influence of phytic acid on early seedling performance. Molecular characterization was carried out using SPDT-linked candidate-gene SSR markers. Expression profiling of SPDT1 and SPDT2 during grain filling was conducted through qRT-PCR to assess transcriptional responses under heat stress. High temperature stress significantly reduced key physiological traits including plant height, chlorophyll content, tiller number, spikelet fertility and grain yield. Grain quality parameters such as amylose, protein and carbohydrate content were adversely affected. Heat stress induced a substantial increase in phytic acid levels while simultaneously reducing grain iron and zinc concentrations, leading to elevated phytic acid-to-mineral molar ratios and reduced mineral bioavailability. Pigmented genotypes exhibited higher mineral density but also higher heat-induced phytic acid accumulation. SPDT-linked

SSR markers showed polymorphism among genotypes, and qRT-PCR revealed differential regulation of SPDT1 and SPDT2 under heat stress, indicating their involvement in phosphorus remobilization. High temperature stress exacerbates phytic acid accumulation and diminishes mineral bioavailability in rice grains, posing nutritional challenges under warming climates. Genotypic variation and SPDT-mediated molecular responses identified in this study offer promising targets for breeding heat-resilient, nutritionally improved rice varieties.

Keywords: Rice, high temperature stress, phytic acid, iron, zinc, SPDT gene, bioavailability, climate resilience

02 TPP 28

Insect dynamics and Hemerobioidea diversity of Vellayani

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ABSTRACT

The study aimed to find out the insect community dynamics and diversity of predominant predatory neuropterans of Vellayani. A total of 13 insect orders were recorded, Hemiptera followed by Lepidoptera and Coleoptera dominated the population. Six genera of hemerobioidea were collected from Vellayani. Four genera of chrysopidae (*Mallada*, *Italochrysa*, *Ankylopterix* and *Evanochrysa*) and two genera of hemerobiidae (*Micromus* and *Psectra*) were identified, among which *Mallada*, *Micromus*, and *Psectra* were the first reports from Kerala. *Mallada desjardinsi* and *Micromus timidus* were the predominant green and brown lacewings. The diversity metrics of hemerobioidea is reported highest in Vellayani across survey conducted in south Kerala, with highest alpha diversity of hemerobioidea, with Shannon–Wiener index (H') of 1.75, Pielou's evenness (J') of 0.98, margalef index (d) of 2.57 and Simpson inverse value ($1/D$) of 5.44. These



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Abstract

patterns indicate distinct spatial differences in lacewing community structure in Vellayani. Hemerobioidea abundance at Vellayani showed marked temporal variation, with low counts early in the year and peaks in mid-September under dry, warm, and humid post-monsoon conditions. Heavy rainfall suppressed activity, while moderate, stable weather supported slight increases. Correlation analysis revealed only weak relationships between abundance and temperature, humidity, or precipitation, indicating limited influence of short-term weather fluctuations. Overall, lacewing occurrence remained generally low but increased when rainfall declined and humidity remained elevated.

Keywords: Diversity, Hemerobioidea, *Mallada*, *Micromus*

02 TPP 29

Water stress tolerance in tuberose cultivars

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ABSTRACT

A research study was carried out at the Department of Floriculture and Landscaping, College of Agriculture, Vellayani, during 2024–2025, to assess the performance of five tuberose varieties, namely Arka Prajwal (V₁), Arka Nirantara (V₂), Arka Sugandhi (V₃), Arka Vaibhav (V₄), and Arka Shringar (V₅), under varying levels of water stress: F₁ (100% field capacity, control), F₂ (75% field capacity), and F₃ (50% field capacity). Water shortage affected most growth and flowering characters. Plant height showed a steady decrease as water stress was applied during all growth stages such as 16 weeks after planting (WAP), 18 WAP, and 20 WAP. The number of leaves, leaf length, and breadth also reduced under stress, and leaf breadth was lowest at 50% field capacity. Shoot fresh and dry weight also decreased under severe stress. Root dry weight also dropped from 0.90 g to 0.77 g. Flowering was delayed as stress increased; flowering took 129.36 days in control and 137.53 days at 50% field capacity. The weight of 100 florets decreased from

115.70 g to 102.07 g, and vase life reduced from 6.33 days to 4.76 days. Under the various physiological parameters evaluated the photosynthetic rate declined from 6.08 $\mu\text{mol CO}_2/\text{m}^2/\text{s}$ to 4.14 $\mu\text{mol CO}_2/\text{m}^2/\text{s}$, and chlorophyll content decreased from 1.44 mg/g FW to 1.05 mg/g FW. Under stress, plants showed higher accumulation of proline and greater activity of SOD, CAT, and POD enzymes, showing that the plants activated defense mechanisms. Among the varieties, Arka Prajwal performed best under water stress, followed by Arka Shringar and can be recommended for cultivation in water-limited areas and used in future breeding programs for stress-tolerant tuberose variety development.

02 TPP 30

Effect of Organic Amendments on Greenhouse Gases Emission and Soil Health in Wetland Rice Growing Soils of Southern Kerala

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ABSTRACT

This study assessed the role of organic amendments on greenhouse gas emissions, soil properties, and nutrient availability in wetland rice soils of southern Kerala (rabi 2024). Eight treatments with Uma rice variety were tested including farmyard manure (FYM), vermicompost, thermochemical organic fertilizer (TOF), green leaf manure (GLM), coconut husk biochar, and controls. Methane flux peaked at 30 and 60 DAT, with FYM showing the highest emissions, while coconut husk biochar reduced CH_4 release by up to 45%. CO_2 emissions declined overtime, with GLM plots recording the highest ($165.79 \text{ mg m}^{-2} \text{ hr}^{-1}$), whereas biochar kept fluxes near control levels, confirming its role in stabilizing carbon. Soil physical properties improved markedly under organic amendments. Bulk density decreased from the



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Abstract

initial 1.37 Mg m^{-3} to 1.23 Mg m^{-3} under biochar (T 6) and 1.29 Mg m^{-3} under vermicompost (T 3), representing reductions of 10% and 6%, respectively. Water-holding capacity increased from 36.64% initially to 52.39% under biochar, a relative gain of 43%. Nutrient availability was enhanced, with vermicompost increasing available N by 40%, P_2O_5 by 42%, and K_2O by 29% compared to initial values. Biochar similarly improved nutrient pools, particularly nitrogen (+45%) and phosphorus (+36%). Overall, biochar and vermicompost proved most effective, mitigating GHGs and improving soil fertility, offering a climate-smart pathway for sustainable rice cultivation in Kerala's wetlands.

Keywords: Organic amendments, Greenhouse gas emission, Biochar, Vermicompost, Soil health and fertility

THEME III

AGROBIODIVERSITY AND RESILIENT AGRI-FOOD SYSTEMS

Exploring pathways to a sustainable food system

Navin Ramankutty

Professor and Canada Research Chair in Data Science for Sustainable Global Food Systems, and Director of the Institute for Resources, Environment and Sustainability at the University of British Columbia.

Our global food system feeds people and provides livelihoods for many. But it is also one of the biggest causes of global environmental problems. Finding ways to feed 10 billion people in an environmentally sustainable and socially just manner remains a major challenge. There is a contentious debate on how this can best be achieved. Some advocate for new technological systems while others argue for agroecology and local food systems. Still others argue that we need to shift to plant-based diets and reduce food waste. In this talk, I will describe the nature of global agriculture today, broadly outline the coupled challenges of food security and environmental sustainability, and explore the benefits and costs of three proposed solutions to address them. I will conclude by suggesting pathways to a sustainable food system that couples both supply and demand side strategies.

Biodiversity and Resilient Agri-Food Systems: Experiences of Michigan State University, U.S.A.

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Michigan State University (MSU) is recognized as a global center of excellence in agricultural research and development. The College of Agriculture and Natural Resources at MSU is actively engaged in research, education, extension/outreach programs focusing on conservation and utilization of Biodiversity towards building resilient agri-food systems. Biodiversity (both crop and non-crop) is important



in providing multiple ecosystem functions and services critical to enhancing food security, pollination, biological pest control, and yield enhancement. This presentation will highlight few examples of MSU research, education, and outreach programs related to conservation and utilization of Biodiversity in agroecosystems.

Mushrooms and Agrobiodiversity Conservation: A Kerala Perspective

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Kerala, endowed with diverse agroecosystems and rich forest–agriculture interfaces, harbours a significant diversity of edible mushrooms that contribute to agrobiodiversity, food security, and rural livelihoods. This presentation examines the edible mushroom resources of Kerala with emphasis on commonly consumed and cultivated genera such as *Termitomyces*, *Pleurotus*, *Lentinus*, and *Macrocybe*, which are closely associated with traditional farming systems, homesteads, and plantation landscapes. In addition, the occurrence and significance of selected rare and regionally valued edible species, including *Amanita hemibapha*, *Cantharellus cibarius*, and *Macrolepiota* spp., are discussed in the context of conservation and sustainable use. The study also places Kerala’s edible mushroom wealth within the broader global scenario, presenting current estimates of edible mushroom diversity worldwide, species-wise contributions to consumption and cultivation, and emerging trends in production and market demand. By linking traditional knowledge, biodiversity documentation, and global perspectives, the presentation underscores the role of mushrooms as an integral component of agrobiodiversity conservation. It highlights the need for systematic documentation, habitat conservation, and promotion of sustainable harvesting and cultivation practices to ensure the long-term conservation and utilization of edible mushroom resources in Kerala.

03 TOP 01

Sustainable farming system intensification: A Climate-Resilient Strategy for Revitalizing Pokkali Ecosystem

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ABSTRACT

The Pokkali rice–fish farming system, unique to the coastal saline wetlands of Kerala, is a resilient organic method adapted to salinity, submergence, and soil acidity. It operates in two phases: monsoon months (June–October) support salt-tolerant rice, while post-monsoon seawater intrusion (November–May) enables natural infiltration of shrimp and fish, forming a rice–prawn rotational system. Though internationally recognized for sustainability, the system is declining due to socioeconomic pressures and the higher profitability of prawn monoculture. Integrating compatible year-round enterprises can enhance income and help restore the ecological and sustainability of the Pokkali ecosystem. To evaluate duck rearing as an additional enterprise for improving nutritional and economic security in the Pokkali ecosystem, a study was initiated at RRS, Vyttila and was further validated in farmers' fields of pokkali system. In this trial, rice–fish rotation was compared with rice–fish+poultry integration. In rice-fish system, rice was followed by fish (Tilapia) stocked at a density of 3000 no.s/acre. In rice-fish+poultry, introduction of fish was followed by ducks@100/acre. Data on grain yield, fish yield, egg production, B:C ratio and soil nutrient status were recorded. Duck and fish droppings, along with poultry waste improved the organic matter and nutrient status of the soil, part of which formed the feed for fish. This enhanced the growth and weight of fish reducing the cost of artificial feeding. Straw and fallen grains, chaff and other residues of rice crop served as part of the feed for fish and duck. This reduced the artificial feeding of ducks, but enhanced the growth and favoured higher egg production. It further helped in enhancing the benefit-cost ratio from 1.72 to 2.02 compared the traditional rice-fish system. Duck rearing is a viable addition to the Pokkali rice–fish system, enhancing nutritional and financial security while supporting climate-resilient farming.

Keywords: Integrated farming system, food security, climate moderation

03 TOP 02

Adoption Dynamics of Climate-Smart Practices in Coffee Production Systems of the High Ranges in Kerala

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ABSTRACT

Coffee is a perennial plantation crop highly sensitive to climatic variability, especially in the High Ranges of Kerala, where options for crop substitution are limited. Climate-smart agricultural technologies and practices (CSATPs) offer a pathway to enhance productivity, resilience, and resource-use efficiency; however, systematic studies on their adoption and regional variation among Indian coffee growers remain limited. The present study focuses exclusively on assessing the level of awareness and adoption of CSATPs and examining regional adoption patterns across Wayanad, Idukki, and Nelliampathy. The study was conducted among 175 coffee growers. An inventory of 20 CSATPs was developed through literature review, expert consultation, sorting, and categorisation into four dimensions: soil management, water management, system approaches, and crop management. The Analytical Hierarchy Process was applied to derive global weights based on five criteria: technical support requirements, cost-effectiveness, subsidisation, labour intensity, and resource conservation. Adoption was quantified using the Adoption Index of Mihretie et al. (2022). Regional mean adoption differences were analysed using ANOVA. Mulching or live mulching (0.289), rainwater harvesting (0.297), regenerative agriculture (0.274), and pruning (0.279) ranked highest for soil management, water management, system approaches, and crop management, respectively. The overall weighted adoption index across the study area was 0.3982, indicating moderate adoption with substantial scope for improvement. Dimension-wise adoption was highest for soil management (0.586), followed by

crop management (0.374), system approaches (0.373), and water management (0.259). Regional differences affected water management and system approaches, but soil and crop management did not vary significantly. The study highlights that although awareness of CSATPs is relatively high among coffee growers, actual weighted adoption remains moderate, particularly for water management and system-level practices. The integrated use of AHP and weighted adoption indexing provides a robust framework for identifying priority practices and regional adoption gaps, supporting targeted climate-smart interventions in perennial coffee systems.

Keywords: Climate-smart agriculture, Coffee production systems, Analytical Hierarchy Process, Technology Adoption, Climate adaptation

03 TOP 03

Cold Plasma Treatment for Improvement of Functional and Physico-Chemical Properties of Cassava Starch

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ABSTRACT

Cassava starch is widely used in food and industrial applications but suffers from limitations such as low solubility, high retrogradation, and poor thermal stability. Conventional modification methods often involve chemical additives and energy-intensive processes. Cold plasma (CP), a non-thermal and eco-friendly technology, was investigated to enhance cassava starch functionality. Cassava starch was treated using dielectric barrier discharge plasma under varying voltage (15–25kV), exposure time (10, 20 and 30 min), and electrode distance (8–10 cm). Response Surface Methodology (RSM) was employed to optimize parameters. Functional properties including water absorption capacity (WAC), oil absorption capacity (OAC), swelling power (SP), gel strength, viscosity, amylose/amylopectin



ratio, and color difference were analyzed. FTIR spectroscopy confirmed structural modifications. Digestibility fractions (RDS, SDS, RS) and glycemic index (GI) were also determined. Cold plasma treatment effectively modified cassava starch through reactive species interactions. Optimization identified 20 kV, 30 min, and 9 cm as ideal parameters (desirability = 0.842), with voltage exerting the strongest influence ($p < 0.001$). At optimized conditions, WAC increased from 1.85 to 2.41 g/g, OAC from 2.16 to 2.24 g/g, and SP improved by 18%, while gel strength decreased by 22%. Peak viscosity and final viscosity increased. FTIR confirmed new carbonyl and hydroxyl groups. Digestibility analysis showed RDS increased while RS and SDS decreased, and GI increased. Cold plasma treatment significantly enhanced cassava starch functionality, yielding improved absorption capacities, increased viscosity which has improved industrial applications of cassava starch. The optimized parameters establish CP as a sustainable alternative to conventional modification, with potential applications in functional foods and biodegradable materials.

Keywords: Cold Plasma, Cassava Starch, Response Surface Methodology, Physico-Chemical Properties, Glycemic Index

03 TOP 04

Enhancing agrobiodiversity and climate resilient production systems through integration of native medicinal plants: *Centella asiatica* (L.) Urban and *Gymnema sylvestre* R. Br.,

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ABSTRACT

The integration of native medicinal flora into existing agricultural systems offers a sustainable strategy to enhance agrobiodiversity and build resilience against

adverse climatic deviations. The present study focuses on two native medicinal species, *Centella asiatica* and *Gymnemasylvestre*, for developing climate-resilient and biodiverse agroecosystems. *C. asiatica* is a high-value medicinal herb with potential to revitalize nerves and brain cells, hence primarily known as “Brain food” in India. Similarly, *Gymnemasylvestre*, is a well-established natural remedy for diabetes and an important constituent of more than 100 herbal formulations recommended for diabetes and obesity. Both species hold a prominent position in the domestic and export market with a huge and escalating demand. A comprehensive evaluation of germplasm (12 nos+53 nos) collected from diverse agroclimatic conditions of India was undertaken at ICAR– IIHR, Bengaluru for 3 consecutive years to identify elite lines with high yield potential and medicinal properties. Elite lines with superior biomass yield and higher bioactive content were identified through biochemical profiling and field performance trials. In *C. asiatica*, Arka Divya (IIHR-CA-1) was identified with a higher dry biomass yield of 2.5 MT/ha /year and Arka Prabhavi was identified with higher asiaticoside content (3.85%) and higher tri-terpenoid content (7.27 %). Whereas, in *Gymnemasylvestre*, the accessions IIHR-GS-9 (7.05 kg leaves/plant) and IIHR-GS-44 (2% gymnemagenin) performed better for growth, yield and quality traits. The inclusion of such native medicinal plant varieties as intercrops or components within existing production systems not only enhances on-farm biodiversity but also contributes to livelihood diversification. Furthermore, their adaptability to marginal environments and perennial growth habit provides ecological stability and resource-use efficiency, thereby promoting a climate-resilient production system. The study underscores the dual benefits of biodiversity conservation and livelihood security through the sustainable utilization of native medicinal plant resources.

