KSCSTE
R&D SUMMIT 2025

Translating R&D Innovations into Scalable Solutions

COMPENDIUM OF R&D OUTCOMES

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R&D SUMMIT 2025

Translating R&D Innovations into Scalable Solutions

The true measure of research is not just in the generation of knowledge but in its transformation into impact. As the world faces increasingly complex challenges—climate change, water scarcity, public health demands, and the need for sustainable development—the ability to convert R&D into actionable, scalable solutions has become essential.

The KSCSTE R&D Summit 2025 is envisioned as a platform to bring together Kerala's State Science and Technology Institutions to present tangible, field-tested outcomes ready for adoption. The summit fosters meaningful engagement between innovators and stakeholders from government, industry, academia, and civil society, with the aim of strengthening Kerala's research-to-application pipeline.

This Compendium of R&D Outcomes features a curated portfolio of technologies, prototypes, services, and policy tools developed by the State S&T institutions. These outcomes are not academic exercises—they are designed with clear applicability in areas such as environmental monitoring, water resource management, geospatial intelligence, agriculture, biodiversity, health technologies, and decision-support systems.

The compendium is both a showcase and an invitation—to adopt, adapt, and scale these innovations in diverse real-world settings. It reflects Kerala's commitment to nurturing an R&D ecosystem that is impact-oriented, inclusive, and aligned with public priorities.

By translating knowledge into solutions, and research into resilience, we move closer to a future where science truly serves society.

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CONTENT

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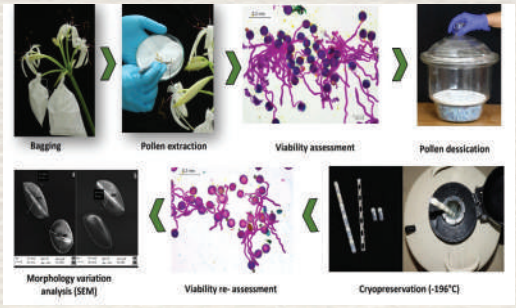
Premium Deep-frozen Germplasm for Herbal & Horticulture Sectors

Innovators
Dr. Manjula K M & Dr. N S Pradeep
KSCSTE- Malabar Botanical Garden and Institute for Plant Sciences



Cryopreservation protocol for pollen/spores

A pioneering cryopreservation protocol has been developed to secure the long-term viability of pollen and spores from high-value plant species, blending conservation with commercial utility. This breakthrough ensures genetic stability and successful post-thaw recovery across a curated selection of medicinal, ornamental, and ecologically important plants.

Key species include ferns such as Asplenium nidus, Pteris vittata, and Nephrolepis cordifolia, alongside angiosperms like *Clitoria ternatea,* eight *Nymphaea species,* three *Nymphoides species,* five *Crinum species,* two *Costus species,* and five orchid varieties. These were chosen for their role in traditional medicine, the herbal and antioxidant-rich food industries, and the ornamental market.

This innovation supports sustainable sourcing of elite planting material for the pharmaceutical, herbal, and floriculture sectors. Cryopreserved materials—especially *Clitoria, Crinum,* and *Costus*—offer scalable solutions for consistent, high-quality input to the herbal and wellness industries. Likewise, cryo-banked Nymphaea, orchids, and ferns meet growing ornamental demand.

By integrating biodiversity conservation with future-ready commercial applications, this initiative transforms plant preservation into a tool for innovation—securing genetic wealth today to meet the agricultural, ecological, and industrial challenges of tomorrow.

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Efficient Jiggat Bark Harvesting for Agarbatti Production

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Bark Stripping Equipment for Jiggat-Yielding Plants

This innovative device revolutionizes the way bark is harvested from Jiggat-yielding trees, offering a safer, more sustainable alternative to traditional methods. Jiggat, a natural binding agent essential to the incense stick (agarbatti) industry, is typically extracted manually using chisels—an approach that is both labour-intensive and damaging to the tree.

Conventional bark removal often injures the vascular cambium, the tree's regenerative layer, leading to bark loss, wilting, and eventual death. The lack of precision in manual methods also limits scalability and threatens long-term resource availability. Addressing these challenges, the newly developed bark stripping tool enables precise, controlled removal of bark with minimal impact on the tree's health. The equipment ensures the inner tissues remain intact, promoting natural regeneration and extending the productive life of the tree.

Compact, user-friendly, and efficient, the device reduces physical strain on workers and improves consistency in bark yield, making it ideal for both community-level use and commercial operations. Importantly, it empowers tribal and rural populations with a sustainable technology that safeguards their income while preserving forest biodiversity.

By combining ecological responsibility with industrial relevance, this innovation presents a practical step forward in non-timber forest product harvesting—supporting livelihoods without compromising nature.

Patent Application No.:
202441029292

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Aqua Flora-Infuse: Nature in a Sip

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Aqua Flora-Infuse: Nature in a Sip

Aqua Flora-Infuse is a caffeine-free herbal drink that blends traditional botanical wisdom with modern wellness trends. Crafted from a scientifically curated mix of medicinal plants, with the goodness of *Nelumbo nucifera* (Lotus) and natural colour of *Clitoria ternatea*. It developed through a gentle drying technique, the formulation preserves essential photoactives and floral aromas, delivering Rejuvenating, antioxidant and anti-inflammatory effects.

Lotus promotes relaxation and detoxification, while *Clitoria ternatea* supports cognitive function and stress relief through its rich anthocyanin content. The result is a refreshing drink that enhances mental clarity, gut health and overall wellbeing. Designed for the clean-label, functional beverage market, Aqua Flora-Infuse contains no caffeine or synthetic additives. Its soothing colour, floral notes and health-boosting properties position it as a premium choice for wellness stores, nutraceutical brands, ayurveda-based products and export markets. This is available in ready to use tea bags.

Its sustainable use of native florals and eco-friendly processing also strengthens its appeal to conscious consumers. Aqua Flora-Infuse is more than a drink, it's a wellness experience, merging India's rich plant heritage with the global demand for functional, natural drinks.

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Diagnostic Tool for Sandalwood Spike Disease

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LAMP Diagnostic Kit for Sandal Spike Disease

Sandalwood Spike Disease (SSD), caused by phytoplasma—cell wall-less bacteria infecting plant phloem—is the most destructive threat to Indian sandalwood (Santalum album). SSD leads to reduced leaf size, bushy growth, sterility, and eventual tree death within 1–2 years.

Despite decades of research, SSD's transmission pathways remain elusive, with suspected but unconfirmed insect vectors and host plants. Detection methods like PCR, DAPI staining, and electron microscopy exist, but they are lab-dependent, time-consuming, and unsuitable for large-scale field screening. This innovation proposes a LAMP-based diagnostic kit—a field-deployable, highly sensitive (100x more than PCR) tool for rapid SSD detection. It enables early identification in both symptomatic and asymptomatic trees, insect vectors, and potential reservoir hosts.

Deploying this technology will accelerate epidemiological mapping, support identification of transmission agents, and inform integrated pest management strategies. It also lays the groundwork for future biological control using natural predators or pathogens by providing precise field-level data.

In the absence of a cure, early, accurate, and scalable SSD detection is vital to protecting India's precious sandalwood heritage. This tool empowers forest managers, researchers, and policymakers to act swiftly—turning diagnostics into a front-line defense in sandalwood conservation.

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Soil Erosion Management Digital Tool

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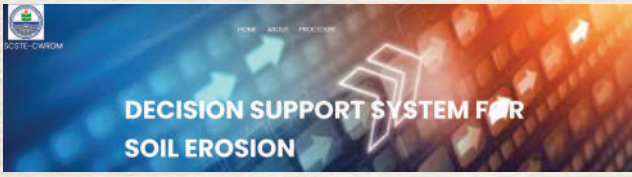

Decision Support System for soil erosion

To tackle the widespread challenge of soil erosion in Kerala's hilly, high-rainfall regions, the Centre for Water Resources Development and Management (CWRDM) has developed a web-based Decision Support System (DSS)-a first of its kind digital tool tailored for local terrain and climate.

Designed for government bodies, Panchayats, NGOs, researchers, and planners, this intuitive platform transforms complex geospatial data into easy-to-use maps and actionable recommendations. Users can zoom into any Panchayat and instantly view erosion risk levels ranging from low to very high-along with customized mitigation suggestions such as vegetative cover, contour bunds, or drainage structures.

What sets this DSS apart is its hyperlocal relevance. Unlike generic national models, it integrates Kerala-specific data on rainfall, land use, and topography. The tool supports grassroots-level planning and aligns seamlessly with government programmes like watershed development and MGNREGS. Accessible freely online without login or specialized software the DSS empowers decision-makers at all levels to plan science-backed, sustainable soil and water conservation measures. Already tested by multiple agencies, it is market-ready and proven in the field.

While opportunities exist to enhance user training and data updates, this innovation marks a major leap in environmental governance-bridging scientific expertise with community action to protect Kerala's fragile landscapes.

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Plant Tissue Culture Protocols for High-Value Crops

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Tissue Culture Protocols for banana, orchids, anthuriums and medicinal plants

Kerala's rich biodiversity and agro-climatic advantage position it to emerge as a national leader in plant tissue culture—a technology that delivers high-quality, disease-free, and true-to-type planting material for ornamental, medicinal, and plantation crops. As global demand for clean planting stock rises, tissue culture offers a scalable and sustainable solution.

However, despite its promise, Kerala's tissue culture sector lacks a dedicated ecosystem for entrepreneurs, start-ups, and farmers. The absence of standardized protocols for emerging plant species and limited access to scientific guidance has hindered commercial adoption. The sector holds transformative potential across pharmaceuticals, cosmetics, herbal wellness, horticulture, and biodiversity conservation. It enables mass propagation of rare, high-value, and endangered species—aligning with both market trends and the state's sustainability goals.

Jawaharlal Nehru Tropical Botanic Garden & Research Institute has led the way in developing protocols for a range of plant species, but industry uptake remains limited due to weak research-to-market linkages. Unlocking Kerala's potential requires stronger public-private partnerships, expanded training and incubation support, and enhanced market access.

With the right support, tissue culture can fuel rural entrepreneurship, employment, and export growth—while contributing to conservation and climate resilience. The time is ripe to position Kerala as a global hub for sustainable, high-value plant propagation through tissue culture innovation.

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Endemic Species Conservation with Ecological Niche Modelling (ENM)

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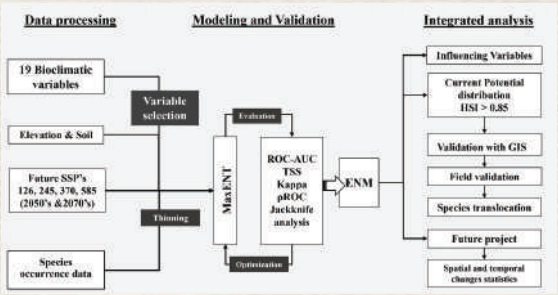

ENM linked translocation for species conservation

Ecological Niche Modelling (ENM) is a valuable tool for identifying suitable habitats for species translocation, particularly for endemic species with limited distributions. This study applies Maxent-based ENM to map habitat suitability for Crinum malabaricum Lekhak & S. R. Yadav, an endemic plant species restricted to the Malabar Plains of the Western Ghats.