Keywords: *Centella asiatica*, *Gymnemasylvestre*, climate resilience, agroecosystems

03 TOP 05

Mixed Fruit Cropping System as a Sustainable Production Strategy for Enhancing Orchard Resilience in Sapota

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ABSTRACT

The declining cultivable land resources to meet the growing demand of fruits necessitates more sustainable and environment friendly alternative production systems. Fruit based mixed cropping systems, by including multiple fruit species in unit area, not only utilizes the resources efficiently, but also provide multiple services to the ecosystems, majorly through carbon sequestration. Though India being the largest producer of sapota fruits globally, there has been a continuous decline in area and production of sapota since 2014-15. One of the major reasons for this tapered production is lower income generation from the senile orchards. As sapota plantations under traditional systems becoming senile after a few years, coupled with low market price, farmers are shifting to alternate remunerative crops. In order to identify a suitable cropping system to transform sapota production sustainable, mixed cropping studies were conducted in 20 years old sapota orchard at ICAR-IIHR during 2015-2021 using five perennial fruits viz., guava, pomegranate, acid lime, fig and Annona. The crops were raised in double rows at a spacing of 2 m x 2 m in the interspaces of sapota trees spaced at 8.0 x 8.0 m. Five years' evaluation revealed acid lime as the suitable mixed crop as compared to guava, pomegranate, fig and custard apple. Acid lime plants could establish well in the interspaces of sapota neither affecting the sapota yield, nor the soil nutrient status, realizing higher net returns (Rs.41950/-), IRR (116%) and cost: benefit ratio of 1:

86. Thus, introduction of a perennial fruit crop in existing senile sapota orchards could enhance the crop productivity, with additional benefits of improved land use efficiency, making a sustainable production system.

Key words: Sapota, mixed fruit cropping, land use efficiency, productivity

03 TOP 06

Nutraceutical Potential of Underutilized Leafy Vegetables of Kerala

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ABSTRACT

Leafy vegetables play an important role in food and nutritional security, as they are vital sources of nutrients, and are inexpensive, easy to cook and provide less calories in the diet. Even some of the traditional leafy vegetables are reported to have higher nutritive value than the well-known common vegetables, despite they fail to compete with commonly used vegetables due to lack of awareness leading to underutilization. Further underutilized species hold great genetic diversity, and a vast heritage of indigenous knowledge is linked to them. However indigenous/underutilized vegetables are in danger of being replaced by a few cultivated species. These species apart from the nutrient richness, are also recognized for their medicinal values such as antioxidant, anti-inflammatory, diuretic, antiviral, antihepatotoxic, antidiabetic, and immunomodulatory properties due to the presence of various phytochemicals. This study evaluated the nutraceutical potential of thirty underutilized edible leafy vegetables collected from different parts of Kerala. The biochemical composition, was analysed using standard procedures. *Murrayakoenigii*(2304.53 mg GAE/g), *Centella asiatica* (2293.52 mg GAE/g) and *Phyllanthus niruri*(2291.46 mg GAE/g) were found to be rich sources of total phenol. Total chlorophyll content was highest in *Murrayakoenigii*(6.6 mg/g), followed by *Sauropusandrogynus*and *Centella asiatica* (5.5 and 5.39 mg/g



respectively). Total carotenoids were highest in *Murrayakoenigii* (73.45 mg/g), followed by *Moringa oleifera* (51.33 mg/g) and *Cassia occidentalis* (48.08 mg/g). This study highlights the phytochemical richness of these underutilized edible species, especially *Murrayakoenigii* (curry leaves) and *Centella asiatica* (Indian pennywort) emphasizing their ethno medicinal significance, leading to future development of nutraceuticals. Adoption of these underutilized leafy vegetable crops with low input requirement will diversify the agriculture and promote nutritional security.

Key words: Edible, Kerala, Nutraceutical, Underexploited leafy vegetables

03 TPP 01

Delineation of Stable and High-Yielding Coriander Cultivars Suitable for Indian Conditions Using Mixed Model Analysis and the HA-GGE Method

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ABSTRACT

Coriander (*Coriandrum sativum* L.) is cultivated across diverse agroclimatic zones in India, yet productivity remains stagnant due to strong genotype × environment (GE) interactions. Identifying stable and widely adaptable cultivars is essential for enhancing national coriander productivity. This study aimed to evaluate the yield performance, stability, and mega-environment structure of advanced coriander lines using mixed models and heritability-adjusted GGE (HA-GGE) biplot analysis. Nineteen test entries, including two national checks, were evaluated across 13 major coriander-growing locations for three consecutive years (2022–24) under the All India Coordinated Research Project on Spices. Trials followed an RCBD design with three replications. REML-based mixed model analysis was performed to partition variance components and estimate genotype BLUPs. HA-GGE biplot

analysis was used to identify ideal genotypes, delineate mega-environments, and assess the discrimination ability and representativeness of test locations. GE interaction contributed the maximum variance compared to genotype and environment main effects, indicating strong crossover interactions. Mean seed yield varied widely among sites (1.51–18.58 q ha⁻¹). RCC 12-7 emerged as the most stable and high-yielding genotype, followed by JCr 2013-15. Jobner, Navsari, and Hisar were identified as ideal testing environments with high discriminative power and representativeness. Six mega-environments were delineated, demonstrating clear differential genotype adaptation patterns. HA-GGE biplot analysis effectively identified stable coriander genotypes and optimal testing sites across India. RCC 12-7 is recommended as an ideal genotype for wider adaptability and was released and notified as Chhattisgarh Dhaniya-3 during 2024 held CVRC. Jobner, Navsari, and Hisar can serve as primary testing locations to optimize multi-location testing and enhance breeding efficiency in coriander.

Keywords: Coriander, Stability analysis, HA-GGE biplot, GE interaction, Mega-environment

03 TPP 02

Agromorphological and Biochemical Characterization of Orange-Fleshed Cucumber (*Cucumis sativus* L.): A Promising Source of Enhanced Nutritional Quality

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ABSTRACT

Cucumber (*Cucumis sativus* L.) is traditionally valued as a refreshing salad vegetable with limited nutritional density. However, the emergence of orange-fleshed genotypes has opened new avenues for biofortification through



natural carotenoid enrichment. The present study aimed to evaluate the agromorphological and biochemical characteristics of orange-fleshed cucumber in comparison with conventional white-fleshed salad types. A set of diverse genotypes was characterized for key morphological traits including fruit shape, size, yield attributes, and fruit pigmentation. Significant variation was observed among genotypes for all recorded traits, with orange-fleshed accessions exhibiting moderate yield potential and distinctive fruit quality parameters. Biochemical analyses revealed substantially higher levels of total carotenoids, particularly β -carotene, along with enhanced antioxidant activity in orange-fleshed cucumbers relative to the common green/white-fleshed types. The findings highlight the potential of orange-fleshed cucumber as a functional vegetable with improved nutritional value and scope for inclusion in breeding programmes aimed at developing nutritionally enriched cucumber cultivars.

03 TPP 03

Evaluating finger millet germplasm for shade tolerance to promote homestead cultivation

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ABSTRACT

A collection of finger millet germplasm was undertaken as part of the project on 'Ecological Restoration and Agro-biodiversity Conservation at the College of Agriculture, Vellayani'. Using the germplasm collected, an evaluation was conducted to identify shade-tolerant finger millet (*Eleusine coracana* L.) varieties suitable for homestead cultivation. The study involved local varieties collected from the tribal belts of Idukki and Palakkad, along with high-yielding varieties released by the Indian Institute of Millets Research (IIMR). These materials were assessed under three light regimes viz., open field (0% shade), 25% shade, and 50% shade created

using shade nets to simulate a partially shaded homestead situation. A total of ten varieties Poovan, Karinganni, Mutti, Mattakkachi, Puthalachi, Kunjikkari, Karimutti were the local varieties and Vakula, Indravathi, Tirumala were the high yielding varieties evaluated for their performance. The results indicated that shade levels exerted a significant influence on growth and yield parameters, particularly grain yield per plant. The highest average grain yield was recorded under open condition (9.82 g per plant), followed by progressively reduced yields under 25% shade (9.34 g per plant) and 50% shade (7.37 g/plant), highlighting the yield penalty under restricted light environments. Among the tested varieties, Mattakkachi recorded the highest yield (10.42 g per plant) and was statistically at par with Puthalachi (9.92 g/plant) and Karinganni (9.76 g/plant) followed by Kunjikkari (8.97 g/plant) and Poovan (8.63 g/plant) indicating their superior adaptability. Importantly, Mattakkachi, Karinganni, Mutti, Puthalachi and Poovan maintained relatively stable performance even under 25% shade (10.94 to 9.4 g/plant), reflecting their tolerance to partial shade and potential suitability for cultivation in homesteads and intercropping systems where light penetration is often limited. Under 50 % shade, Mattakkachi (8.78 g/plant), Karinganni (7.55 g/plant) and Poovan (7.6 g/plant) yielded better than others. The shade-tolerant ragi varieties identified in this study can serve as valuable genetic resources for sustainable millet-based farming systems in Kerala, especially in homesteads.

Key words: biodiversity, finger millet, germplasm, homestead, shade tolerance

03 TPP 04

Wild Leafy Greens – A Forgotten Nutritional Resource

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ABSTRACT

Indigenous wild leafy vegetables of Kerala constitute a significant yet underutilized component of the state's traditional food systems and ethnobotanical heritage.



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A bstract

Although often overlooked in modern agriculture, these species have regained prominence due to their remarkable nutraceutical and functional food properties, reflecting a broader global shift toward biodiversity-based and ecologically sustainable food systems. Traditionally consumed by rural and tribal communities, these wild greens possess rich profiles of phytonutrients, antioxidants, minerals, vitamins and dietary fibre, contributing to enhanced immunity, improved metabolic health and mitigation of lifestyle related disorders. Their relevance has increased in the post-pandemic period as interest in locally available, health promoting foods has intensified. Ecologically, wild leafy vegetables thrive naturally in Kerala's humid tropical climate. Their tolerance to abiotic and biotic stresses positions them as valuable components of climate resilient agroecosystems. Integrating these species into kitchen gardens and diversified cropping systems strengthens ecological functions, including supporting pollinators, natural enemies and beneficial soil organisms. Their suitability for value addition and homestead level fortification further enhances their contribution to food and nutritional security. A wide array of indigenous leafy vegetables forms part of Kerala's culinary and cultural traditions. Commonly utilized species include *Achyranthes aspera*, *Achyranthes bidentata*, *Alternanthera dentata*, *Alternanthera sessilis*, *Amaranthus* spp., *Basella alba*, *Boerhavia diffusa*, *Cassia tora*, *Centella asiatica*, *Colocasia antiquorum*, *Colocasia esculenta*, *Cyathula prostrata*, *Diplazium esculentum*, *Ipomoea aquatica*, *Leucas aspera*, *Momordica sahyadrica*, *Portulaca oleracea*, *Solanum nigrum* and *Talinum portulacifolium*. These species provide accessible, resilient, nutrient dense food sources and embody valuable ethnobotanical knowledge. Sustaining their use and conservation is essential for preserving agrobiodiversity, enhancing dietary diversity and supporting climate adaptive, resource efficient local food systems.

keywords: leafy, nutritional, greens, functional food

03 TPP 05

Performance Assessment of cherry tomato (*Solanum lycopersicum* L. var *cerasiforme*) genotypes for growth, yield, quality and sensory traits under protected cultivation**Naveen Kumar M. B., Nisha S. K., Sarada S., Thasni A. and Arundhathi N. M.**¹*Department of Vegetable Science, Kerala Agricultural University, College of Agriculture, Vellayani, Thiruvananthapuram - 695522, Kerala, India**Corresponding author E mail:nisha.sk@kau.in***ABSTRACT**

Cherry tomato (*Solanum lycopersicum* L. var. *cerasiforme*) is an emerging high-value horticultural crop owing to its attractive small fruits, enhanced sweetness, rich nutritional profile, and increasing consumer preference for salads, gourmet dishes and fresh snacking. Its indeterminate growth habit, extended production period and superior market price have further increased its adoption in protected cultivation systems. However, genotype specific performance under such environments varies considerably, necessitating systematic evaluation to identify promising cultivars. The present study assessed 29 cherry tomato genotypes under naturally ventilated polyhouse at the Department of Vegetable Science, College of Agriculture, Vellayani, Thiruvananthapuram, Kerala during 2022–2023 using Randomized Block Design (RBD) with two replications. Significant variability was observed among genotypes for growth, yield, quality and sensory parameters. Pusa Golden Cherry Tomato-2 exhibited the maximum plant height (257.17 cm), while IIHR-2857 was the earliest to 50% flowering (20.00 days). Punjab Red Cherry recorded the highest number of fruits per cluster (18.00), fruits per plant (173.00) and longest harvesting duration (164.00 days). The genotype IIHR-2863 produced the highest yield per plant (1.24 kg). For quality traits, IIHR-2857 exhibited the highest TSS (7.35 °Brix) and reducing sugars (5.92%), whereas IIHR-2863 registered the maximum ascorbic acid content (38.58 mg 100 g⁻¹). IIHR-2861 had the highest lycopene content (9.51 mg 100 g⁻¹). Sensory evaluation revealed that IIHR-2857 ranked superior for flavour, taste, texture, and overall acceptability. Based on the mean performance of genotypes for growth, yield, quality and sensory traits, IIHR-



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2857, IIHR-2863 and Punjab Red Cherry were identified as the most promising genotypes for protected cultivation in Kerala.

Keywords: Cherry tomato, Genotypes, Polyhouse, Quality, Sensory

03 TPP 06

Phenological evaluation and yield analysis in yard long bean: Parents Vs. Hybrids

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ABSTRACT

Yard long bean (*Vigna unguiculata* subsp. *sesquipedalis* (L.) Verdcourt), a trailing type of vegetable cowpea, is one of the most popular and remunerative vegetable crops, traditionally grown in Kerala. Anthracnose is one of the most destructive fungal diseases affecting yard long bean in Kerala. Fifty vegetable cowpea genotypes, collected from different parts of India including the KAU released varieties, were evaluated for anthracnose resistance under artificial inoculation, in Experiment I. Three high yielding, long podded yard long bean varieties, KAU Deepika, Githika and Vellayani Jyothika were crossed with the highly resistant, short podded bush type vegetable cowpea genotype VU53, to produce three hybrids. The study aimed to evaluate the performance of the four parents and three hybrids under field conditions, with a focus on the key phenological and yield-related traits. Significant variation was observed among the parents as well as hybrids, for the characters observed. Among the hybrids, the earliest flowering was observed in KAU Deepika x VU 53 (57.33 days). The highest number of pods per plant was recorded in KAU Deepika x VU 53 (79.33 ± 0.59), which was on par with Githika x VU 53 (76.73 ± 1.65). KAU Deepika x VU 53 was also the earliest to harvest (67.85 ± 0.96). Yield per plant was the highest in KAU Deepika x VU 53 (1416.00 ± 126.09 g), which was on par with Githika x VU 53 (1343.33 ± 75.06 g). The hybrid

KAU Deepika x VU 53 generally exhibited superior performance compared to the parents, reflecting the expression of heterosis for the traits studied. The results demonstrate the potential of the hybrid KAU Deepika x VU 53 for developing improved yard long bean segregants with desirable phenological and yield traits and anthracnose resistance in the segregating generations.