Out of 23 recorded occurrences, 11 were used for modelling. From 21 bioclimatic and topographic variables, seven were selected based on Pearson's correlation ($r = \pm 0.8$) and permutation importance (>3%). The model's accuracy was evaluated using ROC curve analysis and variable contributions were assessed via Jackknife analysis. The most influential predictors were precipitation and mean temperature of the driest quarter.

The model demonstrated high accuracy, with an AUC ratio of 1.6 and strong values (>8) for AUC, partial AUC, Kappa, and TSS. It identified 2,393 km^2 (3.6% of the study area) as highly suitable habitat (suitability index ≥ 0.85) for C. malabaricum, which is significantly larger than the species' current extent of occurrence (EOO = 283 km^2). Field validation helped identify the species' realized niche and led to the selection of ten suitable translocation sites across the southern Western Ghats.

Given the species' narrow distribution and poor natural dispersal, translocation to these identified habitats is expected to enhance its conservation prospects. This approach demonstrates the reliability of ENM in guiding conservation translocations and can serve as a model for protecting other narrowly distributed endemic species

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Slaughterhouse Wastewater Management Using Biofilm Technology

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Biological nutrient removal of slaughterhouse wastewater using an anoxic-oxic sequential batch biofilm reactor

Slaughterhouse wastewater, characterized by high levels of BOD, nitrogen, and phosphorus, poses a significant treatment challenge, especially in developing countries like India. While Sequencing Batch Reactors (SBRs) have shown satisfactory results in treating such wastewater, they suffer from drawbacks such as excessive sludge production and high sludge volume index. To address these issues, the conventional SBR can be modified into a Sequencing Batch Biofilm Reactor (SBBR) by adding inert carrier materials to support biofilm growth, combining suspended and attached growth systems.

This study investigates the performance of an SBBR for simultaneous removal of carbonaceous organic matter and nutrients from slaughterhouse wastewater under two aerobic/anoxic react period combinations. The system was evaluated under optimal operating conditions, measuring reduction percentages of key parameters.

Results showed COD removal rates of 92–94% for initial COD concentrations of 2800 mg/L. The treated effluent had COD and BOD values of 200 mg/L and 81 mg/L, respectively, with maximum organic matter decomposition achieved within four hours. Denitrification was more efficient in the aerobic-anoxic phase than in the aerobic-only phase, highlighting the effectiveness of phased oxygen conditions.

The biofilm-based system demonstrated higher treatment efficiency and faster reaction rates due to increased microbial growth and biomass accumulation. The study confirms the SBBR's potential as a reliable, cost-effective solution for slaughterhouse wastewater treatment, particularly in resource-limited settings. These findings offer valuable insights for the design and optimization of SBBR systems in future wastewater treatment applications.

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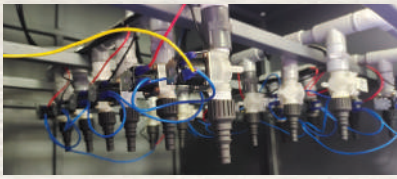
Smart Rainwater Sampling System for Environmental Research



Innovators
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Automated Time-Integrated Rainwater sampler System

Accurately capturing the spatial and temporal variability of rainfall is vital for hydrological, environmental, agricultural, and climate studies. While regional patterns are well studied using monthly or daily data, fine-scale spatial variability is often overlooked and assumed to be uniform.

Traditional methods collect rainwater as daily or monthly composites, limiting the understanding of short-term variations. To overcome this, rainfall must be sampled in a more temporally resolved and spatially distributed manner. Time-based or volume-based sequential samplers are typically used, ranging from costly revolving models to low-cost microcontroller-based systems. However, both face challenges in maintaining sample purity and avoiding cross-contamination between intervals.

To address this, the Centre for Water Resources Development and Management's Ecology and Environment Research Group has developed a low-cost, automated rainwater sampler. Rainwater is collected through a funnel, stored temporarily, and pumped into separate sample bottles at user-defined intervals (e.g., hourly). The system automatically shuts off after sample collection or once rainfall stops.

Designed for field use, the sampler is lightweight, weatherproof, energy-efficient, and constructed from inert materials to prevent chemical contamination. It also supports remote monitoring, enhancing its applicability in diverse environments.

This innovative tool enables high-resolution rainfall sampling, crucial for detailed environmental analysis and hydrological modeling. Its affordability, reliability, and precision make it an effective solution for researchers and practitioners studying water resources, pollution dynamics, and climate impacts. The system addresses a key gap in rainfall data collection, especially in areas with limited monitoring infrastructure.

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Biochar from Bamboo Waste: A Sustainable Solution for Soil and Climate

Innovators
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Biochar

The Kerala State Council for Science, Technology and Environment (KSCSTE) – Kerala Forest Research Institute (KFRI) has established a biochar production unit at its Field Research Centre in Palappilly. This facility converts bamboo waste into biochar, a stable, carbon-rich product created through the pyrolysis of biomass under oxygen-limited conditions.

Biochar is gaining recognition as a sustainable solution with multiple environmental and agricultural benefits. In agriculture, its porous structure enhances soil fertility by improving nutrient retention and increasing water-holding capacity. This is especially beneficial in areas with poor or degraded soils. The presence of biochar in soil also stimulates microbial activity, which plays a key role in nutrient cycling and overall soil health. These combined effects lead to healthier soil ecosystems and improved crop productivity.

Beyond its agricultural applications, biochar plays a significant role in mitigating climate change. As a long-term carbon sink, it stabilizes carbon within the soil for hundreds to thousands of years, thereby reducing the release of carbon dioxide and other greenhouse gases from soils into the atmosphere. This contributes to efforts in reducing overall atmospheric carbon levels and enhancing climate resilience.

The use of bamboo waste as the feedstock makes this initiative even more sustainable, promoting waste-to-resource practices and reducing biomass waste. By integrating biochar production into its research and field programs, KFRI is promoting innovative, eco-friendly technologies that support sustainable agriculture, waste management, and climate action. This initiative serves as a model for scalable, low-cost, and impactful environmental solutions.

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Coir Fibre Root Trainers: A Green Alternative to Plastic in Plant Nurseries

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Coir fibre based root trainers to reduce the use of plastics in nurseries and to increase farmers' income:

Nurseries in India produce crores of saplings annually, largely using single-use plastic containers. In Kerala alone, forest nurseries consume over 25 metric tonnes of plastic each year. With growing concerns over plastic pollution, the Ministry of Environment, Forest and Climate Change (MoEF&CC) and several states have banned plastic use in nurseries. However, due to the lack of viable alternatives, its use continues.

To address this, the Kerala Forest Research Institute (KFRI) and Parambikulam Tiger Conservation Foundation have developed India's first Coir Fibre-Based Root Trainers (CRT). Made from latex-sprayed coir mattress material, CRTs are fully biodegradable and eco-friendly. Each container has four internal ridges and a 20mm drainage hole, supporting healthy root growth and preventing root coiling. The current 150 cc model is ideal for seedlings requiring 2–5 months of nursery development.

CRTs offer multiple advantages: they can be planted along with the seedling, minimizing transplant shock and root damage; require less potting mix and water; and enhance root structure for better survival in the field. Additionally, CRTs promote local employment, boost farmer income through demand for coconut husk products, and offer export potential for eco-friendly planting materials.

Though initially more expensive than plastic, CRTs provide long-term environmental and economic benefits. With further technological improvements, production costs are expected to decrease, making CRTs a practical and sustainable solution for plastic-free nurseries.

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Multipurpose Kora Grass Mats of Killimangalam – Blending Artistry, Culture, and Sustainability

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Killimangalam kora grass mats - for geographical indication tag

Killimangalam Kora Grass Mats, a traditional craft practiced in Thrissur and Palakkad districts of Kerala, are woven using fine-count kora grass (Cyperus spp.), locally known as Thottu Muthanga. In Thrissur, the weaving is centered in Killimangalam (Panjal Panchayat, Talappilly Taluk), while in Palakkad, it is concentrated in Chittur town and village.

This age-old craft, traditionally practiced by the Kurava community, involves intricate weaving of pulpaya (mats) in both coarse and fine varieties. Finer mats, made using 140's or 200's count grass split into 6–8 parts, are known for their quality, intricate designs, and higher market value. Warp threads, usually two-ply yarns with high twist, are used for durability. These mats are functional and decorative, used as sleeping mats, yoga mats, carpets, table mats, and wall hangings.

Designs are inspired by local culture—palm leaves, elephants, processions, and traditional attire like the neriyathu—blending indigenous creativity with utility. The mats' excellence in craftsmanship earned the "Seal of Excellence" from UNESCO CCI in 2004, recognizing their aesthetic value, eco-friendliness, and cultural identity.

To preserve this unique heritage and support weavers, the Kerala Forest Research Institute (KFRI), in collaboration with the Textile Committee (Government of India) and NABARD, has initiated the process to secure a Geographical Indication (GI) tag for Killimangalam Kora Grass Mats. This will help protect traditional knowledge, boost market visibility, and empower artisan communities.

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Organo Clay from Waste Mica: A Sustainable Solution for Pollution Control

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Organo clay from waste mica: a sustainable solution for pollution control

Organo clay developed from waste mica and humic acid presents a sustainable and efficient solution for environmental pollution control. With rising contamination from heavy metals, dyes, and organic pollutants, the need for low-cost, eco-friendly remediation technologies is critical. Traditional methods often face limitations such as high cost and inefficiency against mixed contaminants.

Mica, a widely used industrial mineral, generates significant waste during processing. Though raw mica has low adsorption capacity, its layered structure makes it ideal for modification. By functionalizing waste mica with humic acid, its sorptive properties are significantly enhanced. This transformation not only addresses mica waste disposal but also creates a valuable material from an underutilized by-product.

Humic acid, rich in functional groups like carboxyl, hydroxyl, and phenolic moieties, imparts strong chelation, ion exchange, and hydrophobic interaction properties to the organo clay. The resulting composite efficiently removes pollutants via mechanisms like complexation, electrostatic attraction, and π–π interactions. Its dual hydrophilic-hydrophobic character enables it to act in diverse environmental conditions.

The synthesis process is mild, cost-effective, and avoids hazardous chemicals, making it suitable for large-scale use, especially in developing regions. Applications include wastewater treatment, soil remediation, and industrial effluent purification. The clay also shows good regeneration capability, allowing multiple reuse cycles without significant loss in performance.

Spectroscopic studies confirm its long-term structural and functional stability, making this organo clay a promising candidate for widespread, sustainable environmental remediation.

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Nanocomposite Beads for Efficient Nitrate Removal

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Ternary nanocomposite for removal of nitrates from wastewater

Nitrate contamination in drinking water, primarily from fertilizers, industrial discharges, and domestic effluents, poses serious health risks. The permissible limit is 10 mg/L, and effective removal is critical. To address this, Centre For Water Resource Development And Management has developed a cost-effective, sustainable nanocomposite technology for nitrate removal using Fe_3O_4@chitosan beads coated with Ag-doped TiO_2.This ternary nanocomposite integrates the adsorption capacity of magnetite (Fe_3O_4), the binding and biodegradable properties of chitosan, and the photocatalytic action of titanium dioxide (TiO_2). Ag doping enhances visible light activity of TiO_2, enabling efficient nitrate reduction under sunlight. The nanocomposite is synthesized using a co-precipitation method for magnetite and sol-gel synthesis for Ag-TiO_2, crosslinked with glutaraldehyde.