Keywords: cowpea, genotypes, flowering characters, yield

03 TPP 07

Harnessing Bitter Gourd Genetic Diversity for Yield and Downy Mildew resistance

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ABSTRACT

Bitter gourd (*Momordica charantia* L.) is an important commercial cucurbitaceous vegetable having high demand in Kerala. Downy mildew caused by *Pseudoperonosporacubensis* one of the most serious diseases occurring during the monsoon period, leading to heavy economic losses. Twenty-two genotypes of bitter gourd comprising of genotypes, released varieties and wild/semi-wild species, were collected from different parts of India and screened against *Pseudoperonosporacubensis* under artificial inoculation, in the first experiment. Further field studies demonstrated that Priyanka exhibited superior yield-related traits, while MC 50 was identified as the most resistant genotype. In the present study, the susceptible, but high yielding genotype Priyanka, was used as the female parent, and crossed with the most resistant genotype MC 50, to produce a hybrid.



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Abstract

The hybrid Priyanka x MC 50 was evaluated along with the parents for vegetative and flowering characters and yield in the main field. The hybrid recorded the longest vine (4.48 m), earliest female flower production (36.90 days) and earliest harvest (57.10 days). The highest mean female-to-male sex ratio (16.47) and the maximum number of fruits per vine (22.33) was also exhibited by the hybrid. The parent Priyanka recorded the longest fruit (30.12 cm), whereas the hybrid produced the shortest (21.30 cm). Maximum fruit weight was recorded by Priyanka (228.54 g), while minimum by the hybrid (183.19 g). Despite having smaller fruits, the hybrid recorded the highest yield per plant (3918.39 g), while MC 50 recorded the lowest yield (2249.80 g). Overall, the hybrid outperformed both the parents for morphological characters, recorded the highest yield per plant and the lowest incidence of downy mildew. These results indicate that hybridization between high-yielding but susceptible genotypes and resistant parents is an effective strategy for developing high-yielding and downy mildew resistant bitter melon hybrids.

Keywords: Bitter melon, *Pseudoperonosporacubensis*, Hybridization, Disease resistance, Yield

03 TPP 08

Performance evaluation of cherry tomato hybrids under open field condition in southern Kerala

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ABSTRACT

Cherry tomato [*Solanum lycopersicum* L. var. *cerasiforme* (Dunal) A. Gray] is an important botanical variant of cultivated tomato, valued for its sweet flavour, attractive fruit colour and high antioxidant content. With increasing consumer demand in urban and peri-urban markets, its cultivation is expanding rapidly in Kerala. The considerable genetic variability available in cherry tomato offers scope for selecting superior hybrids with improved yield and quality traits. In this study, fifteen cherry tomato hybrids along with eight parents were evaluated under open-field conditions at the Department of Vegetable Science, College of Agriculture,

Vellayani, to assess variability in growth, yield and fruit quality traits. Significant phenotypic variation was recorded among the hybrids for plant height (101.66–245.66 cm), representing determinate, semi-determinate, and indeterminate growth habits. The hybrid Pusa Red Cherry Tomato × IIHR 2857 showed superior performance, characterised by medium plant height (165.66 cm; semi-determinate type), early flowering (20.33 days), the highest number of fruits per plant (264.66) and the highest total soluble solids (7.03 °Brix). Among the parental lines, IIHR 2857 exhibited the earliest flowering (19.66 days). Maximum fruit weight was recorded in the hybrid VL Cherry Tomato × SL 19 (15.69 g) which was on par with Punjab Kesar × IIHR 2863 (15.59 g), and Punjab Kesar × SL 19 (14.18 g). Since medium-sized cherry tomatoes are generally preferred, the hybrid Pusa Red Cherry Tomato × IIHR 2857 (8.60 g) was identified as the most suitable one. The highest fruit yield per plant was obtained from VL Cherry Tomato × SL 19 (3.32 kg), followed by Pusa Red Cherry Tomato × IIHR 2857 (2.57 kg). Overall, Pusa Red Cherry Tomato × IIHR 2857 emerged as the most promising hybrid, combining high yield potential with desirable quality traits, well suited for open field cultivation under the agroclimatic conditions of southern Kerala.

Key words: Cherry tomato, variability, yield, open field, hybrids

03 TPP 09

Genetic diversity of yard long bean (*Vigna unguiculata* subsp. *sesquipedalis*(L.) Verdcourt)- a comparative analysis for vitamin content

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ABSTRACT

Yard long bean (*Vigna unguiculata* subsp. *sesquipedalis*(L.) Verdcourt), known as 'Vallipayar', 'Achingapayar', 'Kurutholapayar', or 'Pathinettumaniyan', is the most popular and remunerative leguminous vegetable crop, traditionally cultivated



in the humid tropics of Kerala, primarily for the crisp, tender pods, that can be consumed both raw and cooked. Yard long bean is a better source of protein, minerals, vitamins and fibre and an abundant source of folate and micronutrients like zinc, iron, manganese and cobalt. The present study was conducted at the College of Agriculture, Vellayani, aimed at profiling yard long bean genotypes for identifying the superior ones for vitamin content. The experiment was laid out in RBD with two replications and the experimental material consisted of green pods of twenty yard long bean genotypes, collected from diverse sources. Significant difference was observed among the genotypes for the Vitamin A, B₁, B₂, B₃ and C contents. The highest beta carotene content of 512.87 µg100g⁻¹ was recorded in Vyjayanthi. KMV 1 recorded the highest vitamin B₁ content of 0.94 mg 100 g⁻¹ of dry weight, Githika (0.92 mg 100 g⁻¹ of dry weight) and Lola (0.90 mg 100 g⁻¹ of dry weight) being on par. The highest vitamin B₂ and B₃ contents were also recorded in Githika (0.40 mg 100 g⁻¹ of dry weight and 2.21 mg 100 g⁻¹ of dry weight respectively). The highest vitamin C content was recorded in Noori (26.28 mg 100 g⁻¹ of fresh weight), which was statistically on par with KAU Deepika, Githika, Vyjayanthi and FH7 (25.96 mg 100 g⁻¹ of fresh weight) and Vellayani Jyothika (25.32 mg 100 g⁻¹ of fresh weight). The results highlight the superiority of the KAU released yard long bean varieties, Vyjayanthi for vitamin A content and Githika for the vitamins B₁, B₂, B₃ and C contents.

Keywords: Yard long bean, genotypes, nutrient profiling, vitamins

03 TPP 10

Morphological characterization of long melon genotypes

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ABSTRACT

A study was conducted to assess the genetic diversity of fifteen long melon (*Cucumis melo* var. *utilissimus* Duthie & Fuller) genotypes collected from

different parts of India, at the Department of Vegetable Science, College of Agriculture, Vellayani, from September 2024- January 2025. The genotypes were evaluated for variability in 16 different morphological traits. The Shannon Weaver diversity index (H') was applied to quantify phenotypic variability and identify the most informative descriptors among the genotypes. High H' values (2.54–2.71) recorded for polymorphic traits such as predominant and secondary fruit skin colour, flesh colour, taste, fruit size, skin texture, ovary shape, seed weight, fruit ribbing, blossom end shape and placenta colour, indicated broad and balanced morphological variation. In contrast, the remaining characters were monomorphic with limited discriminatory value. The strong association between polymorphic traits and elevated H' values underscores their ability to distinguish genotypes. Overall, the diversity patterns revealed by the Shannon Weaver index underline its importance for trait based selection and provide valuable guidance for long melon germplasm improvement and breeding programmes.

Keywords: *Cucumis melo* var. *utilissimus*, diversity, long melon

03 TPP 11

Dietary Agro-Biodiversity as a Determinant of Resilient Agri-Food Systems: A Study on Nutrient Intake and Degenerative Disease Risks

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ABSTRACT

Agro-biodiversity forms the foundation of resilient agri-food systems by ensuring access to a wide range of nutrient-rich foods essential for preventing degenerative diseases. Dietary diversity was assessed among 100 young adults (21–45 years) to understand how consumption of various biodiversity-linked



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Abstract

Food groups influence early health risks. Participants were categorized into normal (n=25) and at-risk groups for diabetes, coronary heart disease, and hypertension (n=75). Dietary intake was evaluated using a 24-hour recall focusing on cereals and millets, pulses and legumes, green leafy vegetables (GLVs), other vegetables, fruits, nuts and oilseeds, flesh foods, and milk. These groups were used as indicators of agro-biodiversity within diets. Normal subjects demonstrated comparatively better dietary diversity. Among males: cereals, millets, pulses, and vegetables were consumed slightly below recommended intake, while GLVs, fruits, milk, and nuts were consumed above recommended levels. Female normal subjects similarly consumed adequate pulses, milk, fruits, and nuts. This pattern reflected moderate inclusion of biodiversity-rich foods. In contrast, all at-risk groups exhibited a significant decline in dietary diversity. Diabetic, coronary heart disease, hypertensive, and risk-category subjects consumed lower amounts of cereals and millets, pulses, GLVs, vegetables, fruits, flesh foods, and nuts, with milk being the only food group consumed above recommendations. Reduced intake of pulses, GLVs, fruits, and oilseeds, key biodiversity-linked foods, indicate erosion of diet diversity. Nutrient analysis showed higher carbohydrate and fat intakes and lower energy, protein, fibre, and sodium intakes among at-risk subjects, trends strongly associated with insufficient dietary diversity. The findings emphasize that loss of dietary biodiversity contributes to early onset of degenerative disease risks. Strengthening community biodiversity management through the promotion of indigenous millets, pulses, leafy vegetables, and underutilized crops can enhance both nutritional outcomes and agri-food system resilience.

Keywords: Agro-biodiversity, dietary diversity, resilient agri-food systems, nutrient intake, degenerative disease risk, millets and pulses, green leafy vegetables, community biodiversity management, biodiversity-linked food groups, nutritional resilience.

03 TPP 12

**Breaking the yield–susceptibility linkage in rice:
Divergent parental selection for sheath blight
resistance****Bandela Chandana, Adheena Ram A.* and Seeja G.**¹Department of Genetics and Plant Breeding, College of Agriculture, Vellayani,
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ABSTRACT

Sheath blight, caused by the necrotrophic fungus *Rhizoctonia solani*, is a major constraint in rice production worldwide, leading to severe yield losses under favourable conditions. Identifying genetically diverse donor genotypes with desirable resistance and yield attributes is essential for breeding sheath blight resistant rice varieties. In this study, thirty rice genotypes were evaluated for fifteen agro-morphological, yield, and disease-related traits to identify diverse parental sources for breeding sheath blight-resistant, high-yielding varieties. The genotypes were screened in completely randomized design with two replications and were artificially inoculated with fungal mycelial bits at the maximum tillering stage. Observations included phenology, tillering, plant stature, yield components and disease parameters, such as lesion height, relative lesion height, number of lesions and percentage disease index. Genetic divergence was assessed using Mahalanobis D^2 statistics and Ward's clustering, supported by principal component analysis. Cluster analysis grouped the genotypes into four distinct clusters, revealing considerable variability. Cluster III exhibited superior mean performance for yield-related traits, while Cluster I included moderately resistant genotypes. The maximum inter-cluster distance was observed between Clusters I and IV, indicating high divergence and a potential for heterosis and transgressive segregation. Disease severity was lowest in Cluster III and highest in Cluster IV. No single cluster combined all desirable traits, underscoring the need for targeted hybridization between divergent clusters. PCA supported the clustering pattern, with the first principal component highlighting the contrast between yield traits and disease susceptibility. Based on the combined analysis, *Chenthadi* and *Krishnanjana* (Cluster I) were identified as suitable donors for sheath



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blight resistance, while *Uma*, *Prathyasa* and *Bhagya* (Cluster III) were identified as promising high-yielding parents. The significant genetic divergence between these clusters indicates that hybridization between them could effectively break the yield-susceptibility linkage and facilitate the development of rice varieties that combine high yield with durable sheath blight resistance.

Keywords: Rice, sheath blight, *Rhizoctonia solani*, genetic divergence, cluster analysis

03 TPP 13

Agrobiodiversity of non-dessert *Cucumis melo* Types in Kerala

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ABSTRACT

Melon (*Cucumis melo* L.) is one of the most polymorphic cucurbits in India, exhibiting remarkable variability in fruit morphology, acidity, texture, and use-value. Kerala represents a distinct micro-centre of culinary melon diversity, where non-dessert types such as *C. melo* var. *conomon* (oriental pickling melon), *C. melo* var. *acidulus* (culinary melon), and *C. melo* var. *momordica* (snap melon) are traditionally cultivated. Other minor and regionally restricted forms, also occur in localized pockets in India, including *C. melo* var. *callosus* (kachri) and *C. melo* var. *utilissimus* (long melon), shaped by regional culinary preferences for curries, pickles. A study was conducted to evaluate the diversity of various melon accessions, which were assessed for different morphological traits at the College of Agriculture, Vellayani, during February to May 2025. Considerable variation was recorded among the accessions for fruit colour, fruit shape, vine length, seed cavity structure etc. The observed fruit length ranged from 18.53 to 41.18 cm in *C. melo* var. *acidulus*, 13.35 to 21.90 cm in *C. melo* var. *conomon*, 2.55 to 3.10

cm in *C. melo* var. *callosus*, 26.61 to 33.78 cm in *C. melo* var. *chate*, and 29.65 to 40.23 cm in *C. melo* var. *utilissimus*. Variability was observed for skin colour of fruit which was green, white, orange with or without strips and shape of fruit was Globular, Oblate, Elliptical, Pyriform etc. The wide phenotypic variability observed across these subspecies highlights the rich agrobiodiversity present within *C. melo*. Such diversity offers valuable potential for breeding programmes aimed at crop improvement, climate resilience, and nutritional diversification. This study highlights the need to assess the existing melon diversity in Kerala and underscores the importance of conserving these valuable local varieties.

Keywords: Melon, Agrobiodiversity, Kerala

03 TPP 14

Harnessing Genetic Diversity and Heterosis for Yield Enhancement in Bottle Gourd (*Lagenaria siceraria*)

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ABSTRACT

Bottle gourd (*Lagenaria siceraria* (Mol.) Standl.), an ancient cucurbit of high nutritional and genetic diversity, offers a fertile canvas for exploring hybrid vigour as a strategy to enhance productivity. The present investigation, conducted during Zaid 2022 at the Main Experiment Station, Department of Vegetable Science, A.N.D.U.A.&T., Kumarganj, Ayodhya (U.P.), evaluated the manifestation of heterosis and combining ability across twenty-three yield-related traits using nine lines and three testers through a line × tester mating design that produced 27 hybrids. A wide spectrum of heterosis was observed for fruit yield per plant, with values ranging from 115.08% in the hybrid NDBG-65-2 × Narendra Kamna to -13.96% in the hybrid Pusa Naveen × Narendra Pooja over the better parent, and from 115.08% in NDBG-65-2 × Narendra Kamna to -4.60% in Pusa Naveen × Narendra Pooja over the standard parent. The most promising heterotic hybrids



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for fruit yield were NDBG-65-2 × Narendra Kamna, NDBG-65-2 × Narendra Prabha, NDBG-Sel-2 × Narendra Kamna, Narendra Rashmi × Narendra Kamna and NDBG-21 × Narendra Pooja. Significant GCA and SCA variances across all traits indicated the importance of both additive and non-additive genetic components. Among parents, NDBG-Sel-2, Punjab Komal, NDBG-65-2, Narendra Kamna and Narendra Prabha emerged as superior general combiners. The hybrids NDBG-21 × Narendra Pooja, NDBG-17 × Narendra Kamna, Pusa Naveen × Narendra Pooja, NDBG-28 × Narendra Prabha and NDBG-65-2 × Narendra Prabha were identified as the best specific combiners. For fruit yield, NDBG-65-2 was the most desirable general combiner, while Narendra Rashmi × Narendra Kamna showed the highest specific combining ability. Overall, the study highlights the genetic richness within bottle gourd and underscores the potential of targeted hybridization to harness its biodiversity for yield enhancement. The identified heterotic hybrids and superior combiners provide valuable resources for developing high-yielding, climate-resilient cultivars to support sustainable vegetable production.

03 TPP 15

Effect of Pulsed Light Treatment on Microbial Quality and Preservation of Passion Fruit Juice

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ABSTRACT

Growing consumer demand for minimally processed, nutrient-rich beverages has increased interest in non-thermal preservation technologies. This study evaluated pulsed light (PL) technology for preserving passion fruit (*Passiflora edulis*) juice, optimizing treatment parameters while maintaining nutritional and sensory quality. Response Surface Methodology using Box-Behnken design (17 experimental runs) optimized PL parameters: voltage (1500–2000 V), pulses (30–100), and distance (3–8 cm). Four storage treatments were examined over 21 days: control ambient (T1), control refrigerated (T2), optimized ambient (T3), and optimized refrigerated (T4). Quality parameters included microbial load, pH, TSS, ascorbic acid, phenolic content, antioxidant activity, color, and turbidity. Passion fruit

juice processing using PL treatment effectively inactivated microorganisms while maintaining juice quality through photochemical, photothermal, and photophysical mechanisms. The UV-C component (200-280 nm) disrupted microbial DNA, causing structural damage to cell walls and cytoplasmic membranes. Optimization analysis identified 1500 V, 90 pulses, and 5.5 cm distance as ideal parameters (desirability = 0.516), with voltage demonstrating the strongest influence on quality attributes ($p < 0.001$). Refrigerated PL-treated juice (T4) maintained acceptable quality for 21 days, significantly outperforming ambient control (T1, 7 days) and refrigerated control (T2, 14 days). The optimized treatment reduced microbial load by 3.82 log CFU/mL. After 21 days, T4 samples preserved 80% of initial vitamin C (11.5 mg/100 mL) and phenolic compounds (47.55 mg GAE/mL), whereas untreated samples exhibited losses exceeding 50%. Antioxidant capacity remained high at 103.98%, with minimal color degradation ($\Delta E = 2.08$) and stable turbidity. PL treatment effectively extended shelf life of passion fruit juice, enhanced microbial safety, and maintained bioactive and sensory qualities. The findings demonstrate significant potential for passion fruit juice production, offering a sustainable processing solution. Combined PL treatment and refrigeration provided superior preservation compared to thermal methods, establishing PL as a viable alternative for minimally processed juice production.

Keywords: Pulsed light technology, passion fruit juice, non-thermal preservation, microbial inactivation, shelf life extension.

03 TPP 16

Njavara as a Bioactive-Rich Landrace: Strengthening Agrobiodiversity and Climate Resilience

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ABSTRACT

Njavara (*Oryza sativa* L.), a traditional medicinal rice landrace of Kerala, is an important component of India's agrobiodiversity and a valuable reservoir of adaptive genetic traits. Its long history of cultivation, low input requirements, and



inherent tolerance to diverse environmental conditions underscore its relevance for strengthening climate-resilient agri-food systems. In addition to its agronomic value, Njavara is widely recognized for its nutritional richness and therapeutic applications. In this study, methanolic extracts of Njavara grains were subjected to GC–MS analysis, which revealed a broad array of bioactive phytochemicals with potential nutraceutical significance. To further evaluate their functional relevance, the identified compounds were screened *in silico* through molecular docking against major SARS-CoV-2 protein targets. Several metabolites demonstrated strong binding affinities, indicating potential inhibitory activity and suggesting a pharmacological dimension to this landrace beyond its traditional uses. The integration of phytochemical profiling with computational screening illustrates how indigenous crop genetic resources can serve dual roles—enhancing agricultural sustainability while contributing to human health. These findings reinforce the importance of conserving traditional landraces such as Njavara, which act as reservoirs of functional traits and bioactive molecules essential for promoting agrobiodiversity, nutritional security, and climate-resilient agriculture.

03 TPP 17

Characterising Homegarden Diversity in Northern Kerala: An Agrobiodiversity Assessment and Documentation Appraisal

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ABSTRACT

Homegardens represent an integral component of Kerala's agroecological systems, underpinning sustainable resource use, household nutrition, and on-farm agrobiodiversity. Despite their global relevance, empirical documentation remains insufficient (Wiersum, 2006), further constrained by the lack of clear demarcation between homesteads and adjacent cultivated land (Kumar and Nair, 2006). Although the People's Biodiversity Register (PBR), mandated under the Biological Diversity Rules, 2004, is the most comprehensive institutional mechanism

for recording biological resources, its utility is limited by incomplete entries, restricted accessibility, and inadequate household-level data. A primary survey of 80 households in Kadirur Panchayat was conducted to compare household-level observations with existing PBR entries, focusing on documenting food crops, perennial species, and livestock to identify omissions and assess homegarden diversity. The survey revealed significant omissions, including seven food crops and multiple varieties of coconut, arecanut, and fruit species, underscoring critical gaps in local biodiversity inventories. The assessment indicated that homegardens are predominantly composed of coconut, banana, and arecanut, with fruit crops exhibiting the highest species richness. The mean Shannon diversity index was 2.06, with vegetables recording the highest diversity values. Livestock diversity was notably low, with only 6 of 80 households maintaining cows, goats, or hens; poultry was the most common, driven by backyard poultry schemes such as “Adukkalathottathile Kozhivalarthal.” Enhancing structured household surveys, improving PBR documentation protocols, and incentivising livestock diversification are essential to improve biodiversity documentation and enhance the resilience of homegarden-based food systems in Kerala.

Keywords: Homegardens, agrobiodiversity, PBR, Shannon diversity index

03 TPP 18

Biochemical profiling of *Cycas circinalis*, an uncommon edible plant used by the Malasar tribe in Palghat

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ABSTRACT

Food production systems are becoming increasingly fragile as crop diversity in agricultural production systems continues to decline. Moreover, the increasing global population has continued to put immense pressure on the available food resources. It is the need of the hour to think of suitable alternatives to the regular crops. A large variety of uncommon food crops are consumed in diverse tribal communities of Kerala. It was recorded that the Malasar tribe of Palghat were



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making use of *Cycas circinalis* for edible purposes. *Cycas circinalis* L. is a cycad endemic to South India. The study was carried out in Palghat district of Kerala. Data on the various plants consumed by the tribes was collected with the help of tribal people residing in the respective regions. The data collection was done through qualitative analysis like random survey and interview conducted using standardized forms containing, structured and semi-structured questions. The young leaves of *C. circinalis* were then subjected to analysis of various biochemical parameters along with mineral profiling. The biochemical profile of *C. circinalis* was revealed and it showed certain really significant values which well substantiated its usage for edible purposes. The mineral profile was also interesting. The possibility of using *C. circinalis* for edible purposes has been highlighted through this study. In the present times, inspiration can be drawn from the Malasar tribes for the wise usage of plants for human health. This will also help in promoting the cultivation of this plant on a wider scale.

Keywords: Malasar, Palghat, *Cycas circinalis*,

03 TPP 19

Biochemical diversity and value added utilisation of dragon fruit (*Selenicereus* spp.) in Kerala

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ABSTRACT

Dragon fruit (*Selenicereus* spp.) is emerging as an important fruit crop in Kerala due to its adaptability, high nutritional value, and economic potential. However, limited information exists on the biochemical diversity among the major cultivated types, white-fleshed (*Selenicereus undatus*), purple-fleshed (*Selenicereus costaricensis*), and yellow-fleshed (*Selenicereus megalanthus*). The present study assessed key biochemical parameters including Total Soluble Solids, titratable acidity, total sugar, reducing sugar, crude fibre, ascorbic acid, carotenoid, phenol, flavonoid, betalain content, and antioxidant activity in these three types

grown under Kerala conditions. Marked variability was observed: red dragon fruit recorded the highest betalain concentration, and yellow fruits showed superior sweetness and Total Soluble Solids. The biochemical analysis revealed that dragon fruits exhibited biochemical attributes and were rich in bioactive compounds suitable for processing into value added products. To explore the value addition potential, fruit jams were prepared from purple-fleshed dragon fruit. Dragon fruit blended with pineapple, papaya and guava jam formulations were also developed. The developed products showed good sensory acceptability, natural pigmentation, and enhanced functional qualities in blended combinations. The findings highlight substantial biochemical diversity within *Selenicereus* species in Kerala and demonstrate their suitability for the development of nutritionally enriched, value-added products. This study underscores the importance of dragon fruit as a promising horticultural resource contributing to biodiversity and livelihood enhancement in the state.

03 TPP 20

Spatial quantification of agrobiodiversity and agricultural resilience in India using diversification indices, clustering, and geospatial modelling

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ABSTRACT

Agrobiodiversity, the diversity of crops, cropping patterns, and agroecosystems, is central to the sustainability and resilience of agricultural systems. Diversified farming stabilises yields, reduces climate risks, and supports soil and ecosystem health. In India's highly climate-sensitive agriculture, characterised by contrasting agroecological zones ranging from monoculture-dominated systems to diversified landscapes, assessing agrobiodiversity is critical for ecological and economic stability. This study quantifies crop diversification using specialisation and diversity indices (Herfindahl Index, Simpson Diversity Index (SDI), and Shannon Entropy) and evaluates agricultural resilience using instability metrics, Cuddy Della-Valle



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A bstract

Index (CDVI) derived from temporal variability in yield and production. A dual assessment framework integrating structure (diversification) and function (stability) was developed. PCA highlighted coordinated patterns among diversification and instability indicators, and regression analysis showed that SDI and Entropy exert statistically significant negative effects on instability, indicating that more diverse and balanced cropping systems contribute to greater agricultural resilience. State-level machine learning clustering (K-means) classified regions into diversification-resilience regimes, followed by visualisation of different clusters. It was found that the CDVI results reveal substantial variability in productivity across crops and states. Bajra shows the highest instability in Madhya Pradesh, Coconut in Bihar, and Jute & Mesta exhibit peak instability in Assam, Potato in Karnataka, Tomato in Haryana, and Wheat in Karnataka. Overall, productivity instability is markedly uneven across states and crops. The spatial insights generated support targeted diversification strategies and agroecological planning for climate-resilient agriculture in India.

Keywords: Agrobiodiversity, Cuddy Della-Valle Index, Herfindahl Index, PCA, Simpson Diversity Index.

03 TPP 21

Agrobiodiversity and the Specialization Trap: A Pathway to Resilient Agri-Food Systems in India.

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ABSTRACT

The global transition to sustainable agriculture necessitates research on the elements contributing to agricultural resilience. Household level data from the NSS 77th Round (2019) Situation Assessment Survey (SAS) was taken. The study examined how agrobiodiversity/crop diversification (CD) affects resilience among smallholder farmers. The study utilized weighted poisson and logit regression models to evaluate the causal relationships between CD, financial stability, and economic outcomes. The analysis showed that CD is the primary pillar of economic resilience. High diversity farms achieve a mean total income that is more than twice

as high as low diversity farms. This financial benefit is attained even though a high diversity system with a high investment structure has greater expenses. Weighted poisson regression revealed that a rise in irrigated and operated area significantly lowers the rate of CD. This suggests that resource abundance encourages vulnerable specialization in cash crops. This pattern is further validated by regional analysis showing lower diversity in resource rich zones. Weighted logit regression indicates that non-farm net income was the most influential positive factor for obtaining formal credit. It highlighted that diversified livelihoods are essential for achieving financial stability and securing investment capital. In conclusion, although integrated farming systems and agrobiodiversity are established as critical drivers of improved returns and adaptive capacity, policy interventions must deliberately address the specialization incentives that erode crop diversity while simultaneously promoting off-farm income stability to strengthen credit accessibility among economically vulnerable smallholders.

Keywords: Agrobiodiversity, Resilience, Financial Inclusion, Livelihood Diversification, Crop Diversification (CD), Resilience

03 TPP 22

Ozone Treatment for Reducing Quinalphos Residues in Cardamom

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ABSTRACT

Cardamom (*Elettaria cardamomum*) is a major export spice, but its cultivation often involves organophosphate pesticides such as quinalphos. Residues



remaining on harvested capsules create serious food safety concerns and lead to frequent export rejections. Conventional decontamination techniques are not always effective for lipid-soluble pesticides and may affect quality characteristics like colour, aroma, and essential oil content. Ozone (O₃), a strong oxidizing agent recognized as safe, offers a promising non-thermal method for degrading pesticide residues without leaving harmful by-products. This study investigates the effectiveness of aqueous ozone at different concentrations and exposure times in reducing quinalphos residues on cardamom, while also assessing its impact on key physicochemical properties. Fresh cardamom capsules were artificially spiked with uniform quinalphos levels. Treatments included ozone concentrations of 5%, 15%, and 30% applied for 300, 900, and 1800 seconds. After treatment, samples were dried at 50 °C. Residual quinalphos was measured using GC–MS. Quality attributes analysed included colour (L*, a*, b*, ΔE), essential oil, oleoresin, antioxidant activity (DPPH), and total phenolics. Quinalphos degradation increased with higher ozone concentration and longer exposure. Maximum reduction occurred at 30% for 1800 seconds. The combination 15% for 900 seconds achieved effective degradation while maintaining desirable colour, essential oil, and oleoresin content. Moderate ozone levels slightly enhanced antioxidant activity and phenolics, while higher intensities caused minor quality reductions. Aqueous ozone effectively degraded quinalphos residues while preserving cardamom quality. The treatment of 15% ozone for 900 seconds was identified as optimal for safe, high-quality cardamom processing.

Keywords: Cardamom, Ozone, pesticide residue, Quinalphos, Organophosphate, physicochemical quality

03 TPP 23

Spatio-temporal analysis of crop diversification in Kerala

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ABSTRACT

Crop diversification is central to strengthening agricultural sustainability, ecological resilience, and farmer income stability. Kerala, with its diverse

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agro-ecological regions and long tradition of mixed cropping, offers an important context for analysing long-term changes in agrobiodiversity. This study analyzes district-level crop diversification in Kerala over the period 1985-86 to 2023-24. Diversification was measured using the Herfindahl-Hirschman Index (H.I), with the lower values representing increased diversification. The results show that Kerala remains broadly diversified, with most districts having H.I values well below the specialization threshold of 0.66. However, distinct spatial patterns are evident. Kottayam, Pathanamthitta, Kozhikode, Kannur, Kasaragod and Malappuram display a gradual rise in H.I, indicating increasing crop concentration driven by the expansion of plantation crops such as rubber, coconut and arecanut. Thiruvananthapuram and Kollam also show moderate increase while remaining within the diversified range. In contrast, Palakkad records a clear decline in H.I, reflecting a shift toward greater diversification. Thrissur, Alappuzha, Wayanad, Idukki and Ernakulam exhibit relatively stable trends over time. Correlation analysis provides further insight into these patterns. In most districts, higher cropping intensity, larger gross cropped area and greater landholding size have negative correlations with H.I, indicating that increased cultivation or cropping intensity generally support crop diversification and enhance system resilience. Plantation-dominated districts show a different pattern. In both Idukki and Pathanamthitta, H.I has a positive correlation with cropping intensity, suggesting that intensification in these regions tends to reinforce the dominance of perennial plantation crops rather than promote diversified cropping patterns. Overall, the findings reveal a dual trajectory in Kerala's agriculture, while many districts continue to maintain diversified and resilient cropping systems, others are moving toward more specialized and less diverse structures. These results underline the need for district-specific strategies to sustain agrobiodiversity and strengthen long-term agricultural resilience.

Keywords: Crop diversification, Herfindahl-Hirschman Index, Agrobiodiversity, Cropping intensity, Kerala agriculture, Spatial analysis



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Abstract

03 TPP 24

Phytochemical Profiling and *In Silico* Identification of PI3K/Akt/mTOR Inhibitors from Krishna Kamod Rice

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ABSTRACT

Krishna Kamod rice is an indigenous aromatic black rice variety of India, popularly recognized as the “Basmati of Gujarat” due to its distinctive flavour and high consumer preference. This variety is nutritionally rich, containing significant levels of dietary fibre, essential micronutrients such as iron, zinc and magnesium, and B-complex vitamins. It also exhibits a medium glycemic index, making it suitable for health-focused dietary applications. Its characteristic aroma is mainly attributed to the volatile compound 2-acetyl-1-pyrroline, along with several other secondary metabolites that contribute to its unique sensory qualities. The present study explores the anticancer potential of Krishna Kamod rice by evaluating its bioactive constituents for their activity against the PI3K/Akt/mTOR signalling pathway. This pathway plays a central role in regulating cell growth, survival, metabolism and proliferation, and its abnormal activation is widely associated with the development and progression of various cancers. Therefore, targeting this pathway provides an important strategy for discovering new anticancer molecules. LC-MS analysis of Krishna Kamod rice identified 86 phytochemicals, including alkaloids, flavonoids and terpenes. Compounds that satisfied Lipinski’s Rule of Five were selected for molecular docking studies against PI3K (PDB ID: 4TV3). Virtual screening highlighted six promising candidates, of which the top three—Progeldanamycin, Cyclic dehydropoxanthinylfutasosine and (16 α)-16,17-(1-Phenylethylidene)bis(oxy))pregn-4-ene-3,20-dione—showed strong binding affinities of -8.8, -8.5 and -8.2 kcal/mol,

respectively. These values were higher than the affinity of the reference inhibitor Voxelotrisib (-7.4 kcal/mol), indicating superior predicted interaction with the target protein. Further ADMET assessment using SwissADME revealed favourable pharmacokinetic characteristics, including good gastrointestinal absorption and acceptable solubility, suggesting strong drug-like behaviour. Overall, this study provides *in silico* evidence supporting the anticancer relevance of Krishna Kamod rice. The identified lead exhibit strong binding potential toward PI3K and may serve as leads for designing more potent anticancer compounds. Keywords: Anticancer potential, Krishna Kamod rice, LC–MS phytochemical profiling, Molecular docking, PI3K/Akt/mTOR inhibition

03 TPP 25

Accessible Food Forest Farming: Ensuring the Full Participation of the Visually Challenged in Agriculture

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ABSTRACT

Individuals with visual impairments are often systematically excluded from agricultural participation due to their reliance on visual cues, challenging terrain, and the design of standard equipment. This denies them a vital connection to nature, a potential source of livelihood, and the therapeutic benefits of working with plants. This project attempts to address this exclusion by developing an adapted agricultural model that ensures a healthy food source, creates a therapeutic environment, and provides a potential source of study income. To design, implement, and demonstrate a replicable and resource-efficient food forest model that ensures full accessibility through strategic land preparation, mobility-friendly infrastructure, and the development of eyes-free techniques for plant care and maintenance. The model incorporates specific adaptations to overcome barriers posed by vision loss. Key methods include land preparation



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and contouring the land to ensure safe and independent mobility. Multisensory Plant Selection, Prioritizing plant species identifiable through touch, scent, and sound. Infrastructure, utilizing drip irrigation lines and tactile guides to navigate the farm. Eyes-Free Techniques, Designing pits, trenches, and mounds to simplify independent tasks such as manuring, watering, and harvesting. Results of this project demonstrate that with intentional design, agriculture can be transformed into an inclusive and empowering activity for the visually challenged. The accessible farm model aligns with the spirit of the Rights of Persons with Disabilities (RPwD) Act, 2016, by promoting full and effective participation. Beyond food production, the model offers significant therapeutic value, enhances mental well-being, and can generate a sustainable income, thereby bringing profound meaningfulness to the lives of persons with disabilities.