When exposed to sunlight, the beads generate electron-hole pairs that reduce nitrates effectively, achieving ~97% nitrate removal in one hour of sunlight and ~66% removal within 30 minutes via adsorption. The system performs efficiently even in real groundwater samples, outperforming pure chitosan beads due to enhanced electrostatic attraction and photocatalytic activity.

Centre For Water Resource Development And Management has secured an Indian patent for this innovation (Patent No. 563497, dated 25-03-2025), and a functional prototype water filter has been developed. The nanocomposite offers a promising, low-cost solution for point-of-use water purification and has potential for larger-scale wastewater treatment applications. The technology presents a significant step forward in addressing nitrate pollution in water resources.

Patent No. 563497
Dated 25-03-2025

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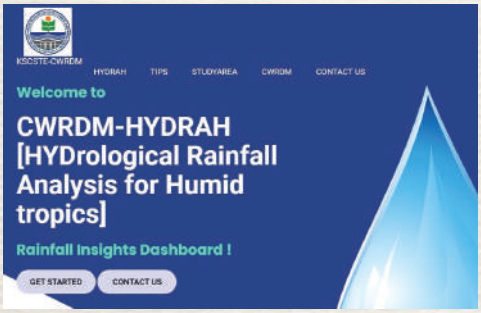
Rainfall Insights Dashboard



Innovators
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HYDRAH rainfall insights dashboard

The HYDRAH (Hydrological Rainfall Analysis for Humid Tropics) dashboard is an interactive data visualization tool developed using the Shiny package in R. It enables users to explore rainfall data and analyze trends and patterns relevant to humid tropical regions. Designed for researchers, environmental planners, and decision-makers, HYDRAH offers an intuitive interface that supports both technical and non-technical users.

The dashboard includes several analytical tabs tailored to different aspects of rainfall study. The "Rainfall Overview" tab allows users to select a date range and view annual, monthly, and daily rainfall distributions, helping to identify long-term trends, anomalies, and variations. The "Seasonal Analysis" tab supports deeper exploration of seasonal patterns using tools such as time series plots, histograms, and seasonal decomposition, allowing users to detect intra-annual shifts in precipitation behavior.

Another important feature is the "Rainfall Summary & Extreme Events" tab, which offers a concise statistical summary of the data along with the identification of extreme rainfall events. This functionality is especially useful for applications in flood risk assessment and climate resilience planning. User-friendly controls such as date range selectors, seasonal filters, and reset buttons enhance ease of use and allow for flexible data manipulation.

Overall, the HYDRAH dashboard provides a powerful and accessible platform for understanding rainfall dynamics in tropical environments. It aids in improving hydrological research, informing water resource management, and supporting climate adaptation strategies through accurate, data-driven insights.

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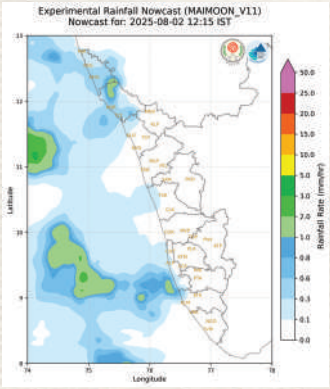
ML-Based Rainfall Nowcasting



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ML-Based rainfall nowcasting

The Machine Learning-based Rainfall Nowcasting system is an experimental forecasting tool designed to provide high-resolution, short-term predictions of rainfall. This innovative approach uses real-time data from geostationary satellites, specifically leveraging infrared and water vapor channels to monitor cloud characteristics and atmospheric moisture. By observing these variables, the system can assess the evolving conditions that typically precede precipitation.

To further refine prediction accuracy, the model integrates a high-resolution Digital Elevation Model (DEM), which enables it to account for the influence of local terrain on weather systems. Terrain features such as elevation and slope can significantly impact rainfall formation and distribution, making this component crucial in improving forecast reliability, especially in topographically diverse regions.

All collected and processed data are fed into a deep learning model based on a Convolutional Long Short-Term Memory (ConvLSTM) architecture. This model architecture is specifically designed to recognize complex spatial and temporal patterns in atmospheric data, enabling it to predict near-term precipitation events with greater precision. The ConvLSTM framework is particularly well-suited for sequential data like satellite imagery, where time and spatial dependencies are critical for accurate nowcasting.

The output of the system is a dynamic rainfall intensity map that indicates predicted precipitation rates in millimeters per hour (mm/hr). These forecasts are updated continuously as new satellite data is received, offering users timely and localized information. This nowcasting system represents a significant step toward more responsive weather prediction tools, supporting disaster preparedness, agriculture, and water resource management in rain-sensitive regions.

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Copper-Nickel Nanocomposite for Water Purification

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A method for heavy metal adsorption by Bimetallic polymer nanocomposite

A novel method for water purification involves the use of bimetallic CuNi nanoparticles (BNPs) embedded within a porous polymer nanocomposite. Copper nanoparticles (Cu NPs) are known for their low toxicity, biocompatibility, and antimicrobial properties, while nickel nanoparticles (Ni NPs) offer strong chemical and magnetic characteristics along with antimicrobial activity. When combined, the synergistic properties of CuNi BNPs enhance their effectiveness in removing heavy metals and bacterial contaminants from water.

The composite material offers several practical advantages. CuNi BNPs can be synthesized rapidly, are cost-effective due to the abundance of raw materials, and remain stable across a wide pH range. Notably, these BNPs have shown high efficacy in adsorbing arsenic—a major water pollutant.

To prevent nanoparticle aggregation and enable easy separation after treatment, the BNPs are immobilized on porous polymer microspheres, particularly styrene-divinylbenzene (St-DVB) microbeads. These polymer supports are non-toxic, reusable, and exhibit high surface area, tunable porosity, and chemical stability. Their porous structure increases contact between adsorbent and contaminant, improving overall adsorption efficiency.

The resulting nanocomposite functions effectively in continuous adsorption column systems, where water flows through and interacts with the composite's inner and outer surfaces. This system allows for high-performance purification while offering simple handling, low leakage, and long-term usability. The innovation presents a low-cost, scalable solution for removing arsenic and other heavy metals, positioning it as a promising technology for sustainable water treatment in both urban and rural settings.

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Microbial consortium for Composting for High altitude-low temperature region

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Microbial consortium for windrow composting for high altitude-low temperature region

The increasing demand for eco-friendly waste management has highlighted the importance of microbial consortia in composting processes, particularly in challenging climates. This project, led by IRTC, addresses effective biowaste management in high-altitude, low-temperature regions like Munnar by developing a customized microbial consortium using local psychrophilic and efficient microorganisms.

Given Munnar's distinct climatic conditions, conventional composting methods are less effective. To overcome this, local soil and decayed debris were screened to isolate cold-tolerant microbes, forming a unique consortium capable of functioning optimally in such environments. This was complemented with the design of a polyhouse structure to trap available solar heat, thus maintaining favorable composting temperatures during the day.

The developed microbial consortium enables the windrow composting of 3–4 tons of biowaste daily, currently processed and marketed as "Munnar Green Biomanure" by the Munnar Local Self Government Institution (LSGI). The initiative ensures year-round composting through regular inoculum supply and minimizes environmental and public health hazards.

This approach promotes sustainable waste management, generates employment, and supports women's empowerment in the region. By integrating biotechnology and local resources, the project not only provides an efficient waste solution but also enhances social welfare, public health, and quality of life. The model stands as a replicable framework for other high-altitude regions facing similar climatic challenges.

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Microbial Consortia for Sustainable Waste Management

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Microbial consortium for windrow composting for tropical regions

This innovation presents a scalable, eco-friendly solution for waste management through the development of purpose-driven microbial consortia. Moving beyond conventional chemical treatments, the project harnesses the power of microbial fermentation—ushering in a new era of green biotechnology.

The core breakthrough lies in the large-scale production of tailored microbial blends that can effectively treat diverse waste streams. These consortia are designed to be application-specific and adaptable, enabling year-round deployment for decentralized and sustainable waste processing.

A dedicated repository of these microbial inoculants ensures consistent supply, empowering local bodies, industries, and households to adopt zero-waste disposal practices. This technology is not just a scientific milestone—it is a catalyst for social change. By integrating community-level applications, it opens up livelihood opportunities, promotes women's participation in bio-based enterprises, and enhances public health outcomes.

The innovation aims to minimize environmental hazards associated with waste mismanagement, while simultaneously improving the quality of life. It supports a circular economy framework where waste becomes a resource, thereby aligning with the State's vision of inclusive, sustainable development.

This ready-to-deploy microbial solution has the potential to revolutionize waste management in Kerala and beyond—marking a shift from problem-solving to opportunity creation.

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Rooftop Rainwater Calculator: Smart Planning for Water Security

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Roof-top rainwater calculator

This innovation introduces a user-centric, web-based tool designed to promote household level water security through scientific planning of rooftop rainwater harvesting (RWH). Developed specifically for Kerala's climatic conditions, the interface enables accurate estimation of harvestable rainwater using localized rainfall data and household specific parameters. The system integrates location based meteorological inputs with user provided details such as rooftop dimensions, roof material, household size, and seasonal water scarcity duration. It estimates the volume of water that can be harvested during key hydrological seasons including South West Monsoon, North East Monsoon, and Winter/Summer months, providing a comprehensive overview of potential water availability.

A key feature of the tool is its ability to calculate the optimal storage capacity required to meet household water demands during periods of shortage. It also offers preliminary guidance for implementing rooftop harvesting systems by detailing essential components such as gutters, conveyance pipes, flush valves, filters, storage tanks, and recharge structures, making it a practical solution for individuals, planners, and policy implementers. By facilitating the adoption of decentralized water systems, this digital platform aligns with Kerala's vision for water sustainability and resilience. It supports climate adaptation efforts, fosters resource conservation, and empowers communities to transition from dependency to self-reliance in water management.

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Nature-Inspired Neurotoxins: The Commercial Potential of Nepenthes Pitcher Plant Chemistry

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Bait, not reward: CO_2-enriched Nepenthes pitchers secrete toxic nectar

Indian Nepenthes pitcher plants have been found to function as natural carbon dioxide (CO_2) chambers—harboring CO_2 concentrations nearly ten times higher than atmospheric levels ($\approx$ 4000 ppm). This elevated CO_2 not only attracts insect prey but also fuels key biological processes within the pitchers, including growth, metabolism, digestion, and defense. The study redefines the understanding of these carnivorous plants, showing that the seemingly harmless extrafloral nectar (EFN) they secrete is far from a nutritional reward. Instead, this EFN is a carbohydrate-rich but nitrogen-deficient substance, laced with a potent neurotoxic compound—(+)-isoshinanolone, a natural inhibitor of acetylcholinesterase (AChE). By impairing neuronal activity and flight response in insects, this compound acts as a 'toxic sugar bait', luring arthropods to their doom. The dual function of the EFN—as both attractant and toxin—reveals the sophisticated and deceptive prey capture strategy of Nepenthes. This discovery challenges long-held ecological assumptions and opens exciting translational possibilities: the identified AChE inhibitor shows promising potential as a natural insecticide and a candidate molecule for Alzheimer's disease therapy. Nepenthes, with their CO_2-driven traps and neuroactive secretions, represent a unique plant model at the intersection of ecology, biochemistry, and pharmacology—showcasing nature's innovation in chemical warfare and resource acquisition.

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Nutritious Bamboo-based Food Products

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Bamboo shoot powder and flakes

Bamboo, traditionally valued for its industrial and ecological significance, is now emerging as a nutritional powerhouse through innovative food processing. While bamboo shoots are a dietary staple in East Asia and northeastern India, their adoption in southern India remains limited, largely due to short harvest windows, perishability, and lack of value-added products.

To bridge this gap, we have developed two innovative, shelf-stable bamboo shoot products bamboo shoot powder and freeze-dried flakes designed for wider culinary use and commercial potential. Harvested during the monsoon season, fresh bamboo shoots are nutrient-dense but highly perishable and contain cyanogenic compounds requiring careful processing. Our standardized protocols not only ensure safety but also unlock the full nutritional value of this underutilized resource.

Bamboo shoot powder, rich in fiber and micronutrients, can be blended into traditional recipes such as breads, biscuits etc., enhancing both taste and health benefits. Freeze-dried bamboo shoot flakes, developed using lyophilization technology, retain maximum nutrients while dramatically increasing shelf life. This process involves freezing the shoots and removing moisture via sublimation under vacuum preserving flavor, texture, and nutritional integrity.

These innovations transform bamboo shoots from a regional delicacy into versatile, safe, and market-ready products suitable for modern kitchens and food industries. By adding value at the source, we promote sustainability, nutrition, and rural entrepreneurship paving the way for bamboo to take root as a next-generation health food.

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Sustainable & High-Potency Dried Mushrooms Powder for the Future

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Sustainable and high-potency dried mushrooms & powders

The Integrated Rural Technology Centre (IRTC) is transforming mushroom cultivation into a scalable, income-generating enterprise for rural communities through an end-to-end innovation model. Moving beyond traditional methods, IRTC offers a scientifically-driven cultivation program that combines hands-on training, cutting-edge biotechnology, and sustainable production systems.

IRTC always ensures the production of high-quality, contamination-free mushroom spawn critical for consistent yields and healthy crops. Over 1,000 individuals across Kerala and neighbouring regions have been trained through IRTC's dynamic programs, which simplify complex cultivation techniques into accessible, step-by-step modules. From substrate preparation and spawn inoculation to climate control and post-harvest care, participants gain practical skills to confidently launch and scale mushroom ventures.

Innovations like ready-to-fruit mushroom beds pre-sterilized and inoculated enable hassle-free cultivation, reducing setup time and effort for growers. IRTC supplies certified spawn to over 400 farmers, ensuring genetic purity and performance. In strengthening the mushroom value chain, IRTC also supports processing and market integration. Their dried mushroom products, processed to retain peak nutrition and flavor, offer a shelf-stable, value-added option with strong market appeal.

By integrating technology with grassroots capacity building, IRTC's initiative boosts food security, sustainability, and entrepreneurship in rural areas. This model not only redefines how mushrooms are grown but also creates a replicable path for agro-based innovation-led development across India

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Probiotic chocolate with Prebiotic fibres from Kerala's Seasonal Fruits

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Probiotic chocolate incorporated with prebiotic fibres from indigenous and seasonal fruits of Kerala

Functional foods are reshaping the future of preventive health and CoEM brings a delicious innovation - a probiotic chocolate enriched with prebiotic fibres from Kerala's indigenous fruits.This unique product combines the indulgence of chocolate with the science of gut health. It incorporates live probiotic cultures to support a healthy microbiome, paired with natural prebiotic fibres derived from underutilized, seasonal fruits such as jackfruit, Indian apple, banana, mango, and pineapple. These fruits not only offer dietary fibre but also antioxidants and micronutrients, significantly enhancing the functional value of the chocolate.

What sets this innovation apart is its holistic approach that blending nutrition, sustainability, and local empowerment. By using regionally available fruits, the initiative promotes post-harvest utilization, reduces food waste, and supports local farmers through value addition.Targeted at the growing segment of health-conscious consumers, especially urban millennials, this clean-label product aligns with the rising demand for natural, functional snacks. With India's functional food market expanding rapidly, this chocolate offers a high-potential entry into premium health and wellness segments in both domestic and global.More than just a treat, this probiotic-prebiotic chocolate is a symbol of science-driven innovation rooted in traditional resources, paving the way for rural development and modern health solutions through locally sourced, value-added food technologies.

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Next-Generation Starter Culture for Kerala's Traditional Fermented Food

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A reliable and modular starter culture for Kerala's Traditional Fermented Foods

Kerala's culinary identity is deeply rooted in fermented foods like idli and dosa, staples known for their flavor, digestibility, and health benefits. Traditional fermentation typically involves using a portion of previously fermented batter. While this age-old practice is widely followed, it often leads to variations in quality, unpredictable results, and a higher risk of microbial contamination.

To bring scientific precision to this tradition, CoEM is developing an innovative, standardized starter culture for a modular, ready-to-use microbial blend derived from Kerala's authentic idli-dosa batters. This culture is formulated by isolating and selecting beneficial bacteria with strong acidification, gas production and textural properties. Advanced genome sequencing ensures the strains are safe, effective, and potentially probiotic—offering added value for health-conscious consumers.

Designed for home kitchens and food businesses alike, the starter culture guarantees consistent fermentation, improved nutritional quality, and enhanced food safety—free from preservatives or synthetic additives. It also supports India's shift toward sustainable, microbial alternatives in line with emerging FSSAI guidelines that limit the use of antibiotics.

More than a convenience, this innovation is a future-ready solution that safeguards Kerala's food heritage while unlocking new commercial possibilities. With potential applications in probiotic supplements, clean-label products, and rural entrepreneurship, this smart starter culture exemplifies how tradition can be reimagined through science to meet modern needs. This product represents a modern, health-forward approach to preserving tradition and promoting wellness in a changing world.

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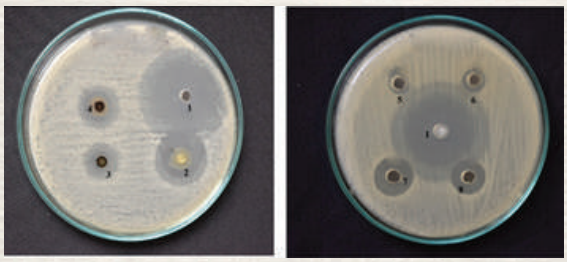
Fungus-Derived Antimicrobial for Pharma and Agri Use



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Discovery of Diethyl Phthalate from *Diaporthe penetriteum*: An antimicrobial compound from endophytic fungi

In response to the global threat of antimicrobial resistance (AMR), our research has identified *Diaporthe penetriteum,* an endophytic fungus isolated from Lagenandra toxicaria, as a novel microbial source of diethyl phthalate, a compound with broad-spectrum antimicrobial activity. Cultured under controlled lab conditions, the fungus produced metabolites extracted using eco-friendly ethyl acetate. These extracts demonstrated strong antimicrobial efficacy in agar well diffusion assays, showing zones of inhibition ranging from 20.5–23.7 mm against major human pathogens such as *Staphylococcus aureus, Bacillus subtilis, Pseudomonas aeruginosa,* and *E. coli.* HPLC analysis confirmed diethyl phthalate as the active compound—reported for the first time from *D. penetriteum.*

This natural product-based innovation is currently at Technology Readiness Level (TRL) 3–4, with demonstrated lab-scale effectiveness and a green extraction process. With further development—including compound purification, formulation, and toxicity profiling—this discovery holds strong potential for commercialization in both healthcare and agriculture. Potential applications include next-generation natural antibiotics and bio-based crop protectants. Intellectual property protection for the microbial strain and production process is under consideration.

The project seeks an investment of ₹10–15 lakhs for scale-up and pre-commercial validation. It offers a promising opportunity for licensing or startup incubation aligned with national AMR strategies and sustainable bioresource utilization. This innovation not only opens a new avenue in antimicrobial discovery but also underscores the untapped potential of India's rich endophytic biodiversity.

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Gene-to-Structure Platform for Rapid Antiviral Discovery

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Gene-to-structure discovery platform at the department of antiviral research, IAV

The Department of Antiviral Research (DAV) at the Institute of Advanced Virology (IAV) has established a cutting-edge Gene-to-Structure Discovery Platform, offering end-to-end support for biotech startups and pharmaceutical partners focused on antiviral therapeutics. This platform enables rapid structural characterization of viral and host proteins, delivering critical mechanistic insights to drive data-informed drug development.

DAV's integrated capabilities include target gene cloning into optimized vectors, recombinant protein expression in bacterial, insect, and mammalian systems, and high-purity protein purification with biochemical validation. Advanced 3D structure determination using X-ray crystallography supports structure-based drug design and molecular docking. Complementing this, real-time binding assays using Bio-Layer Interferometry (BLI) and Isothermal Titration Calorimetry (ITC) allow for precise measurement of drug–target interactions.

What distinguishes DAV is its domain expertise in resolving complex viral protein structures, paired with a translational focus that bridges basic science and clinical relevance. The platform supports both early-stage target discovery and later-stage lead optimization, offering modular collaboration models tailored for emerging biotech teams. By significantly reducing the timeline from gene to structure, this platform helps accelerate antiviral pipelines—from idea to impact.

With a commitment to scientific excellence and industry alignment, DAV invites strategic partnerships to co-develop next-generation antiviral therapeutics—positioning Kerala as a hub for innovation in infectious disease research.

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Point-of-Care Prognostic Device for Dengue Severity

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Prognostic device for the early prediction of dengue severity

Dengue poses a significant clinical challenge due to its unpredictable progression—from mild illness to life-threatening complications such as plasma leakage and organ dysfunction. One of the major gaps in current dengue care is the lack of reliable tools to predict disease severity early, often resulting in widespread but unnecessary hospitalizations. Addressing this, a pilot study utilizing machine learning identified specific endothelial-derived proteins that are differentially expressed in the early febrile phase of patients who later develop severe dengue. These biomarkers offer strong potential for early risk stratification.

The innovation now being developed is a lateral flow-based point-of-care device that can detect and quantify these host proteins from serum or plasma samples—enabling frontline healthcare workers to predict dengue severity at the onset of illness. Unlike existing diagnostics that confirm infection by detecting antigens or antibodies, this device focuses on prognosis, helping clinicians distinguish patients likely to deteriorate from those with mild disease.

This portable, rapid, and affordable prognostic tool fills a critical void in dengue care, particularly in outbreak-prone and resource-limited settings. It will empower physicians to make timely, informed decisions, reduce strain on healthcare systems by avoiding unnecessary admissions, and improve outcomes through early intervention. With significant potential for real-world impact, the technology is positioned to transform how dengue is managed across endemic regions.

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Pathogen Enrichment Method for Accurate Microbiome Sequencing

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A novel method for pathogen reads enrichment in metagenomic detection of gut and other organ microbiomes (including bacteria, phages, and viruses) shift in healthy, ill, chronic treatment, or dietary change-nutraceutical conditions

In metagenomic studies of microbiomes—which include bacteria, phages, and viruses—the overwhelming presence of host DNA often masks the genetic signatures of key microbial players. This limits the accuracy and sensitivity of pathogen detection, especially when investigating microbiome shifts associated with health conditions, treatment responses, or nutraceutical intake. To address this challenge, we have developed a novel enrichment method that selectively reduces host genome reads, dramatically improving the resolution and efficiency of metagenomic sequencing.