Keywords: Accessibility, Adapted Equipment, RPwD Act 2016, Eyes-Free Environment, Food Forest, Horticultural Therapy, Biodiversity, Inclusive Farming.

03 TPP 26

“Thekken”: Tapping the Biodiversity Gold Mine for Superior Black Pepper Yields

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ABSTRACT

Black pepper (*Piper nigrum* L.), the king of spices, originated in the Western Ghats, represents one of India’s most iconic biodiversity resources. Among indigenous cultivars, *Thekken* exhibits an exceptionally high-yielding phenotype driven by a distinctive branching architecture, positioning it as a candidate genetic resource for bridging yield gaps and supporting sustainable spice production. The present study investigated developmental, molecular, histological, protein-level, and hormonal

determinants underlying Thekken's unique spikelet formation and branching behaviour, compared against the widely cultivated genotype Panniyur-1 and the traditional cultivar Karimunda with the objective to incorporate the branching trait for enhancing yield. Morphological characterisation demonstrated that Thekken produced a six-fold increase in berries per spike (480) relative to Panniyur-1 (79), despite comparable spike length (12 cm vs. 14 cm). Floral morphology revealed thicker bracts and elongated internodes in Thekken during early developmental stages, culminating in visible branching during stage-3, a feature absent in non-branching cultivars. Histological analysis provided anatomical evidence supporting branching capacity. A distinct meristematic cell mass was observed adjacent to the floral meristem in Thekken during stage-1, progressively differentiating into spikelets by stage-3. This meristematic reservoir was absent in both Panniyur-1 and Karimunda, indicating a developmental divergence enabling secondary meristem initiation and prolonged reproductive capacity. Molecular analysis targeted two architectural regulatory genes: PIN-FORMED1 (*PIN1*), an auxin efflux carrier, and BREVIPEDICELLUS (*BP*), a homeobox developmental regulator. Primer design and amplification confirmed the presence of both genes, with sequencing showing 25% nucleotide variation in *PIN1* and 5% variation in *BP* between Thekken and Panniyur-1. Expression profiling via qRT-PCR revealed elevated transcription of *PIN1* across all developmental stages in Thekken, with a 14-fold peak in stage-1. *BP* expression displayed a contrasting pattern: a 27-fold increase in Thekken during stage-1 but reduced expression in stage-2, implying temporal regulation linked to meristem establishment followed by structural differentiation. Fluorescence in situ hybridisation localised *PIN1* expression predominantly in floral meristems, corroborating the auxin-driven spatial signalling mechanism. Proteomic profiling via SDS-PAGE established a distinct expression signature in Thekken, including unique proteins of 100 kDa (stage-1 and 2) and 48 kDa and 55 kDa (stage-3), suggesting branching-specific functional proteins involved in cell wall remodelling, signaling, or meristem activity. Hormonal quantification demonstrated a contrasting regulatory framework between cultivars. Thekken contained lower indole-3-acetic acid (IAA) levels (25 ppb) relative to Panniyur-1 (90 ppb) and Karimunda (60 ppb), while cytokinin levels progressively increased over development, peaking at



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stage-3. This auxin–cytokinin interplay, combined with elevated PIN1 expression and BP modulation, suggests a hormonal rebalancing mechanism promoting lateral primordia initiation and sustained spikelet branching. Collectively, the findings identify Thekken as a biodiversity-rich, branching-enabled, high-yield cultivar with distinct regulatory pathways at genetic, histological, proteomic, and hormonal levels. Its unique biological architecture positions it as a promising genetic resource for future breeding strategies aimed at sustainability, resilience, and yield enhancement in black pepper cultivation.

Keywords: Black pepper; Thekken; High yield; Spike branching; PIN1; Hormonal regulation

THEME IV

**GOVERNANCE, POLICY, AND
INDIGENOUS KNOWLEDGE SYSTEMS
& VALUATION OF ECOSYSTEM
SERVICES FOR AGROBIODIVERSITY
CONSERVATION**

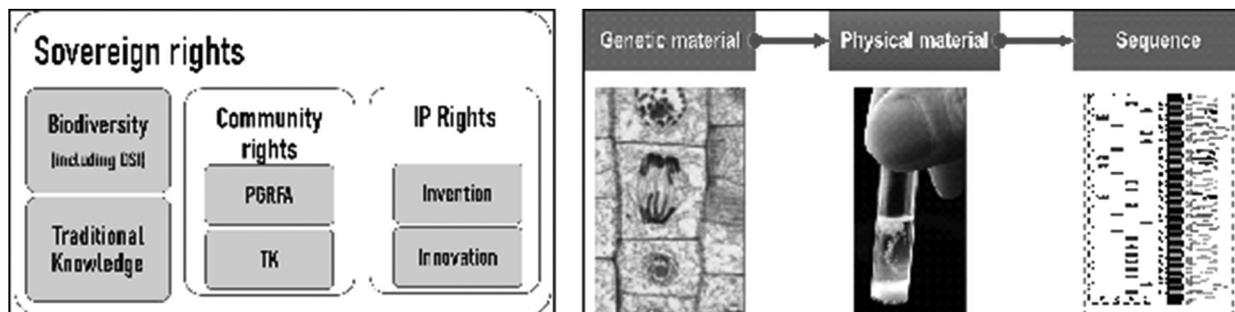
Plant Genetic Resources Policy: Rights and Responsibilities

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Biodiversity manifests life as ecosystem diversity, species diversity, and genetic diversity. Plant Genetic Resources for Food and Agriculture (PGRFA) are the genetic component of agricultural biodiversity. PGRFA includes traditional varieties, modern cultivars, and wild relatives. PGRFA is an indispensable component of plant breeding by providing traits for higher yields, pest resistance, and climate adaptation. Erosion of PGRFA threatens future food sufficiency, underscoring the need and significance of conservation.

Utilization of genetic resources is vital for food and nutritional security and climate resilient agriculture. Plant breeders and researchers need to access PGRFA from various sources for their genetic characterization and eventual use in crop improvement. PGRFA in India, however, are associated with multiple layers of protection in interplay. Sovereign rights and Community Rights recognized by Convention on Biological Diversity establish a clear modus of access and benefit sharing (ABS). Implementation of intellectual property rights needs protection of inventions and associated commercial interests. ABS governance becomes convoluted without clearly comprehending the rights and obligations.



ABS governance is challenging because PGRFA occurs in a variety of contexts—in situ, on farm and ex situ conditions with heterogeneous and overlapping ownerships. It is further complicated by the advancements in technology that



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allow dematerialized use of PGRFA in research and development. As a result, agricultural researchers need to understand that rights come with responsibilities. India is endowed with the plant biodiversity and associated traditional knowledge. Lack of awareness leads to conflicts among stakeholders, choice of wrong policy by administrators and failure to effectively utilize PGRFA for betterment of the nation.

04 TOP 01

Indigenous Agrobiodiversity Knowledge and Its Contribution to Climate Resilient Millet Farming among Tribal Communities of Attappady, Kerala

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ABSTRACT

Indigenous agrobiodiversity knowledge constitutes a vital reservoir of ecological insight that supports traditional farming systems, particularly in tribal landscapes where biodiversity and cultural heritage are deeply intertwined. In Attappady, the millet-growing hotspot of Kerala, these knowledge systems continue to shape climate-resilient agroecosystems and strengthen local food security. This study explored the role, relevance, and scientific rationale of Indigenous Traditional Knowledge (ITK) in millet farming among tribal communities, with a focus on its contribution to climate resilience and agrobiodiversity conservation. A structured survey combined with participatory rural appraisal was conducted among 118 respondents from 25 tribal households to document ITK practices and assess their adoption patterns. Statistical analyses, including correlation tests ($p < 0.05$) and Principal Component Analysis (PCA), were employed to evaluate the factors influencing ITK retention and its relationship with ecological resilience. Traditional soil fertility management was considered essential by 83% of farmers, while 97%

reported enhanced yield stability when ITK practices were integrated with selected modern techniques, demonstrating the value of blended knowledge systems. Key agrobiodiversity-enhancing practices such as selecting mature earheads for seed material (100%), multi-seed sowing (98%), and mixed cropping (96%) were widely implemented and acknowledged for improving resilience, nutrient cycling, and in situ conservation. However, plant-based bio-repellents made from turmeric and garlic had limited acceptance (36%), indicating the need for further scientific validation. Statistical analysis confirmed a strong positive association between ITK adoption and drought resilience, particularly among experienced and small-scale cultivators, while PCA highlighted cultural continuity and experiential learning as major determinants driving ITK persistence. The study demonstrates that indigenous agrobiodiversity knowledge is central to sustaining climate-resilient millet farming in Attappady. Integrating traditional ecological wisdom with contemporary scientific innovations can significantly enhance sustainable agriculture and strengthen community-based agrobiodiversity management in tribal regions.

Keywords: Indigenous knowledge, Climate-resilient agriculture, Millet-based farming systems, Tribal communities, Sustainable food systems.

04 TOP 02

Policy Pathways for Agrobiodiversity Conservation: Evaluating the Effectiveness of Kerala Conservation of Paddy Land and Wetland Act (2008)

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ABSTRACT

Agriculture has historically shaped Kerala's ecological, cultural, and agrarian identity, with paddy cultivation forming the core of its wetland ecosystems



and community-based farming traditions. The diverse rice environments from the below-sea-level Kuttanad to the Kole wetlands and the saline-resilient Pokkali fields are vital for sustaining biodiversity, regulating hydrology, supporting rural livelihoods, and ensuring long-term ecological stability. Over the past several decades, however, Kerala has witnessed a continuous decline in paddy area due to urbanisation, rising land values, labour shortages, and competing crop choices. This decline has raised concerns about food security and biodiversity loss. In response, the government of Kerala enacted the Kerala Conservation of Paddy Land and Wetland Act (KCPWA), 2008, to protect paddy-wetlands. This study evaluates the effectiveness of the Act using structural break analysis, CAGR, decomposition analysis, and district-wise trend evaluation. Farmer perceptions were assessed using a binary logistic regression model to understand how socioeconomic factors shape attitudes toward the Act. The structural break analysis identified a major breakpoint in 2009–10, indicating a shift in the pattern of decline immediately after the implementation. While the area under rice declined sharply by 18.5 percent during 2003–04 to 2009–10, the decline moderated to 14.5 percent in the post-Act period (2010–11 to 2022–23). The negative CAGR for the area improved significantly after the enactment of KCPWA. Decomposition results showed a substantial reduction in the negative area effect, highlighting the role in slowing conversion. District-level trends further revealed stabilisation or gains in many districts, including Kollam, Pathanamthitta, Malappuram, and Thrissur. Moreover, farmer perceptions reflected the importance of adequate water access, family labour, and diversified landholdings in shaping support for the Act, while labour scarcity, limited wetland holdings, and lower yields hindered acceptance. Overall, the results indicate that the Act has meaningfully slowed the decline in paddy area, enhanced governance mechanisms, and supported the conservation and stabilisation of paddy-wetland systems.

Keywords: KCPWA, Biodiversity, Structural break analysis, Decomposition analysis, Farmer perceptions, Governance

04 TOP 03

Performance Effectiveness of Biodiversity Management at Grama Panchayats in Kerala

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ABSTRACT

Biodiversity Management Committees (BMCs), constituted under the Biological Diversity Act, 2002, play a key role in decentralized biodiversity conservation at the Grama Panchayat level. In Kerala, with its rich ecological diversity, the effectiveness of BMCs is crucial for sustainable resource management, and this study examines their performance effectiveness in biodiversity governance. Considering the biodiversity richness and ecological sensitivity, a purposive selection process was employed to identify four blocks from distinct geographical regions within Kerala. The chosen blocks encompassed the low lands of Kannur and Alappuzha districts, mid lands of Kollam and Malappuram districts, and high ranges of Wayanad and Idukki districts. A sample of 180 BMC members was chosen from six districts to evaluate BMC performance. Based on a comprehensive review of the relevant literature and consultations with subject matter experts, a scale has been developed to assess the performance effectiveness of BMCs at the Gram Panchayat level in Kerala. Consequently, five key dimensions were identified to facilitate the classification and measurement of BMC performance effectiveness at the Gram Panchayat level. These dimensions include conservation, sustainable use of biodiversity & Access and Benefit Sharing (ABS), documentation, biodiversity education awareness & capacity building, and administrative & advisory functions. The findings revealed that the administrative and advisory function (mean score of 2.07) was the most significant factor influencing overall performance effectiveness.



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A bstract

Notably, a significant proportion of BMC members (68.90%) perceived a low level of effectiveness, while only about one-third (31.11%) recognized a high level. A chi-square test indicated variability in perceptions among BMC members across the three regions, with notable differences between the Kollam and Malappuram districts ($\chi^2 = 4.0219$, p-value = 0.044913). These insights underscore the challenges in enhancing BMC effectiveness in Kerala.

Keywords: Biodiversity Management Committee (BMC), Performance, Effectiveness, Grama Panchayats, Biodiversity.

04 TOP 04

Recognizing Kole Wetlands as a Local Agrobiodiversity Heritage System

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ABSTRACT

Conservation of traditional agricultural systems that embody both ecological resilience and cultural heritage has gained increasing global recognition over the past decades with initiatives such as the FAO's Globally Important Agricultural Heritage Systems (GIAHS). Biological Diversity Act of India (2002 & 2023) has also a provision that directs the State Governments in consultation with the local bodies to notify, areas of biodiversity importance as Biodiversity Heritage Sites (BHS). Such initiatives could be also noted as early steps in safeguarding the rights of nature in parallel to the efforts that went into rivers like Whanganui (New Zealand) and Ganges (India). Kole wetlands, part of the larger Vembanad-Kole Ramsar system represent one of Kerala's distinctive paddy agroecosystems with remarkable ecological, agricultural, and socio-cultural value. This study documents the uniqueness & significance, existing threats & challenges, and the way forward for the Kole wetlands to support future proposals to consider the unique agroecosystem as a local agrobiodiversity heritage system (LAHS). A mixed-method approach integrating secondary literature review, stakeholder workshops & field surveys was employed. The study synthesizes key ecological & environmental attributes, agricultural performance, socioeconomic dynamics,

and community perspectives to generate a holistic understanding of the system's agricultural heritage and potential. Studies show that these wetlands host rich floral & faunal biodiversity and serve as a critical habitat along the Central Asian Flyway. However, the system faces interconnected threats & challenges along agriculture & livelihood, market & institutions, ecological and environmental pressures, human wildlife conflict, declining cultivation & food security risks. The study highlights the urgent need for integrated and community-centered conservation & management strategies, including adaptive co-management, hydrological restoration, pollution control infrastructure, sustainable livelihood diversification, and enhanced monitoring. Recognizing Kole wetlands as an agrobiodiversity heritage system will help reinforce their role in regional food & livelihood security, biodiversity conservation, and cultural lineage.