This host-depletion technique is compatible with a wide range of sample types and experimental conditions, making it ideal for clinical diagnostics, microbiome monitoring, and translational research. By enriching microbial sequences, it enhances the detection of low-abundance pathogens and facilitates high-confidence profiling of microbial communities—offering clear advantages for early disease diagnosis, therapeutic tracking, and personalized medicine. The method not only improves data quality but also reduces sequencing costs, thereby increasing throughput and affordability of metagenomic analyses. This innovation holds immense potential for applications in public health surveillance, infection control, nutraceutical evaluation, and microbiome-targeted therapies.

Scalable and adaptable, this enrichment strategy enables broader access to high-resolution microbiome insights, accelerating the integration of metagenomics into mainstream healthcare and life sciences. It represents a transformative step in precision diagnostics—where identifying “who’s there” in the microbiome becomes clearer, faster, and more actionable.

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Monoclonal Antibodies for Detecting and Blocking Viral Infections

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Development of monoclonal antibodies against emerging and re-emerging viral infections

Monoclonal antibodies (mAbs) are powerful tools for viral diagnostics and therapeutics, offering high specificity in detecting viral antigens or antibodies. In this study, mAbs were developed using hybridoma technology, where BALB/c mice were immunized with viral structural proteins expressed via plasmid-based gene delivery. Antibody response was monitored using IgG indirect ELISA, and once optimal titers were achieved, splenocytes were harvested and fused with myeloma cells. Hybridomas were selected using HAT medium and screened for antibody production. Positive clones were subcloned in semisolid media to establish stable monoclones that secrete antibodies specific to viral proteins.

The generated mAbs are now undergoing functional characterization using Western blot and immunofluorescence assays to confirm binding specificity and suitability for downstream applications. Planned epitope mapping will pinpoint precise antigenic sites critical to the antigen–antibody interaction, providing a foundation for designing neutralizing antibodies that could block viral entry mechanisms.

This pipeline not only supports the development of next-generation diagnostic assays but also lays the groundwork for therapeutic antibody design against emerging and re-emerging viral threats. With high relevance for viral surveillance, outbreak preparedness, and targeted treatment, this innovation aligns with national priorities in infectious disease management and biodefense. It also offers commercial potential for diagnostic kit development and therapeutic licensing.

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Rapid Point-of-Care Diagnostics for Viral Infections

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Next-generation diagnostic assays for acute viral infections

To address the urgent need for timely and accessible diagnostics in outbreak-prone and resource-limited settings, we are developing next-generation point-of-care diagnostic assays for the rapid detection of acute viral infections. These cost-effective, easy-to-use tools are designed to support early clinical decision-making and strengthen disease surveillance where centralized lab infrastructure is limited.

Our diagnostic platform integrates two complementary technologies: antigen-antibody detection via lateral flow assays, and nucleic acid-based detection using isothermal reverse transcription loop-mediated amplification (RT-LAMP). The lateral flow devices enable visual detection of viral proteins within minutes, similar to a home pregnancy test. Meanwhile, the RT-LAMP assays, embedded in cartridge-based formats, allow rapid amplification of viral genetic material at a constant temperature—eliminating the need for thermocyclers or complex lab setups.Both formats are optimized for simplicity, requiring minimal training and no specialized equipment. Results are generated within 15–30 minutes, making them ideal for deployment in community clinics, mobile health units, or during field surveillance efforts.

Clinical validation will be conducted using both synthetic controls and patient-derived samples to ensure diagnostic accuracy and robustness. These tools hold immense potential to support early detection, limit virus transmission, and guide immediate treatment decisions, especially in low-resource and high-risk regions.

This platform represents a scalable, field-ready solution for improving pandemic preparedness, epidemic response, and public health resilience—bridging diagnostic gaps at the frontline of infectious disease management.

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Recombinant Viral Antigens for Diagnostics and Vaccines

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Recombinant viral antigens

Recombinant viral antigens are produced using recombinant DNA technology, enabling the development of highly specific, safe, and scalable antigenic proteins. This approach involves inserting a gene encoding the antigen of interest into an expression vector, which is then introduced into a suitable host organism such as *E. coli,* yeast, insect, or mammalian cells. The host's cellular machinery expresses the recombinant protein, which is subsequently harvested, purified, and validated for downstream use.

E. coli is the most commonly used host for recombinant protein expression due to its fast growth rate, ease of genetic manipulation, and cost-effectiveness. However, when producing proteins for therapeutic applications, mammalian systems are preferred. Mammalian cells, such as HEK293, are capable of carrying out complex post-translational modifications, correct protein folding, and disulfide bond formation, which are often essential for biological activity and stability of the antigen.

At IAV, we offer well-established protocols and proprietary vectors tailored for both bacterial and mammalian expression systems. Our E. coli-based platforms are optimized for rapid protein expression and scalability, while our HEK293-based system is ideal for producing functionally active antigens requiring post-translational modifications.

Our infrastructure includes specialized molecular biology suites for gene cloning and vector construction, dedicated laboratories for bacterial and mammalian cell expression, and advanced protein purification facilities. These are equipped with cutting-edge chromatography systems such as the ÄKTA pure™ system, ensuring high-yield and high-purity protein production suitable for diagnostic, research, or therapeutic applications.

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Affordable Advanced Wound Care Using Herbal-Based Nanopad

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Multi-functional nanofibre pad for wound healing

A novel multifunctional wound healing pad has been developed using a layer-by-layer construction strategy, with each layer designed to perform a specific therapeutic function. This innovative approach enables targeted intervention at multiple stages of the wound healing process, enhancing overall efficacy and patient outcomes.

At the core of this invention is a specialized wound healing layer that incorporates a bioactive compound, referred to as Coded Compound X. This compound was isolated from Coded Plant Y using an activity-guided isolation method. Preclinical studies in rat models demonstrated that Coded Compound X significantly improved wound healing when compared to a standard reference drug, highlighting its therapeutic potential.

The multi-layered architecture of the pad contributes to accelerated wound repair by offering a combination of properties such as antimicrobial protection, moisture retention, and enhanced tissue regeneration. Each layer works synergistically, creating an optimized microenvironment for healing and reducing the risk of infection or delayed recovery.

One of the most notable advantages of this indigenous wound healing pad is its cost-effectiveness. It is significantly more economical than many commercially available alternatives, making it a highly accessible solution for the broader population. This affordability, combined with its enhanced therapeutic performance, makes it an ideal product for widespread public use, particularly in resource-limited settings.

In summary, the multifunctional nanofibre wound healing pad represents a promising and practical advancement in wound care technology, offering an affordable, efficient, and accessible option to support faster and more effective recovery.

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Safe & Scalable Sweet Flag Clones for Pharma Use

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Scale up production of elite clones of highly traded sweet flag through *in vitro*

Acorus calamus L., commonly known as 'sweet flag', belongs to the family Acoraceae and is a traditional medicinal herb widely distributed across America, Russia, Europe, China, and India. In India, it grows in both temperate and tropical regions. The calamus oil, primarily extracted from the plant's rhizome, is known for a wide range of pharmacological properties including nootropic, neuroprotective, CNS depressant, hypotensive, analgesic, anticonvulsant, sedative, antipyretic, diuretic, carminative, and antirheumatic effects, making it relevant in managing neurological and metabolic disorders.

Around 145 compounds have been isolated from A. calamus rhizomes, including phenylpropanoids (notably asarone and eugenol), sesquiterpenoids, sterols, and alkaloids. β-asarone is a major bioactive component, with its concentration influenced by plant part and ploidy level. Tetraploid varieties (2n=4x=48) typically contain the highest β-asarone levels (70–96%), followed by triploids and diploids.

Despite its therapeutic potential, high levels of β-asarone are toxic and potentially carcinogenic. Regulatory bodies including the USFDA, WHO, and European Commission have restricted the use of calamus oil in food and therapeutics, recommending only low β-asarone varieties for commercial applications.

Recognizing this, JNTBGRI has identified elite low β-asarone accessions and developed rapid multiplication protocols using biotechnological interventions. These protocols facilitate large-scale propagation of safer, pharmacologically effective A. calamus varieties, supporting their sustainable use in pharmaceutical and commercial applications. This approach ensures safety, efficacy, and scalability for broader public health and industry needs.

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Herbal Drug for Comprehensive Wellness

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A herbal drug composition possessing multiple therapeutic effects

This innovative herbal drug composition is a novel single-herb formulation developed in two user-friendly forms—granules for oral use and ointment for topical application. It is uniquely designed to deliver multiple therapeutic benefits including anti-inflammatory, analgesic, hepatoprotective, and antioxidant effects from a single natural source. Unlike conventional polyherbal or synthetic drugs, this formulation harnesses the pharmacological potency of one herb known for its broad-spectrum activity. Rich in bioactive compounds such as flavonoids and polyphenols, the herb offers a simplified yet highly effective treatment approach. These compounds work synergistically to inhibit inflammatory mediators like COX-2 and TNF-α, alleviate pain, protect hepatocytes, and combat oxidative stress by enhancing antioxidant enzyme activity and liver enzyme balance. Free from synthetic additives and preservatives, the composition is completely natural, non-toxic, and safe for long-term use. Its dual-form availability provides flexibility for both systemic and localized treatment based on therapeutic needs. Manufactured using standardized processes, it ensures consistency in potency and therapeutic outcomes. Supported by scientific studies and traditional medicinal wisdom, this formulation offers a safe, holistic alternative to chemical-based drugs for managing pain, inflammation, liver dysfunction, and oxidative stress-related conditions. Its unique single-herb composition, scientifically validated efficacy, and dual administration format give it a significant advantage in modern phytopharmaceutical applications.

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Probiotic from Infant Microbiome for Infection Prevention

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Probiotic formulation from infant gut microbiome as prophylactic/adjuvant to combat selected bacterial infections

In response to the escalating threat of antibiotic resistance, a novel probiotic formulation derived from the infant gut microbiome has been developed, offering a promising prophylactic and adjuvant solution against selected multidrug-resistant bacterial infections. The lead strain exhibits potent antimicrobial activity, particularly against Klebsiella pneumoniae strains resistant to colistin, a last-resort antibiotic. In vivo studies using murine models infected with colistin-resistant K. pneumoniae demonstrated significant reduction in infection severity and prevention of pathogen dissemination to internal organs. Beyond K. pneumoniae, the strain also displays broad-spectrum antimicrobial efficacy against high-priority pathogens including MRSA, drug-resistant *Vibrio cholerae, Salmonella enterica serovar Typhimurium, Shigella sonnei,* and enteropathogenic *E. coli.* Genome sequencing has confirmed the absence of virulence factors and antibiotic resistance genes, supporting the strain's safety for human use. Currently at Technology Readiness Level 4 (TRL-4), this formulation has shown strong proof-of-concept and is under further development. The strain's dual functionality—supporting gut health and offering protection against drug-resistant infections—makes it an attractive candidate for both therapeutic and functional food applications. With rising global demand for safe, natural, and effective alternatives to antibiotics, this infant gut-derived probiotic holds significant potential to address critical healthcare gaps, especially in resource-limited and high-risk settings. The technology is now open for co-development by innovators, biotech firms, and healthcare enterprises aiming to create market-ready products that bridge preventive healthcare and antimicrobial resistance management. This platform presents a unique opportunity to transform a validated microbiome discovery into a scalable public health solution.

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Eco-Friendly Innovation in Incense Stick Production

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Binding matrix for incense sticks or incense cones

A novel eco-friendly approach is redefining traditional incense stick production by introducing a sustainable binding matrix. Conventionally, incense sticks use Jigat (Litsea glutinosa) bark as a binder along with wood powders, charcoal, and essential oils. This innovation replaces Jigat with a locally available alternative—*Litsea deccanensis* bark powder—combined with bamboo sawdust and bamboo charcoal, creating a greener, cost-effective solution.

What sets this method apart is the smart utilization of waste bamboo, especially the inter-nodal portions that typically go unused. Around 70% of such waste is now repurposed, significantly reducing raw material costs while promoting zero-waste manufacturing.

The ingredients are blended with distilled water into a semi-solid paste and coated onto bamboo sticks (3 mm diameter, 15 cm coating). Once dried at 50°C for three hours, these sticks deliver a clean, consistent burn—lasting approximately 40 minutes with minimal smoke. The same paste can also be shaped into incense cones (dhoop), allowing fragrance to be added either during or after production.

This innovative formulation not only enhances burning quality but also aligns with eco-conscious market trends. It opens new avenues for sustainable incense production using renewable resources, making it commercially viable for small-scale producers and artisans while protecting natural forests from overharvesting.

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Biopesticide Innovation for Sustainable Teak Protection

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A bio-pesticide based on nucleopolyhedrovirus for the management of teak pest *Hyblaea puera*

Biopesticide Innovation for Sustainable Teak Protection Innovators Dr. T V Sajeev KSCSTE-Kerala Forest Research Institute A bio-pesticide based on nucleopolyhedrovirus for the management of teak pest Hyblaea puera : Teak plantations in Kerala face severe losses from the teak defoliator Hyblaea puera, with timber productivity declining by up to ₹75,000 per hectare annually. In response, the Kerala Forest Research Institute (KFRI) has developed an innovative and eco-friendly solution—a biopesticide based on Hyblaea puera Nucleopolyhedrovirus (HpNPV), a host-specific virus that targets only the pest without affecting beneficial or non-target species.

First identified and characterized during a DBT project and perfected through a DFID-UK-supported project, the virus demonstrated high specificity and potency against third-instar larvae of the pest, causing mortality within three days. KFRI pioneered mass-production methods using infected larvae to extract virus-laden polyhedral inclusion bodies (PIBs), followed by development of refined formulations, including freeze-dried wettable powders. Field trials showed remarkable success: early-stage spray applications of 1×105 PIB/ml reduced leaf damage by up to 76%, while higher concentrations (2×10^{11} PIB/ha) achieved over 80% pest mortality. Strategic timing of application—particularly late afternoons before rainfall—further improved efficacy. This HpNPV-based biopesticide forms a core component of KFRI's integrated pest management strategy, which also includes real-time monitoring and predictive modeling of pest outbreaks. Though the technology is yet to be widely adopted in Kerala, private teak planters in Chhattisgarh have begun successful implementation.

As a patented, environmentally safe, and scientifically validated innovation, KFRI's HpNPV biopesticide presents a sustainable leap forward in forest protection, offering long-term ecological and economic benefits for India's valuable teak plantations.

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Eco-Friendly Blood Stain Removal

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Bio-based Blood Stain Removal Using Protease Enzyme Extracted from Endophytic Bacteria *Bacillus altitudinis*

Blood stains are notoriously difficult to remove due to their protein-rich composition, and conventional chemical detergents often prove ineffective while also posing environmental concerns. In response to this challenge, researchers have identified a novel protease enzyme extracted from Bacillus altitudinis, a bacterium isolated from the rhizosphere of the medicinal plant Lagenandra toxicaria. This biologically derived enzyme demonstrates strong potential as an eco-friendly alternative for stain removal.

The enzyme was tested on blood-stained cotton fabric under optimized laboratory conditions. Observations showed a clear, time-dependent degradation pattern: moderate fading of the stain was visible within three hours, substantial breakdown by six hours, and near-complete removal of the stain within twelve hours. The enzyme functions by cleaving peptide bonds in haemoglobin and associated blood proteins, converting them into water-soluble fragments that can be washed away easily. Importantly, it achieves this without causing damage to the fabric.

This microbial enzyme exhibits high activity at ambient temperatures and broad proteolytic efficiency, making it suitable for applications in households, hospitals, and industrial settings. It is currently at Technology Readiness Level (TRL) 3–4 and is yet to be commercialized. Although intellectual property has not yet been filed, the unique strain, extraction method, and application technique are potentially patentable.

The development of this technology aligns well with the rising demand for biodegradable and sustainable cleaning products. Future plans involve purification and stabilization of the enzyme, pilot-scale production, and formulation trials. An estimated funding of ₹8–12 lakh is required to move this technology toward commercialization. With its safety, efficiency, and environmental advantages, this enzyme holds strong potential to be integrated into existing detergent formulations or to form the basis of new bio-cleaning solutions through industry collaborations or startup ventures.

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Tropical Soil Scent: Bottling the Aroma of Rain

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Tropical Soil Scent

The distinctive aroma that arises when rain first touches dry earth—commonly known as "petrichor"—has captivated scientists, artists, and perfumers alike. This earthy fragrance is primarily caused by a volatile compound called geosmine, which is naturally produced by certain soil-dwelling bacteria. When raindrops strike dry soil, geosmine and other aerosols containing bacterial spores are released into the air, evoking the refreshing and often nostalgic scent of freshly moistened ground.

Building on this phenomenon, a recent innovation has enabled the identification and extraction of geosmine from a plant-based source, offering a natural alternative to synthetic formulations. Researchers developed a crude yet authentic version of this scent by using essential oil extracted from the plant. The product, named "Tropical Soil Scent," was validated using Gas Chromatography–Mass Spectrometry (GC–MS), which confirmed the presence of geosmine along with other volatile components that contribute to the petrichor experience.

This novel fragrance was showcased at the Global Science Fest 2024 held in Thonnakkal, Thiruvananthapuram, where it drew wide interest for its originality and sensory appeal. Visitors were particularly struck by the scent's ability to evoke memories and emotions linked to monsoon rains and natural landscapes. The demonstration emphasized both the aesthetic and commercial potential of this nature-derived fragrance in the wellness and perfumery sectors.

"Tropical Soil Scent" represents a significant step in sustainable fragrance innovation. It harnesses the richness of plant-based chemistry and modern analytical techniques to recreate a beloved olfactory sensation. As the demand for green and biodegradable products continues to rise, this development offers a meaningful intersection of traditional sensory experiences, eco-consciousness, and scientific precision—bringing the comforting scent of rain-drenched soil into everyday life.

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Eco-Friendly Dry Flower Hamper

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Aqua Florea

As part of a green initiative, eco-friendly dry flower mementos have been developed using locally sourced flowers and foliage, with a unique focus on Xerochrysum bracteatum, commonly known as the Strawflower. Known for its vibrant, long-lasting petals, this ornamental plant adds aesthetic appeal to each handcrafted piece. However, in the Nilgiris, Xerochrysum is classified as an invasive species, posing a serious threat to native biodiversity by displacing endemic flora. This innovation turns an ecological challenge into a creative solution. It transforms an environmental concern into a meaningful, value-added product while simultaneously raising public awareness on the impact of invasive plants.

The mementos are fully biodegradable, handmade without chemicals, and offer a sustainable alternative to plastic or synthetic gifts. Widely appreciated at academic and institutional events demonstrating early adhesion and public interest in eco-conscious gifting. Blending Xerochrysum with native dried flora, each piece reflects a story of conservation, creativity and sustainability. With increasing demand for green products, these mementos hold significant commercialization potential in eco-tourism hubs, botanical gardens, craft fairs and as institutional gifts.

By training local communities, especially women and self-help groups, this initiative promotes rural entrepreneurship and decentralized production, showcasing how ecological restoration and sustainable livelihoods can go hand in hand.

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GI Registered Kannadippaya (Bamboo Mat): From Mats to Wall Hangings

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Geographical Indication has been registered in the register in respect of Kannadippaya (Bamboo Mat)

Kannadippaya, a traditional bamboo mat crafted by five Scheduled Tribe communities—Oorali, Mannan, Muthuva, Malayan, and Kadar—in Kerala, has been awarded a Geographical Indication (GI) tag. This unique heritage craft is practiced in Idukki, Thrissur, Pathanamthitta, Ernakulam, and Palakkad districts, using slivers from thin-walled reed bamboo *(Teinostachyum wightii)* sourced from specific forest areas in the Western Ghats.

The hallmark of Kannadippaya is its intricate kannadi (mirror) designs—square motifs created by interweaving warp and weft patterns. These designs range from simple single squares to highly complex arrangements with over sixty motifs, including diagonal and reflective patterns. High-end versions may also feature detailed images of animals, birds, and trees along the borders. The mats are noted for their softness, flexibility, and light-reflective qualities, which enhance their visual appeal depending on the angle of view.

Fine-quality Kannadippaya can be rolled and inserted into a bamboo culm due to its flexibility. They are crafted in various sizes and forms—sleeping mats, yoga mats, table mats, and wall hangings—based on consumer needs. Names like vedan paya, ottakkannan, and naaluvari denote specific design styles.

The Kerala Forest Research Institute (KFRI) played a pivotal role in documenting and promoting this craft, leading to its GI registration. This recognition not only preserves the cultural legacy of Kerala's tribal artisans but also boosts local livelihoods, market visibility, and opens avenues for global appreciation of this eco-friendly, indigenous art form.

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Advanced Electrode Platform for Fast-Charging Supercapacitors

Innovators
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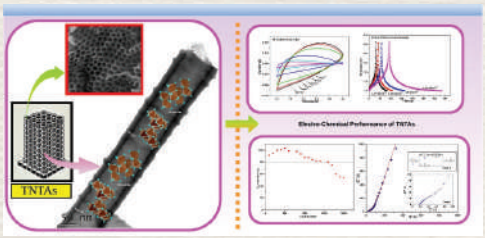

Temperature controlled water bath anodization technique for synthesis of high-performance TiO2 nanotube arrays as electrodes in supercapacitors

A novel temperature-controlled water bath anodization technique has been developed for synthesizing high-performance TiO_2 nanotube array (TNTA) electrodes for supercapacitors. This method enables in-situ crystallization, forming a mixed-phase structure consisting of monoclinic TiO_2(B), which supports pseudocapacitive ion intercalation, and orthorhombic Brookite, facilitating surface redox reactions. The electrodes exhibit outstanding electrochemical properties, including a high specific capacitance (~2000 F/g), energy density ranging from 100–800 Wh/kg, and power density between 1000–10,000 kW/kg. These superior properties are attributed to a high concentration of oxygen vacancies and the presence of dual pseudocapacitance mechanisms, resulting in excellent cyclic stability.