Keywords: Kole wetlands, agrobiodiversity, agricultural heritage

04 TOP 05

Tribal Agrobiodiversity and Developing Tribal Agri-Entrepreneurship Model

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ABSTRACT

The conservation and scientific management of agrobiodiversity are crucial for ensuring food security, livelihood enhancement and sustainable ecosystems. These resources are important for the development of new cultivars in crop breeding processes. Tribal agrobiodiversity specifies the conservation and sustainable



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utilisation of agricultural ecosystems managed by tribal communities for centuries, consisting of indigenous varieties and crop landraces, their wild varieties, livestock, and other associated species that influence ecosystem function and agricultural productivity. These indigenous communities hold invaluable traditional knowledge on these crops, seed varieties, farming practices, and pest management, passing it from one generation to the next. A total of twenty-four tribal communities including Kurichiya, Adiyar, Hill Pulaya (Mala Pulaya), Paniya, Irular, etc., are involved in agriculture and allied sector for their livelihood. Documentation of the agrobiodiversity of tribal custodian farmers through field survey data collection of crops, cultivation methods, associated flora, fauna, and associated traditional knowledge is crucial. These field studies will further help in identifying wild varieties and recovering lost species. These tribal custodian farmers, particularly tribal youths, should be empowered as 'Local Genome Saviours' through updated skill development training with upgraded technology interventions to start on-farm cultivation of crop varieties. The upscaling of on-farm crop cultivation can further lead to the development of value-added products based on market demands. Thus, a novel model of tribal agri-entrepreneurship can be established, ensuring the protection of their intellectual property rights with the involvement of the respective Biodiversity Management Committees.

Keywords: Traditional knowledge, food security, livelihood enhancement, tribal custodian farmers, value-added products, intellectual property rights

04 TOP 06

Evaluating Human-Wildlife Conflict Management Strategies in Wayanad: An Importance-Performance Analysis Approach

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ABSTRACT

This study explores Human-Wildlife Conflict (HWC) in Kerala's Wayanad district, where recurring interactions cause crop losses, livestock predation, property damage and occasional human fatalities, and where conflicts persist despite multiple management strategies due to the lack of systematic and periodic evaluation. Therefore, the study evaluates farmers' perspectives on Human-Wildlife Conflict (HWC) management in Wayand using Importance-Performance Analysis (IPA), a cost-effective and user-friendly tool for prioritizing interventions. The district consists of four blocks Mananthavady, Kalpetta, Sulthan Bathery, and Panamaram, from which one panchayat with significant forest cover and frequent wildlife conflict cases was selected in consultation with Forest Officers, Agricultural Officers, and local panchayat representatives. From the selected panchayats, namely Thirunelly (Mananthavady block), Vythiri (Kalpetta block), Noolppuzha (Sulthan Bathery block), and Panamaram (Panamaram block) 30 farmers were randomly selected, yielding a total sample size of 120 respondents. Results of gap analysis revealed significant



gaps between importance and performance across all the selected strategies, indicating that current management falls short of local expectations. The IPA matrix identified high-priority strategies such as payment of ex gratia to affected individuals, provision of water and food in forests, wildlife population regulation measures, and installation of solar fences require urgent attention. Strategies such as rapid response teams, voluntary relocation, of human settlements, community engagement in policy and program implementation, research and development for innovative HWC solutions translocation of problem animals, construction of elephant-proof trenches, and building elephant-proof wall were rated as effective and should be maintained. These findings highlight the utility of IPA in guiding resource allocation, monitoring, and stakeholder engagement, providing policymakers with actionable insights to enhance the effectiveness of HWC mitigation and promote sustainable human-wildlife coexistence in Wayanad.

Keywords: Human-Wildlife Conflict (HWC), Management strategies, Importance-Performance Analysis (IPA), Gap Analysis, Strategic Prioritisation

04 TOP 07

Beyond crop damage: psychological burden of Human Wildlife Conflict (HWC)

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ABSTRACT

Human-wildlife conflict (HWC) poses growing conservation and social challenges within protected area landscapes, particularly where human settlements

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overlap with wildlife habitats. Beyond economic losses, the psychological implications of HWC, such as stress and sleep disruption, remain comparatively under-studied. This study assesses the perceived stress levels and sleep disturbance among farmers experiencing recurrent wildlife incursions in the Kanthalloor and Marayoor Ranges of Idukki district, Kerala. A total of 180 farmers (90 per range) were surveyed using a 5-point Likert scale to evaluate emotional stress and night-time sleep disruption attributed primarily to elephant encounters. Descriptive analysis revealed a consistently high psychological burden in both ranges. The mean stress score was 4.02 ± 0.81 in Kanthalloor and 4.04 ± 0.79 in Marayoor, indicating that most farmers fall within the “very stressful” to “extremely stressful” category. This elevated stress can be attributed to frequent crop raids and the persistent fear of dangerous interactions with wild animals. Farmers reported heightened vigilance, particularly during harvest, along with concerns about personal safety while working or guarding crops near forest fringes. Sleep related impacts were similarly substantial. Kanthalloor recorded a mean score of 3.96 ± 0.79 , whereas Marayoor reported 3.77 ± 0.91 , indicating moderate to severe sleep disruption. Frequent crop guarding and anxiety caused by animal movements contribute to irregular sleep patterns and potential long term health issues. The findings underscore that psychological distress is a critical dimension of HWC and must be recognized alongside tangible crop and livelihood losses. Hence, clinical ethnographic studies may be undertaken to observe and understand the impact of wild animal attack on well being of farmers. Community centric management interventions including real time wildlife alert systems, enhanced night time monitoring, and mental health support are essential to strengthen farmer resilience and foster coexistence in biodiversity rich human–wildlife interface regions.

Keywords: Human–wildlife conflict, psychological stress, sleep disturbance, well being, community resilience

04 TPP 01

Empowering Tribes for Alternate Agricultural Livelihoods through Medicinal Plant Cultivation- A Participatory Approach

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ABSTRACT

Tribal communities often depend on traditional agriculture, which is increasingly challenged by low productivity, climate variability, limited market access and shrinking land resources. These constraints make livelihood diversification essential for enhancing economic stability. Medicinal plant cultivation offers a viable and sustainable alternative livelihood option, as it aligns with indigenous ecological knowledge and meets the growing market demand for Ayurvedic and other natural products. This paper explores the potential of medicinal plant farming as an alternate agricultural livelihood for tribes and assesses its socio-economic and ecological benefits. Considering this, various Government agencies like NMPB, SMPBs are promoting cultivation of medicinal plants with people's participation, aimed to provide economic stability and production of quality raw materials for the Ayurvedic/Herbal Drug industry. A participatory approach was employed across selected tribal settlements by incorporating the IK systems of the particular tribes. Training sessions and capacity-building programmes are conducted to introduce cultivation techniques for high-value medicinal plants. The study showed a notable increase in farmers' technical knowledge, sustainable cultivation practices and income diversification. In several cases like TBGRI model of medicinal plants cultivation at Kani and Malapandaram settlements, Mattathur Model - Kurumthotti Cultivation and medicinal plant farming generated higher returns compared to

traditional crops, with lower input costs and better resilience to climatic fluctuations. Community members expressed increased confidence in adopting market-linked medicinal plant cultivation as a long-term livelihood strategy. Medicinal plant farming demonstrates strong potential as an alternate agricultural livelihood for tribal communities. The approach not only enhances income security but also supports biodiversity conservation, sustainable land use and strengthens IK systems. The study highlights the importance of continued capacity building, market linkage development and institutional support to upscale this model. Integrating medicinal plant farming into tribal development programmes can contribute significantly to poverty alleviation and holistic rural development.

Keywords: Biodiversity conservation, Rural development, Mattathur Model-Kurumthotti Cultivation, Income generation, Kani and Malapandaram tribes

04 TPP 02

Indigenous Agricultural Practices and Germplasm Conservation among Muthuvan Tribes of Kerala

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ABSTRACT

The Muthuvan tribe of Kerala is one of the indigenous, historically self-sufficient social groups, dependent on forest-centric livelihoods. The tribe possess distinctive expertise in Indigenous Agricultural Practices (IAP), traditionally designed for sustainable food security. Their IAP were deeply rooted in ecological understanding, indigenous crop diversity, community resource sharing and spiritual traditions associated with land stewardship. An ethnographic approach was adopted involving tribal elders and agricultural practitioners inhabiting on the hilly tracts of Idukki, Ernakulam, Thrissur, Palakkad and Malappuram districts. Data on indigenous crop diversity, cultivation techniques, organic soil and nutrient management, seasonal ecological knowledge and community-based germplasm conservation practices were systematically recorded, categorized



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and cross-verified. The study showed that Muthuvan IAP, a nature-dependent organic mixed farming system (shifting cultivation), has gradually shifted to settled agriculture using chemical fertilizers and pesticides. This system supports nutritional/ecological resilience, techniques for pest control, disease prevention and seed conditioning. The integration of animal husbandry with farming contributes to soil fertility, labour sharing, food availability and collective ownership, both focuses on collective well-being rather than profit-driven objectives for community resource. It strengthens cropping outcomes while reinforcing social cooperation, food sharing and cultural reciprocity. Despite its sustainability, Muthuvan IAP faces increasing decline. The shift toward modern agriculture, external seed dependency, land-use transitions and socio-economic changes have accelerated the loss of indigenous crops. Threats such as cultural erosion, human-wildlife conflict, unpredictable climate/natural calamities and reduced intergenerational knowledge transfer destabilize IAP. Considering these vulnerabilities, it will be worthwhile to carry out comparative agricultural research on IAP vis-à-vis modern agricultural practices to determine the best, viable, nature-friendly agricultural practices i.e. beneficial and healthy for nature and its inhabitants as a whole. If the IAP practiced and germplasm is conserved effectively, Muthuvan agricultural wisdom may offer a scalable model for natural, organic, community-centred and climate-resilient farming system.

Keywords: Sustainable agricultural practices, Shifting cultivation, Community resource management

04 TPP 03

A Unified Antiviral Medicinal Plant Database: Integrating Traditional Knowledge, Phytochemical Profiling, and In Silico Screening for Drug and Nutraceutical Development

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ABSTRACT

Medicinal plants have been central to traditional healing practices for centuries, offering natural solutions for managing viral and other infectious diseases.

As interest grows in developing safe, cost-effective antiviral agents, there is a strong need to validate traditional knowledge through modern scientific methods. This study introduces the first integrated antiviral medicinal plant database that consolidates data on ethnomedicinal, phytochemical and in silico screening results into a single accessible platform. The database documents 100 medicinal plant species traditionally used for viral ailments, detailing their morphological traits, ethnobotanical significance, phytochemical constituents, and known biological activities. Approximately 11,500 phytochemicals from these plants were analyzed using molecular docking against major viral targets, with a focus on the SARS-CoV-2 main protease (M^{pro}). Several compounds demonstrated high binding affinity and broad antiviral potential, with predicted activity against SARS-CoV-2, dengue virus, and hepatitis B and C viruses. Plant parts with these lead molecules were further developed into optimized herbal formulations, which showed encouraging preliminary antiviral effects in vitro. Nutraceuticals—plant-derived dietary components with immune-supportive and disease-preventive benefits—were also given emphasis. The identification of antiviral compounds in commonly consumed and wild nutraceutical species highlights their relevance in daily preventive healthcare. The study additionally stresses the need to conserve medicinal plant diversity, as many species face pressures from overuse and habitat degradation. Overall, this database provides a scientifically rigorous foundation to advance antiviral research, guide nutraceutical innovation, and support conservation-focused decision-making.

04 TPP 04

Bridging Traditional Knowledge and Modern Drug Discovery: Multi-Target Anti-SARS-CoV-2 Agents Identified from *Aegle marmelos*

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ABSTRACT

A*egle marmelos* (L.) Corrêa, widely known as the bael tree, koovalam in Malayalam, is a key medicinal plant in Ayurveda and is traditionally used to manage infectious, inflammatory, and gastrointestinal disorders. With the



continuing emergence of viral pandemics such as COVID-19, the search for broad-spectrum antiviral agents has intensified. Multi-target inhibitors, which can simultaneously block several viral and host pathways, offer a strategic advantage by reducing the likelihood of viral resistance and enhancing overall therapeutic efficacy. In this context, the present study explores the anti-SARS-CoV-2 potential of *A. marmelos* using an integrated *in silico* and *in vitro* framework. A total of 200 phytochemicals, including 54 compounds identified through LC–MS analysis, were screened against five key therapeutic targets. These targets include the viral spike protein, responsible for receptor binding and entry; the human ACE2 receptor, which facilitates viral docking; the main protease (Mpro), essential for processing viral polyproteins; RNA-dependent RNA polymerase (RdRp), required for viral genome replication; and COX-2, a host inflammatory mediator that contributes to cytokine imbalance during infection. *In vitro* antiviral assays demonstrated significant inhibitory activity of *A. marmelos* extract, supporting the computational findings. Docking analysis revealed that 24 phytochemicals possess notable multi-target inhibitory potential, with several compounds exhibiting stronger binding affinities than established reference drugs such as arbidol, chloroquine, nirmatrelvir, remdesivir, and celecoxib. Myrcetin-7-rhamnoside emerged as the most potent multi-target lead, showing high affinity for the spike protein (−8.0 kcal/mol), ACE2 (−10.4 kcal/mol), Mpro (−9.1 kcal/mol), and RdRp (−8.7 kcal/mol). Seselin displayed the highest binding affinity toward COX-2 (−9.2 kcal/mol), suggesting a complementary anti-inflammatory role. Molecular dynamics simulations for 100 ns confirmed the structural stability of the key protein–ligand complexes. Overall, this study bridges traditional Ayurvedic knowledge with modern drug-discovery strategies by scientifically validating the multi-target antiviral potential of *A. marmelos*. The identification of myrcetin-7-rhamnoside as a strong multi-target candidate highlights the value of traditional medicinal plants in modern antiviral research. Further *in vivo* and pharmacological evaluations are required to advance these leads toward clinical relevance.

Keywords: *Aegle marmelos*; SARS-CoV-2; Multi-target inhibitors; Molecular docking; Antiviral activity.

04 TPP 05

Decoupling agricultural growth from CO₂ emissions in India: Insights from Tapio Elasticity and the Environmental Kuznets Curve framework

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ABSTRACT

Agriculture remains the backbone of India's economy and rural livelihoods, yet it is one of the major contributors to greenhouse gas emissions of the nation, particularly methane and nitrous oxide from rice cultivation, manure and fertiliser use. Achieving sustainable agricultural growth, therefore, requires understanding whether economic expansion can be decoupled from environmental pressure. This study evaluates the dynamic relationship between agricultural GDP (in Cr. ₹) and agricultural CO₂-equivalent emissions (in Gg CO₂e) in India from 2010 to 2020 using Tapio's decoupling elasticity model, and interprets the resulting decoupling patterns through the theoretical background of the classical Environmental Kuznets Curve (EKC). The Tapio elasticity index was computed using year-on-year percentage changes in agricultural output and agricultural CO₂ emissions. The results revealed a predominance of weak decoupling (WD) across the study period, notable in 2011, 2013, 2014 and 2017 to 2019, where emissions continued to rise but at a slower pace than the output. Periods of strong decoupling (SD) were observed in 2012, 2015 and 2016, indicating phases where agricultural growth was achieved alongside declining emissions. The unusual recessive coupling as observed in 2020 is attributable to COVID-19-driven output contraction. The emerging shift from weak to strong decoupling reflects improvements in agricultural efficiency, adoption of resource-conserving technologies and climate-smart practices. This transition aligns with the descending stage of the inverted-U-shaped EKC trajectory, suggesting India may be approaching an economic threshold beyond which agricultural growth becomes less emissions-intensive. The findings underscore



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the policy need for accelerating low carbon agricultural strategies, enhancing biodiversity friendly production systems, and integrating emissions metrics into agricultural planning to support sustainable and climate resilient development.