Further performance enhancements were achieved through doping strategies. A symmetric supercapacitor fabricated using unmodified TNTA electrodes delivered an energy density of 219 Wh/kg and a power density of 3.7 kW/kg at a current density of 1.7 mA/cm^2, with a gravimetric specific capacitance of 686 F/g and an areal capacitance of 313 mF/cm^2. Self-doping of TNTA electrodes pushed these values even higher, reaching 916.27 F/g and 417.97 mF/cm^2 at 1.3 mA/cm^2 within a 2V potential window, achieving 509 Wh/kg at 2.9 kW/kg.

These results mark a promising step toward next-generation, high-performance supercapacitors.

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Smart Traffic Signal System for Emergency Vehicle Priority

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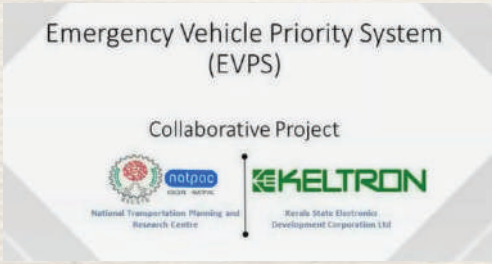

Emergency vehicle priority system - a collaborative project with M/s KSEDC (KELTRON)

The Emergency Vehicle Priority System (EVPS), developed in collaboration with M/s Kerala State Electronics Development Corporation (KELTRON), was field-tested at the Infosys junction on the Thiruvananthapuram–Kazhakkuttam bypass road. This system aims to reduce travel time for emergency vehicles by giving them priority at traffic junctions. During the field trial, an ambulance was equipped with the vehicle unit, while the junction unit was integrated with the existing "hurry call" system. The GPS coordinates of the two junction arms—Thiruvananthapuram to Kazhakkuttam and vice versa—were used in the controller to detect the approach of the emergency vehicle.

The evaluation process compared the time taken by an ambulance to cross the junction with and without the EVPS. Results showed a significant reduction in crossing time with the system activated. For example, in the Kazhakkuttam to Venpalavattom direction, time savings ranged from 10 to 25 seconds. Similarly, in the Venpalavattom to Kazhakkuttam direction, the system reduced delay by up to 24 seconds. On average, a time saving of over 10 seconds per signal was observed, which is highly impactful in urban corridors where every second counts during an emergency.

To further enhance system performance, ongoing fine-tuning efforts focus on increasing the detection range of the sensors, allowing emergency vehicles to be recognized earlier by the traffic signal system. This initiative marks a critical step in improving urban road safety and ensuring faster, unhindered passage for emergency vehicles.

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Transportation Database Management System

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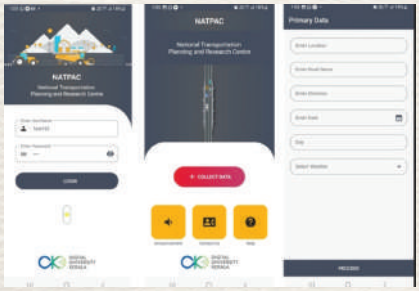

Kerala Transportation Database Management System (KTDMS)

The Kerala Transportation Database Management System (KTDMS) was developed to support strategic road asset management through a GIS-based, web-enabled platform. Its goal is to manage critical transportation data including traffic characteristics, road inventory, crash and pavement details, and overall network data. A key component is the Road Asset Management System (RAMS), which utilizes GIS and service-oriented architecture (SOA) for spatial data analysis and effective policy support.

The study involved phased development of a web-based GIS database and mobile applications to collect, manage, and analyze transportation data. Primary surveys were conducted at selected Kerala road locations to populate the database. The Software Requirement Specification (SRS) document was prepared to define system components, user roles, analytical modules, and deployment architecture.

Mobile applications were created for traffic volume and parking data collection, and road inventory. The apps allow manual counting of vehicle types with timestamps, enabling accurate traffic monitoring. Data collected via mobile is sent to the web interface, where it's stored, processed, and analyzed through specialized analytical modules—including vehicle and pedestrian volume analysis and signal warrant assessments.

Web services were developed, and Android application integration was completed. The system was tested under field conditions, with feedback-driven improvements incorporated. The KTDMS, currently at Technology Readiness Level 6 (TRL 6), enables efficient, accurate, and timely data collection and analysis, thus enhancing transportation planning and decision-making in Kerala through a unified mobile-web ecosystem.

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Smart Speed Display Boards for Safer Roads at Critical Locations

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Effect of dynamic speed display boards on driver behaviour at black spots & critical locations

Kerala has witnessed a steady rise in road accidents, with human factors—especially speeding—being a major contributor. This study investigates the impact of Dynamic Speed Display Boards (DSDBs), which provide real-time speed feedback, on driver behaviour, particularly at black spots and critical road locations.

The findings demonstrate that DSDBs significantly reduce overspeeding across various vehicle types. These boards raise driver awareness about their current speed and encourage compliance with speed limits. Survey results indicate a broadly positive perception of DSDBs among drivers, irrespective of gender, age, or other socio-demographic characteristics. However, behavioural factors such as age, driving experience, and trip purpose do influence the tendency to overspeed.

Using a Structural Equation Model (SEM), the study identifies key psychological factors influencing driver behaviour. Attitude towards DSDB (ATD), Perceived Behavioural Control (PBC), and Subjective Norms (SBN) are significant predictors of the Intention (INT) to reduce speed. Among these, PBC—drivers' belief in their ability to control their speed—has the strongest influence on this intention. Furthermore, a strong link is found between intention and actual speed reduction behaviour (SPR), confirming that drivers who intend to slow down are likely to follow through.

In summary, DSDBs are effective in enhancing road safety by reducing overspeeding and influencing positive behavioural change. They improve drivers' perceived control over their actions and encourage adherence to speed regulations, making them a valuable tool in traffic safety management at accident-prone locations.

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Sustainable Construction Materials from Industrial Waste

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Characterization of flowable fills incorporating industrial byproducts

Controlled Low-Strength Materials (CLSM) are self-compacting, cementitious slurries commonly used in backfilling applications, particularly in utility trenches where soil compaction is difficult. Designed to achieve a compressive strength below 0.7 MPa after 28 days, CLSM ensures ease of excavation using hand tools. This study investigates the feasibility of incorporating industrial byproducts—specifically concrete waste and quarry waste—as partial replacements for fly ash in CLSM mixtures, with minimal cement content, to create sustainable, cost-effective, and excavatable backfill materials.

The reuse of concrete waste, a major construction debris, offers a sustainable waste management solution while enhancing CLSM performance. Laboratory results showed that the inclusion of concrete waste reduced water demand and bleeding, improving the mix's stability. Mixes with 10% and 20% concrete waste exhibited notable increases in unconfined compressive strength (UCS), especially at lower cement contents, with early strength gains also observed. The dry density of CLSM mixes was found comparable to sand, and the split tensile strength showed a linear correlation with UCS and dry density.

Pozzolanic reactions, primarily driven by fly ash, and increased inter-particle friction due to quarry waste contributed significantly to strength development. These mechanisms were validated using SEM and XRD analyses. An optimal CLSM formulation was identified: 30% fly ash, 50% quarry waste, and 20% concrete waste with 3% added cement and 250 mm flowability, suitable for utility backfills requiring both adequate strength and easy hand-tool excavation. This approach promotes sustainable construction through effective reuse of industrial byproducts.

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Compact Wind Energy Solution for Residential Power Needs

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2.5 kW vertical axis wind turbine for residential use

A 2.5 kW vertical axis wind turbine (VAWT) has been developed under the leadership of Dr. Sreejith M S, Senior Scientist at IRTC, Mundur. The prototype incorporates high-performance magnets imported from Germany and is currently undergoing pilot testing at a height of 10 meters. On windy days, it produces approximately 25 kWh of electricity per day, demonstrating significant potential for decentralized and renewable energy generation.

Designed for residential and small commercial applications, the compact VAWT offers a practical alternative to large horizontal-axis turbines. Its design allows installation at the household level, where it can effectively complement rooftop solar systems, especially in areas with good wind availability. Engineer Sreeraj contributed throughout the development and installation phases.

The project was fully funded by the KSCSTE Plan Fund 2022–23. Post-commercialization, production costs are expected to decline, making the system more accessible to common households, similar to how solar technology became widely adopted. The initiative also opens opportunities for entrepreneurship and job creation, particularly through small-scale manufacturing units that can assemble the turbine by importing critical components like magnets.

With further institutional and policy support, the turbine design could be scaled up for broader deployment across Kerala and other regions. The project represents a promising step toward local energy self-sufficiency and a cleaner, greener future.

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Making Kerala's Roads Safer: An Evaluation of Calming Techniques

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Evaluation of the effectiveness of traffic calming measures in Kerala

Traffic calming measures (TCMs) are implemented to improve road safety by reducing vehicle speeds, especially in areas like sharp curves, accident-prone zones, and school vicinities. This study evaluates the effectiveness of three TCMs—Speed Humps, Speed Tables, and Transverse Bar Markings (TBMs)—at 21 locations across Kerala, including urban and rural areas in Thiruvananthapuram, Kollam, Kottayam, and Kozhikode.

Data collection involved both primary and secondary sources. Speed data were gathered using drone and camera-based videographic surveys during off-peak hours to capture free-flow speeds. Data were processed using Kinovea and Data from Sky software for six vehicle categories. Crash data were collected from local police stations and NATPAC for three years before and after the TCM implementation in 2017.

The study found that Speed Humps and Speed Tables significantly reduced speeds—by 64% and 58.4% respectively—and also reduced crashes by approximately 40%. TBMs were the least effective in both aspects. Multiple linear regression models developed using SPSS showed that increased height of humps and tables resulted in greater speed reduction, while increased width reduced their effectiveness. Greater TBM thickness also contributed modestly to speed reduction.

An effectiveness indicator based on speed reduction and crash data revealed Speed Tables as the most effective TCM, followed by Speed Humps. TBMs were least effective. Overall, Speed Tables were identified as the most suitable measure for Kerala's road conditions, ensuring smoother and safer vehicle movement.

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Evaluating Road Safety Using Surrogate Measures on Two-Lane Highways

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Assessment of surrogate safety measures for two-lane road with inclusive motorized two-wheeler lanes

Motorized two-wheelers (MTWs) are widely used in Kerala due to their affordability and ease of navigation through congested roads. However, their high involvement in road accidents calls for safer infrastructure. One such solution is inclusive MTW lanes—lanes marked within the main carriageway specifically for two-wheelers. This study evaluates a pilot implementation on the Muvattupuzha–Vengalloor stretch, assessing operational efficiency, user compliance, and safety impacts.

Traffic analysis showed that inclusive MTW lanes improved road capacity to 3069 PCU/hr (LOS C). However, roadside friction like pedestrian activity reduced this to 2426 PCU/hr (LOS E). The 85th percentile speed for cars increased from 50 km/h on standard roads to 60 km/h on roads with MTW lanes. Spot speed studies indicated slight speed improvements for two-wheelers.

Despite benefits, only 21% of MTW users used the lanes, with lower compliance during peak hours. About 25% were unaware of the lane's purpose; some mistook it for parking. Issues such as inadequate lane width, interference from side roads, and poor markings affected usability. Recommendations include better signage, awareness campaigns, design enhancements, and stricter enforcement.