Keywords: Agricultural emissions, Agricultural GDP, Environmental Kuznets Curve, Tapio decoupling

04 TPP 06

An Investigation on the plant extracts obtained from *Nymphaea omarana* for the formulation of a novel cosmeceutical product

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ABSTRACT

The invasive species can devastate native ecosystems, causing plants and animals to be pushed out or even driven to extinction, ultimately eroding the rich biodiversity that makes ecosystems thrive. Invasive species cause significant global economic damage mainly by reducing agricultural productivity, impacting livestock, sustenance of forests and waterbodies. *Nymphaea omarana*, commonly referred to as the Tropical Night-Blooming Water Lily, is an aquatic plant species that has been documented in the state of Kerala. It is originated in South America, and it has been introduced to various other regions around the world primarily as an ornamental plant for gardens and water features. Its extensive spread in Kerala after its introduction necessitates an evaluation of its invasive potential. The present study explores the sustainable utilization of *N. omarana*, an invasive aquatic plant, for the development of novel herbal moisturizer. The primary objective was to extract active compounds from the leaves using an aqueous extraction procedure and to evaluate the effectiveness and safety of the formulation on topical application. Biochemical and physicochemical analysis of value-added products derived from the invasive *N. omarana* demonstrates its vast potential in the pharmaceutical, nutraceutical and cosmeceutical industries. The formulations showed safety, stability and efficacy, highlighting their suitability

for skin application. By harnessing the potential of invasive species, this study contributes to sustainable development, improves agrobiodiversity, ecological conservation and innovative product development.

Keywords: Biochemical and physico-chemical analysis, Herbal moisturizer, *Nymphaea omarana*, Sustainable utilization,

04 TPP 07

Mango Peel as functional ingredient in Green Mango RTS Beverage

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ABSTRACT

Mango, often referred to as the “King of Fruits,” is valued for its distinctive flavour, high nutritional value and abundance of bioactive compounds such as phenolic acids, flavonoids, carotenoids and essential micronutrients. Mango peel, which makes up about 7-24% of the fruit, serves as a nutrient-dense component, supplying carotenoids, dietary fibre, vitamins and potent antioxidant polyphenols like mangiferin, gallic acid and quercetin. Ginger is equally notable for its active constituents gingerols, shogaols and zingerone that impart strong antioxidant, anti-inflammatory and medicinal effects, making it an important functional food ingredient. The proper utilization of mango by-products and ginger in functional foods offers significant economic and environmental benefits. Hence, the study was conducted to analyse the nutritional quality of green mango, mango peel and ginger to explore the possibility of development of functional Ready To Serve beverages. Totapuri is a widely used mango cultivar in the processing sector were utilized to prepare green mango pulp as well as mango peel powder. Ginger extract was prepared by hot-water extraction ($50 \pm 5^\circ\text{C}$). The green mango pulp, mango peel powder and ginger extract were evaluated for total soluble solids, titratable acidity, ascorbic acid, total sugars, reducing sugars, total phenolics and total flavonoids. The results revealed that both mango peel and ginger extract contain high levels of bioactive constituents and can be used for the development of functional beverages. The functional green mango RTS beverage was developed using 15%



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green mango pulp along with varying levels of mango peel powder (0.5% and 1%) and ginger extract (1% and 2%). The formulation of functional green mango RTS beverage was standardised based on the biochemical and sensory qualities. The utilization of mango peel and ginger as functional ingredients enhances nutritional and economic value while supporting agrobiodiversity, minimizes waste and contributes to resilient agri-food systems.

04 TPP 08

Farmers' Willingness to Accept Compensation for on farm Conservation of local cultivars of Banana

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ABSTRACT

Traditional banana varieties in Kerala are experiencing a serious decline due to shrinking cultivation areas, shifting consumer preferences, and increasing competition from high-yielding commercial cultivars. Despite their exceptional cultural significance, nutritional value, and ecological resilience, these traditional cultivars are gradually being displaced from farming landscapes. Contingent Valuation method is a widely accepted method where Willingness to Accept (WTA) compensation can be used to value natural resource. Understanding farmers' WTA for their conservation is therefore crucial for designing effective incentive-based programmes that safeguard biodiversity and cultural heritage. This study investigates the socio-economic and farm-level determinants of WTA using primary data collected from 30 banana growers. A multiple linear regression model was employed to identify the factors influencing compensation expectations. Findings revealed that years of schooling and farmers' willingness to devote land exclusively for conservation of local cultivars significantly increased WTA, underscoring the importance of education and land-use commitment in shaping conservation decisions. Conversely, household size exerted a negative influence,

while gender, age, and gross income did not exhibit statistically significant effects. These results suggest that conservation willingness is driven more by resource allocation and knowledge-related factors than by demographic characteristics. The mean observed WTA among respondents was ₹33,625.5 per/cent year, with 90 per cent of farmers expressing willingness to participate in compensation-based programmes. These findings highlight broad support for structured conservation incentives and emphasise the need for farmer-centred mechanisms that integrate awareness initiatives and land-use support. Overall, the study demonstrates that targeted compensation schemes, combined with education and conservation-oriented land allocation, can play a pivotal role in sustaining traditional banana cultivars in Kerala, thereby ensuring long-term agrobiodiversity conservation and cultural continuity

Keywords: Local cultivars, Willingness to accept, Agrobiodiversity conservation

04 TPP 09

Valuation of Provisioning Ecosystem Services Through Optimized Harvest Maturity in Purplish Red Dragon Fruit

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ABSTRACT

Accurate harvest maturity determination plays a critical role in enhancing provisioning ecosystem services within sustainable agri-food systems. This study evaluated the developmental, physicochemical, and sensory attributes of purplish-red dragon fruit (*Hylocereus costaricensis*) from 10 to 32 days after flowering to identify an optimum harvest index that maximizes quality and resource efficiency.



Results established the 29th day after flowering as the ideal harvest maturity, characterized by superior fruit weight, maximum pulp percentage, optimal sugar–acid balance, and peak levels of ascorbic acid and carotenoids. Sensory evaluations further confirmed the highest consumer acceptability at this stage. Optimizing the harvest maturity index directly enhances provisioning ecosystem services by: reducing postharvest loss and generating more usable fruit from the same ecosystem; improving nutritional and sensory quality, resulting in greater consumer value and health benefits; increasing farmer income through reduced rejection rates, premium pricing, and improved marketability; and promoting efficient use of land, water, and agricultural inputs by minimizing resource waste. By linking optimized maturity with ecological efficiency and economic gains, this study demonstrates that maturity indexing is an impactful sustainability strategy. Integrating scientifically validated harvest indices into resource-management frameworks strengthens the resilience, productivity, and overall value of tropical fruit-based agri-food systems.

Keywords: Dragon fruit, Harvest maturity index, Provisioning ecosystem services, reduction of postharvest loss.

04 TPP 10

Willingness to pay to conserve the agrobiodiversity in the Vellayani Lake ecosystem

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ABSTRACT

Vellayani Lake, the largest freshwater lake in Thiruvananthapuram district, serves as a vital source of drinking water and a cornerstone of agrobiodiversity. Its waters support traditional farming systems, protect diverse crop varieties and native species, and provide essential freshwater for surrounding communities, making it crucial for agricultural resilience and ecosystem conservation. However, the lake is under severe ecological stress, necessitating an assessment of local residents' support for its conservation. To capture community perspectives, a contingent valuation method was employed, and a survey was conducted among 30 households in Kalliyoor Panchayat (where a major portion of the lake lies)

using the double-bounded dichotomous choice format. The study revealed a mean Willingness to Pay (WTP) of ₹3,730 per household per year for conserving the lake ecosystem, indicating a clear readiness to contribute financially toward conservation. Sixty per cent of respondents expressed WTP, demonstrating strong recognition of the lake's ecological importance. Among the 40 per cent unwilling to pay, 91.33 per cent believed conservation is the responsibility of the government, while 8.33 per cent cited limited income as the main constraint. Socioeconomic factors such as monthly income, distance from the lake, and property submerged by the lake significantly influenced WTP. Payment preferences showed that 43.33 per cent favoured a mandatory contribution through water bills, while 16.67 per cent preferred voluntary payments. These findings highlight the community's valuation of Vellayani Lake and their expectation of government leadership, making household perspectives central to any conservation strategy. Participatory approaches that integrate household WTP with institutional initiatives, and align community preferences with equitable mechanisms for low-income groups, can strengthen agrobiodiversity conservation. Ultimately, safeguarding Vellayani Lake requires a balanced approach combining public participation, financial commitment, and strong government action to secure its freshwater functions and its role as a reservoir of agrobiodiversity supporting traditional farming systems and diverse crops.

Keywords: Vellayani Lake, Freshwater, Agrobiodiversity, Contingent Valuation, Willingness to Pay

04 TPP 11

Small waters, big value: Unveiling farmers' willingness to pay for farm pond biodiversity in Palakkad district of Kerala

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ABSTRACT

Farm ponds are among the most ecologically significant yet undervalued components of Kerala's agrarian landscapes, especially in Palakkad district, which



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has the highest concentration of ponds in the state. These small freshwater bodies serve much more than their primary role as supplementary irrigation sources; they act as biodiversity reservoirs supporting aquatic life, providing habitat continuity in intensively cultivated farmlands, and enhancing ecosystem stability for farming communities. However, increasing land pressure, irregular maintenance, and changes in farm management practices threaten their ecological functions, raising urgent concerns about their long-term sustainability. Understanding how local farmers perceive the ecological value of these ponds is therefore crucial for designing conservation efforts that align with community priorities. This study assesses farmers' willingness to pay (WTP) for conserving pond-associated biodiversity in Palakkad, capturing both their ecological awareness and economic commitment to maintaining these landscape features. A sample of 30 farmers from pond-dependent agricultural households was surveyed using a structured questionnaire to evaluate their valuation of biodiversity benefits such as improved water quality, enhanced habitat for aquatic species, and overall ecosystem health. Descriptive analysis showed that farmers recognised the multifunctional ecological importance of ponds and expressed strong support for their ecological restoration. The average willingness to pay was estimated at ₹3,720 annually, indicating a tangible economic willingness among farmers to contribute to biodiversity-focused pond management. These findings reveal that farmers see ponds not just as vital agricultural resources but also as ecological lifelines essential for sustaining local biodiversity. Their strong willingness to pay provides a clear pathway for community-led conservation financing, participatory restoration programs, and farmer-driven biodiversity monitoring. Incorporating these values into panchayat-level water governance can bolster ecological resilience, safeguard local water systems, and promote sustainable agroecosystem management across Palakkad's pond-rich landscape.

Keywords: Farm ponds, Biodiversity conservation, Willingness to pay (WTP), Sustainable water resource management

04 TPP 12

**Balancing Groundwater Use and Agrobiodiversity:
Integrated Strategies for Sustainable Irrigation and
Rural Livelihoods****Rashmi R.^{1*}, Durga A. R.² and Ashitha S. Santhosh³**^{1,3} PG scholar, Department of Agricultural Economics, College of Agriculture, Vellayani²Assistant Professor, Department of Agricultural Economics, College of Agriculture, Vellayani

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ABSTRACT

Groundwater irrigation sustains agricultural productivity and ecological integrity in many semi-arid and monsoon dependent regions. This study integrates hydrological surveys, economic valuation and household interviews to characterize groundwater recharge and extraction dynamics, farmers' willingness to pay for improved water services, and evaluate biodiversity outcomes across cropping systems. Field monitoring indicates that groundwater extraction is driven primarily by landholding size, farm income, irrigation technology and well depth. Contingent valuation method gives the willingness to pay of INR 250 to 300 per month for enhanced water delivery and management services. Scenario analysis evaluates policy interventions such as micro irrigation subsidies, watershed recharge initiatives and incentives for organic and diversified farming. Results suggest that combining targeted micro irrigation adoption with community based recharge projects and market linked incentives for diversified cropping can reduce extraction pressure, improve water use efficiency and enhance the on farm biodiversity while maintaining farmer income. The study emphasizes the need context specific governance, equitable cost sharing mechanisms and capacity building to support adoption and long term resilience. Integrating hydrological, economic and social analyses gives a practical guidance in aligning groundwater governance with ecological conservation. Policies that combine targeted finance, extension services and measured to ensure equitable participation are likely to accelerate transition towards sustainable water governance, improved farm level income and ecological restoration in groundwater dependent agricultural regions.

Keywords: Groundwater irrigation, Agrobiodiversity, Water-use efficiency, Micro-irrigation, Willingness to pay

04 TPP 13

Crop Diversification and Production Performance under Climatic Vulnerability in Kerala: An Empirical Assessment Using Secondary Data

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ABSTRACT

Agriculture in Kerala was highly exposed to climatic vulnerabilities such as floods, landslides, droughts, and changing rainfall patterns, which threaten production stability. Meanwhile, shifts in crop diversification patterns had significant implications for agro-biodiversity and farm resilience. This study examined the relationship between crop diversification and agricultural production under climatic vulnerability in Kerala over the past two decades using secondary data. The analysis integrated time-series data on area and production of major crops and rainfall data from different reports of government of Kerala state. Crop diversification was measured using the Herfindhal, Simpson and Entropy indices, while production variability was assessed using production loss and variability indicators. Rainfall deviation and officially reported extreme climatic events were used to identify climatically vulnerable years. The results indicated that higher crop diversification was associated with low production loss, whereas crop concentration increased vulnerability to production due to the climatic shocks. Rainfall deviation displayed only a weak relationship with production loss and minimal influence on diversification patterns. The findings provided empirical evidence that crop diversification enhanced the production stability and resilience under adverse climatic conditions, offering important policy insights for promoting climate-resilient and biodiversity-based agricultural systems in Kerala.

Keywords: Crop diversification, Climatic adaptation, Production instability, Farm-level resilience

04 TPP 14

**Embeddedness in Sustainable Food Systems:
an empirical analysis**Smija P. K.¹ and Sunil V. G.²¹ PhD scholar, Department of Agricultural Extension, College of Agriculture, Vellanikkara, 680656² Assistant Professor (Agricultural Extension) ATIC, Mannuthy, Kerala Agricultural University, Thrissur, 680656**ABSTRACT**

Food systems are not merely chains of production and consumption but are deeply embedded socio-cultural and institutional arenas that shape livelihoods, sustainability, and community well-being. As defined by the High-Level Panel of Experts (HLPE), food systems encompass all activities and outcomes linked to production, processing, distribution, and consumption, all of which are situated within networks of governance and regulation. The concept of embeddedness, rooted in Karl Polanyi's work, provides a macro-level framework for understanding the dynamics of sustainable food systems. According to Polanyi, economies are always "submerged" in social relations, norms, and institutions, and attempts to create a self-regulating market are inherently fictitious. Conventional policy approaches often reduce food systems to measurable outputs such as price and productivity, thereby overlooking the embedded social, cultural, and ecological processes that shape system behaviour. In contrast, Sustainable Food Systems (SFS) are typically seen as more strongly embedded. Fred L. Block operationalised the concept of embeddedness through the ideas of *marketness* and *instrumentalism*, which capture whether economic decisions are driven primarily by price or by social values. Building on this operationalisation, a Vermont-based study introduced the Embeddedness Type Matrix (ETM) to measure embeddedness in sustainable food systems (SFS). The present study employs the ETM to assess the sustainability orientation of 60 farmers who participated in a pilot project on Good Agricultural Practices for small cardamom (*Elettaria cardamomum*). It also attempts to refine



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the measurement process in the specific context of cardamom cultivation in Kerala. The results revealed that farmers frequently fell within the embedded, over-embedded and under-embedded quadrants of the ETM. The matrix also identifies a “sustainability region,” which suggests that some degree of instrumentalism is essential for farm economic success, while a certain level of price orientation is required for long-term profitability.

Keywords: Sustainable food systems, Embeddedness, Small cardamom, Good Agricultural Practices

CUSTODIAN FARMERS FORUM

Protection of IPR on Agrobiodiversity – Strategies and Challenges

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ABSTRACT

The TRIPS Agreement (1995) marked a pivotal shift in global Intellectual Property (IP) norms, significantly impacting the agricultural sector with extension of IP rights over crop varieties including new, extant and traditional ones, biological resources and unique agricultural goods tied to biological diversity. The International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA, 2001) aims to manage plant genetic resources sustainably. Moreover, under ITPGRFA, states are obliged to protect and promote farmers' rights. In alignment to ITPGRFA and UPOV, India enacted the Protection of Plant Varieties and Farmers' Rights (PPV&FR) Act, 2001, balancing breeders' rights with farmers' interests. The PPV&FR Act establishes a system for protecting plant varieties, recognizing the rights of farmers and plant breeders, with encouragement to the development of new varieties along with conservation of traditional genetic resources. It grants Plant Breeders' Rights (PBR), an IP right, giving the owner (Breeder) exclusive rights to produce, sell, market, distribute, import, or export a protected variety, for a specific period of time. A standout feature of India's PPVFR Act is its formal recognition of farmers' rights, a first globally. Farmers rights have three aspects *viz.* farmers' privilege (saving, using, exchanging seeds), benefit-sharing, and IP ownership over crop varieties. The Act recognizes farmers as cultivators, conservators, and breeders, entitling those conserving genetic resources to recognition and rewards. As cultivators farmers can save, use, exchange, or sell farm produce of a protected variety, except as branded seed. Farmers and communities can register the new varieties developed by them and traditional varieties owned by communities in their names. Under researchers' rights, the Act permits using



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registered varieties for experiments, research, or as a source for creating new varieties. Complementing to TRIPS Agreement, India enacted the Geographical Indications of Goods (Registration and Protection) Act, 1999, to protect rights over goods including agricultural goods linked to crop genetic resources. The Biological Diversity Act, 2002, regulates access to biological resources. It mandates equitable benefit-sharing for use of biological resources, innovations, and associated knowledge. The Biological Diversity Act requires prior approval of NBA for IPR applications involving biological resources from India, with exemptions for local communities. Database and community registers are vital tools for safeguarding community rights over biological diversity. Traditional knowledge often underpins innovations, necessitating legal frameworks to protect it amid biopiracy concerns. The protection of IP rights on agrobiodiversity faces challenges in balancing the interests of breeders, farmers, and communities, particularly in ensuring fair benefit-sharing and preventing biopiracy of traditional knowledge. Additionally, the complexities of defining and enforcing rights over traditional varieties and traditional practices often lead to conflicts between farmers and the users of TK and biological resources.

CLIMATE RESILIENCE STRATEGIES IN INTEGRATED FARMING SYSTEMS

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Kerala is distinct from the rest of the country in terms of its agro-ecological characteristics and demographics. It spans a small stretch of territory measuring 38863 square kilometres, with a long coastal line spanning 590 kilometres, and is situated between the Arabian Sea and the Western Ghats. The land lying between 3.0 meters below sea level to above 2000 meters have been taken up for cultivation of more than 40 crops ranging from food grains, spices, fruits, vegetables, oilseeds, beverages, medicinal plants, narcotics, cashew and rubber.

The total number of operational holdings in Kerala is 68,31,000 of which 96% i.e., 65,80,000 operational holdings fall in the marginal landholding category. On the other hand, in terms of area operated, marginal landholdings constitute only 59%, while landholdings in the size range of 1-1.99 ha constitute 19%. Operational holdings under the size class of 2.00 to 10 ha and above, constitute only 1 per cent of the total landholdings whereas in terms of area operated, they constitute 15 per cent of the total area under operational holdings in the state (GoK, 2023).

The Farm Plan Based Development Approach, initiated by the State Government in 2022-23, with the main objective of moving away from an individual crop-based approach towards integrated multiple cropping-farming systems-based development of holdings. Through this approach, it is targeted to tap the resource potential scientifically at the basic farm unit level, thereby enhancing the income of the farmer and contributing substantially to the production economy of the state.

The government is actively promoting integrated farming systems among smallholder farmers to increase income, build climate resilience against extreme weather events, and ensure holistic and sustainable use of limited land resources.

IFS for Climate Smart Agriculture

Integrated Farming System (IFS) is a key strategy for achieving climate-resilient agriculture in Kerala, a state highly prone to extreme weather events such as



floods, droughts, and changes in monsoon patterns. It is a rational mix of two or more interrelated and complementary enterprises on the same farm unit aimed at maximizing resource utilization, efficiently recycling agricultural waste, increasing productivity, and providing a stable income to the farming family throughout the year. The synergy created by these integrated elements is much greater than the sum of the individual parts.

In essence, IFS is seen as a “climate-smart” solution for Kerala’s agriculture sector. It provides a pathway to net negative emissions by reducing greenhouse gas emissions and maximizing the farm’s carbon sequestration potential, thereby directly contributing to the state’s goal of achieving carbon neutrality.

Core Philosophy in IFS: Synergy and Circular Economy

The fundamental principle that allows IFS to diversify and strengthen existing systems is the creation of a circular or closed-loop economy within the farm boundary.

Waste as a resource: In an IFS, “waste” from one enterprise becomes a valuable input for another. For example: crop residues (e.g. rice straw, vegetable waste) → fodder for livestock or raw materials for mushroom cultivation. Animal manure/bedding (e.g. from cattle, poultry, ducks) → organic fertilizer for crops or feed/nutrients for fish in an aquaculture pond. Pond sludge/mud → highly fertile fertilizer for field crops

Complementarity: Operating on the principle of minimal competition and maximum cooperation, different initiatives are selected to support and enhance each other. This interconnectedness reduces the need for expensive external inputs (such as fertilizers, pesticides, and feed), thereby reducing production costs and increasing the self-sustainability of the farm.

Key Elements for System Diversification in IFS

Diversification involves introducing new enterprises that are environmentally and economically suitable for a particular location, moving beyond a single crop or activity. The selection of elements depends mainly on factors such as landholding size, resource availability (especially water), market access, and agro-climatic conditions.

Enterprise Category Specific Elements Role in Diversification and Integration

Crop & Horticulture : Cereals, pulses, oilseeds, vegetables, fruits, and fodder crops. Diversifying field crops through intercropping, multi-tier cropping (especially with horticultural/garden crops), and crop rotation to improve soil health and provide

diversified production (food, cash, and fodder).

Livestock & Poultry: Dairying, goats, sheep, poultry (chicken/duckling), pig farming. Presents year-round sources of income (milk, meat, eggs) and provides high-value organic fertilizer to the crop component, reducing the need for chemical fertilizers. Ducks in paddy fields are a good example of integrated pest management and fertilization.

Fishfarming: Water bodies (ponds, paddy fields) are used for a high-value protein source. The fish release nutrients into the water, which can then be used to irrigate crops and fertilize.

Agroforestry: Trees (fruits, fuelwood, fodder, timber), shrubs, bamboo. Provides vertical diversification by utilizing the space above ground. Trees on field ridges or borders prevent soil erosion, act as windbreaks, provide additional income/forage, and enhance biodiversity and carbon sequestration.

Supporting enterprises: Beekeeping, mushroom cultivation, vermicomposting, biogas unit can be supplemented to the existing system. Low investment, high return enterprises that provide specialized products (honey, mushrooms, organic fertilizer), increase the use of agricultural by-products, and further diversify income and employment.

Comprehensive Benefits of IFS for Diversification

Diversification achieved through an integrated farming system provides several key benefits *viz.*, financial resilience and income stability, risk reduction, year-round income, the environmental sustainability and resource efficiency, efficient nutrient cycling. IFS models create a diverse, synergistic, and self-sustaining agricultural ecosystem that is inherently more resilient than monocultures and less susceptible to complete failure under climate stress.

Resource reuse and reduced external dependency

Efficient waste recycling reduces waste and pollution, and the most importantly, reduces reliance on expensive, external inputs such as fertilizers, which stabilizes agricultural costs against market fluctuations and supply chain disruptions caused by weather events.

Nutrient cycling and soil health, microbial ecology, and soil organic carbon (SOC): The combination of livestock (dairy, poultry, fish) and crops helps to continuously add organic matter to the soil through manure, compost/vermicompost. Increased SOC improves soil structure, water holding capacity, and nutrient retention. "Soil resilience," is important for enabling crops to better withstand short-term droughts



and heavy rainfall. IFS practices such as crop rotation, use of crop residues, and application of organic manure (from livestock or compost) produced on the farm increase the amount of organic carbon in the soil. Healthy, carbon-rich soil is an important component of carbon sequestration.

Water and energy efficiency

Many IFS models in Kerala incorporate rainwater harvesting structures such as farm ponds, which are often used for fish farming (fish/duck farming). This method not only conserves water but also provides life-saving irrigation to crops during inter-seasonal droughts (a common climate change problem in Kerala). The pond water, enriched with fish/duck excrement, serves as a nutrient-rich irrigation source.

Soil carbon enhancement: IFS practices such as crop rotation, use of crop residues, and application of organic manure (from livestock or compost) produced on the farm increase the amount of organic carbon in the soil. Healthy and carbon-rich soil is an important factor in carbon sequestration.

Long-term crops: The long-term nature of Kerala's major crops (e.g. coconut, rubber, spices, various fruit trees) provides long-term carbon storage in their biomass.

Reduction of Greenhouse Gas (GHG) Emissions

IFS helps reduce the overall carbon footprint of agriculture by reducing external inputs and optimizing resource use. KAU (2024) reported that homestead based IFS model recorded the most negative GHG emission and the highest carbon sequestration. Through proper integration of different enterprises, all the IFS models were suited for climate smart farming.

Low fertilizer use: By integrating livestock (e.g. cows, goats, poultry) and using practices such as legume intercropping and composting, IFS produces plant nutrients internally. This significantly reduces the reliance on artificial fertilizers, especially nitrogen fertilizers, the production and use of which are major sources of greenhouse gas emissions (especially N₂O).

Table 1. Nutrients generated and recycled within the system (kg)

IFS Models (0.2 ha)	N	P ₂ O ₅	K ₂ O
Homestead based	42.84	24.31	30.4
Coconut based	112.54	60.02	72.70
Rice based	76.46	19.95	32.82
Banana based	64.36	31.42	37.65

(KAU, 2024)

KAU (2024) studied nutrient regeneration in four IFS models. The results revealed that all the IFS models generated substantial quantities of plant nutrients. The coconut based IFS model generated N, P and K in higher quantities. *In situ* incorporation of crop residues and azolla grown in coconut contributed substantially to nutrient addition in the coconut based model. Generation of nutrients was highest in the coconut model which could be well related with the generation of a variety of organic manures including stall wash and cowdung.

Table 2. Fertilizer equivalent of nutrients generated within each system (kg)

IFS Models (0.2 ha)	Urea	Rajphos	MOP
Homestead based	92.96	121.55	50.77
Coconut based	244.21	300.1	121.41
Rice based	165.92	99.75	54.81
Banana based	139.66	157.1	62.88

(KAU, 2024)

The fertilizer equivalent of nutrients generated was worked out for each model. The coconut based model recorded the highest urea equivalent of 244.2` kg, higher equivalents for Rajphos (300.1 kg) and Muriate of potash (121.41 kg) compared to all other models.

Table 3. Energy and Price equivalent of fertilizers saved in different models (kg)

IFS Models (0.2 ha)	Energy (MJ)	Price equivalent of fertilizers saved (Rs)
Homestead based	3069.62	4098
Coconut based	7973.23	10070
Rice based	5074.81	4339
Banana based	4501.24	5318

(KAU, 2024)

Among the IFS models, the energy saving on fertilizers was the highest in coconut based model (7973.23 MJ) followed by rice, banana and homestead. Price equivalent of fertilizers was highest in coconut followed by banana, rice and homestead model, respectively.

Recycling and waste management: The system promotes a circular, closed-loop approach where the output of one component becomes an input for another. This proper disposal and recycling of farm waste reduces methane emissions from decomposing organic matter.



Conclusion

Innovative integrated farming techniques can be widely adopted to increase input efficiency, lower chemical and other energy-based input application rates, adapt agro eco-systems and mitigate anthropogenic global warming, and improve the nutritional value of agricultural produce. Scientific assessment of existing cropping system, adoption of new technologies, scientific selection of components and suitable crop management practices based on agro-ecological units (would minimize the risk of crop loss and maximize income per unit area. Thus nutritional security and self-sufficiency in food production were given prime focus through integrated farming systems. Thus achieving sustainable land use system in the era of climate change.

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FOOD FUTURES: STARTUPS AND INNOVATIONS FOR RESILIENT, SUSTAINABLE, AND BIODIVERSE AGRI-FOOD SYSTEMS

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Global agri-food systems are confronting unprecedented challenges arising from climate variability, biodiversity loss, resource degradation, supply chain disruptions, and shifting consumer preferences. Ensuring future food and nutritional security requires resilient, sustainable, and biodiversity-rich food systems that integrate scientific innovation, entrepreneurship, and environmentally responsible production models. Agrobiodiversity—encompassing diverse crops, livestock, microorganisms, and traditional knowledge—forms the biological foundation of resilience, yet remains underutilised in modern food systems dominated by a narrow range of species.

This paper explores how startups, scientists, food technologists, and policy ecosystems can collaboratively transform agrobiodiversity into market-ready, value-added, and globally competitive food products. Drawing on examples from Kerala's rich biodiversity, including indigenous crops, fermented foods, and traditional formulations, it highlights the role of modern food processing technologies in preserving nutritional quality, enhancing shelf life, and enabling global market access. Advanced non-thermal processing, hybrid drying systems, retort processing, extrusion, 3D food printing, and encapsulation technologies are discussed as critical enablers for developing functional, clean-label, ready-to-eat, and ready-to-cook foods rooted in regional bioresources.

The paper emphasises translational research as a bridge between traditional knowledge and modern food science, enabling the scientific validation, standardisation, and commercialisation of heritage foods and bioactive ingredients. Sustainability is addressed through low-carbon, energy-efficient processing systems, renewable energy integration,



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and circular economy approaches that convert agri-food waste streams into value-added products.

Agri-food startups are positioned as key innovation catalysts, driving value chain development, rural entrepreneurship, and commercialisation of research outputs. Supported by incubators, policy initiatives, and certification frameworks, startups can align biodiversity-based foods with emerging global market trends for functional, preservative-free, and sustainable products. The paper concludes by advocating a collaborative, multi-stakeholder approach to co-create future-ready agri-food systems that harmonise biodiversity, innovation, entrepreneurship, and sustainability for long-term planetary and human well-being.



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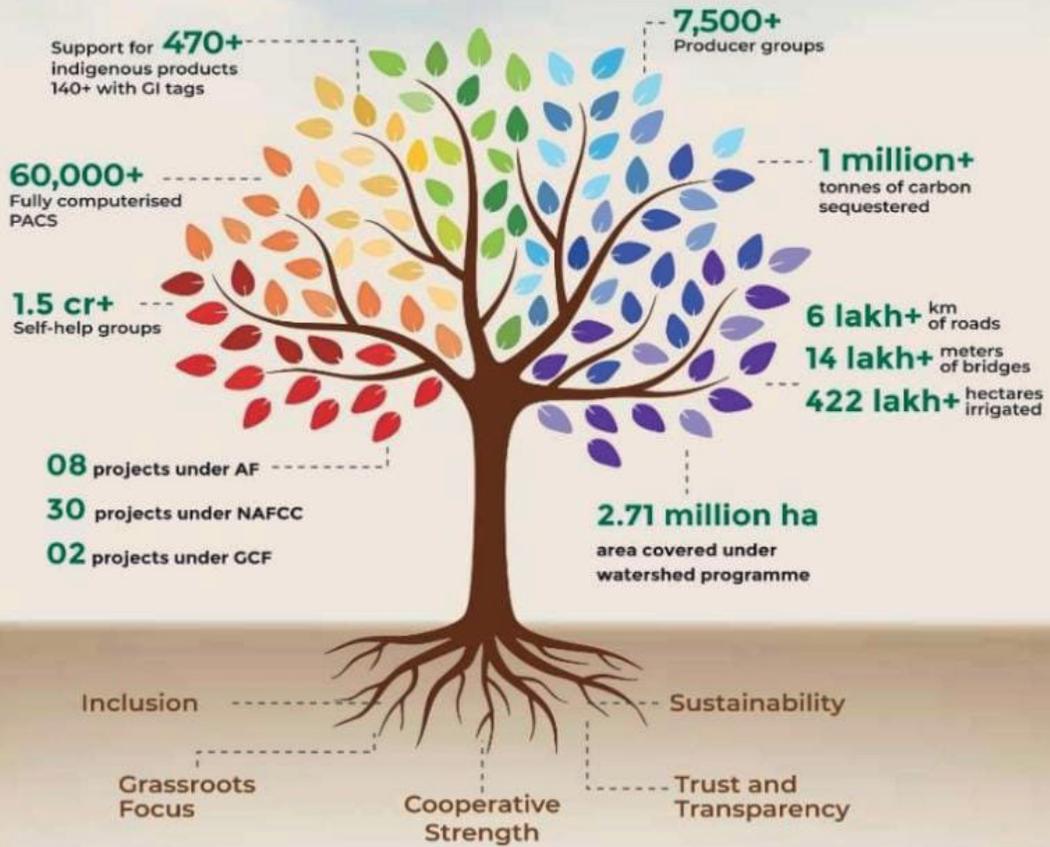
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