Safety analysis was conducted using GIS-based risk mapping, drone data, and surrogate safety metrics. Conflict analysis identified Kothamangalam junction as a high-risk location. Car–two-wheeler conflicts were most frequent, with an average Time-to-Collision (TTC) of 1.34 seconds, indicating high criticality. Microsimulation models are proposed to further analyze and suggest interventions to reduce conflicts and improve safety at such locations.

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High-Performance Concrete Enhanced with Hybrid Fibres

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Hybrid fibre reinforced high performance concrete :

Rapid advancements in civil engineering have led to the development of innovative materials such as High-Strength Concrete (HSC), Self-Compacting Concrete (SCC), High-Performance Concrete (HPC), Ultra High-Performance Concrete (UHPC), Fibre-Reinforced Concrete (FRC), and Hybrid Fibre-Reinforced Concrete (HFRC). This project explores the development of a novel concrete variant—Hybrid Fibre Reinforced High-Performance Concrete (HFRHPC)—which combines the advantages of HPC and HFRC.

In HFRHPC, Ground Granulated Blast-Furnace Slag (GGBS) is used as a partial replacement for cement to enhance durability and sustainability. Additionally, a combination of macro and micro polypropylene fibres is incorporated to control the propagation of both macro and micro cracks, improving ductility and toughness.

The study involved designing M35 grade concrete mixes with 30%, 50%, and 70% GGBS replacement and adding polypropylene fibres. These mixes were evaluated and compared against a control mix of M40 grade concrete. Parameters such as strength, durability, and crack resistance were thoroughly assessed.

The results indicated that HFRHPC exhibits superior fresh and hardened properties, including improved workability, strength, toughness, and crack-arresting capabilities. These enhancements make it a promising material for applications like white topping, precast panels, prestressed elements, and structural repair or retrofitting.

Overall, the project demonstrates the feasibility of using HFRHPC as a high-performance, durable, and sustainable construction material suitable for a variety of demanding structural applications.

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Plant Authentication Service

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Plant authentication service

In an era increasingly driven by molecular tools, morphological plant authentication remains a vital and innovative cornerstone for confirming species identity. This technique, grounded in the meticulous observation of external and internal plant traits, blends tradition with scientific rigor. By examining both macroscopic and microscopic features and referencing validated sources such as herbarium specimens and taxonomic keys, morphological authentication serves as a cost-effective and accessible gateway to accurate plant identification.

Its role is particularly critical in the pharmaceutical and herbal sectors, where the integrity of raw materials can determine the safety and efficacy of a final product. Morphological similarities between authentic medicinal plants and their adulterants often lead to misidentification, making early morphological verification an indispensable quality control step. This method also underpins agricultural innovation by aiding in variety selection, pest resistance strategies, and the prevention of invasive species spread.

The technique extends beyond the lab into high-stakes industrial applications. From ensuring regulatory compliance in seed and plant trade to validating ingredients in botanical extracts for cosmetics and nutraceuticals, morphological authentication enhances transparency and traceability across supply chains. Conservation biology, too, benefits as the method helps document and preserve rare and endemic flora.

Morphological authentication may be centuries old, but its relevance is continually renewed. As industries seek sustainable, low-cost, and reliable approaches to plant identification, this method stands out as a scientifically sound, innovation-friendly bridge between traditional knowledge and modern needs.

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DNA Tools for Timber Forensics

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DNA barcoding/Fingerprinting for Timber Forensics

The Centre for DNA Barcoding and Timber Forensics at KSCSTE-KFRI is India's pioneering facility dedicated to using genetic evidence in the fight against illegal timber extraction. By integrating advanced molecular techniques with forestry science, the Centre offers a powerful and tamperproof method to verify species identity in wood and non-wood forest products. This innovation significantly enhances the country's ability to trace the origin of timber, curb adulteration, and uphold legal and sustainable trade practices.

Central to this effort is a comprehensive DNA barcode reference database developed by KFRI, covering a wide array of commercially valuable timber species. This database is routinely employed to identify species in timber theft cases, enabling quick and reliable verification in judicial proceedings. The Centre further applies genome-wide DNA fingerprinting to match confiscated logs with their source stumps, producing conclusive evidence in court. These tools are widely used by law enforcement, forest departments, and the judiciary to debunk false origin claims and prosecute offenders.

Beyond enforcement, the database plays a critical role in global trade compliance. Agencies such as the Forest Stewardship Council (FSC) and the European Union Timber Regulation (EUTR) use KFRI's tools for certification and sustainable trade verification. Timber industries and customs officials benefit alike, ensuring integrity in sourcing and preventing illegal material from entering supply chains.

To date, DNA evidence from the Centre has been used in 20 judicial consultancy cases and supports 18 ongoing technical projects in 2025, affirming KFRI's national leadership in timber forensics and traceability.

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JNTBGRI's Eco-Tourism: Nature, Knowledge, and Conservation

Innovators
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Ecotourism Initiatives at JNTBGRI

The Jawaharlal Nehru Tropical Botanic Garden and Research Institute (JNTBGRI), established in 1979 under the Government of Kerala, is a premier institution located at the foothills of the Western Ghats in Palode, Thiruvananthapuram. Spread across 325 acres of forests, wetlands, grasslands, and rocky outcrops, the institute is a living repository of tropical biodiversity. Recognizing this ecological wealth, JNTBGRI has partnered with Kerala Tourism Infrastructure Limited (KTIL) to launch an innovative eco-tourism initiative that blends conservation, education, and sustainable livelihoods.

This initiative is designed to redefine tourism through immersive, low-impact experiences that highlight the region's biological and cultural richness. Plans include thematic biodiversity trails, canopy walks, and curated medicinal plant gardens, guided by trained naturalists and scientists. By integrating learning with exploration, the project aims to raise ecological awareness, particularly among students and youth, while preserving sensitive habitats.

A distinctive component is the focus on Biodiversity Tourism, where visitors can engage in citizen science, phenology tracking, and interactive exhibits featuring digital and augmented reality tools. The program also weaves in traditional ecological knowledge, empowering local communities to participate as stewards and storytellers of the land.

With planned upgrades in infrastructure, training, and eco-friendly amenities, JNTBGRI's eco-tourism model aspires to serve as a blueprint for responsible tourism. It is envisioned as a vibrant confluence of science and society—where conservation goals meet meaningful visitor engagement and sustainable development.

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Bamboo Innovation Hub: Art, Ecology, and Enterprise

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Bamboo Crafts

As part of the National Bamboo Mission, the Jawaharlal Nehru Tropical Botanic Garden and Research Institute (JNTBGRI), under the Kerala State Council for Science, Technology and Environment (KSCSTE), has launched a Bamboo Craft Centre to empower rural communities through skill development and sustainable enterprise. This Common Facility Centre is dedicated to training unemployed youth, women, and artisans in developing eco-friendly bamboo products that blend traditional techniques with modern design.

The Centre focuses on hands-on training for value-added product development—ranging from souvenirs to functional home décor—enabling participants to turn local, renewable resources into viable income opportunities. The initiative also includes support for branding, marketing, and linking artisans with buyers, thereby opening new avenues for livelihood and entrepreneurship. Strengthening this initiative is JNTBGRI's 20-acre Bamboo Conservatory, which conserves over 1,200 bamboo accessions. Select mature poles from the collection are sustainably harvested and used as raw material, ensuring both quality and continuity of supply.

The bamboo products crafted at the Centre are showcased and sold through JNTBGRI and KSCSTE outlets, while broader networks are being developed to enhance market access. By combining conservation, innovation, and community engagement, this initiative demonstrates how science and sustainability can converge to create resilient, locally rooted economies.

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Testing and Calibration Services for Instruments, Food, Water & Materials

Innovators
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Calibration, Testing, Analytical Services, Training & Consultancy

The Sophisticated Test and Instrumentation Centre (STIC), located at Cochin University Campus, delivers a wide spectrum of high-end services in calibration, testing, and analysis to industries, academic institutions, and research organizations. A joint initiative of KSCSTE and CUSAT, STIC is equipped with NABL-accredited Calibration and Testing Services (CTS) that ensure accuracy across electro-technical, thermal, and mechanical domains—critical for both industrial quality control and scientific research.

Its Sophisticated Analytical Instrument Facility (SAIF), supported by DST, Government of India, provides access to advanced instrumentation for researchers, industries, and students working in various science and engineering fields. Complementing this is a state-of-the-art Food and Water Testing Laboratory, established with KSCSTE support, offering essential analysis services for public health, safety, and compliance.

Beyond services, STIC is a key hub for capacity building—regularly organizing training programmes, workshops, and hands-on courses in calibration, analytical techniques, and safety standards. With the addition of a dedicated Consultancy Services division, STIC now extends expert support in niche areas such as aerospace and defense technologies.

By integrating technical excellence, infrastructure, and skill development, STIC plays a pivotal role in strengthening Kerala's scientific ecosystem and industrial competence.

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Reviving Native Ecosystems: A Sustainable Restoration Initiative

Innovators
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Developing a detailed plan for the eco-restoration of monoculture plantations

Kerala is home to a rich diversity of ecosystems, including tropical evergreen and deciduous forests, sholas, grasslands, and mangroves. These natural habitats play a crucial role in climate regulation, nutrient cycling, and biodiversity conservation. However, large-scale deforestation and the introduction of exotic monoculture plantations for wood and biomass production have significantly altered the state's ecological balance.

Historically, Kerala's forests remained largely intact until British colonial rule, which saw the introduction of teak, eucalyptus, acacia, and rubber plantations. Later programs, such as the World Bank Forestry Project, expanded monoculture plantations across the state. While initially economically beneficial, these plantations have contributed to soil degradation, groundwater depletion, biodiversity loss, and reduced carbon sequestration. Recent studies have specifically highlighted the adverse ecological impacts of species like Acacia, which deplete groundwater, disrupt soil microbial communities, and harm native ecosystems.

Recognizing the urgent need for ecological restoration, a comprehensive site-specific plan is being developed. This involves detailed field-level data collection and ecological assessments to inform restoration strategies. The plan will outline phased removal of exotic monoculture species, reintroduction of native vegetation with both ecological and economic value, and integration with existing state and central environmental policies and schemes.

The primary goal is to reverse the environmental damage caused by monoculture plantations and restore Kerala's native ecosystems. By promoting sustainable land use and enhancing biodiversity, the eco-restoration initiative aims to improve ecosystem resilience, support livelihoods, and contribute to long-term environmental sustainability across the state.

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EcoScape Solution – For Urban & Rural Land Use

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Innovative landscaping for living spaces

Landscaping is a powerful tool for transforming underutilized or degraded spaces into vibrant, functional, and ecologically balanced environments. By thoughtfully integrating plants, natural materials, and design elements, it enhances the aesthetic, environmental, and social value of both urban and rural areas.

Beyond beautification, modern landscaping addresses critical environmental concerns. It helps prevent soil erosion, improves air quality, reduces urban heat, and promotes biodiversity. The strategic use of native, drought-tolerant, and low-maintenance plant species ensures long-term sustainability and resilience. Landscaped green spaces also contribute to public well-being, offering places for recreation, relaxation, and community interaction.

Innovative techniques such as groundcover planting, vertical gardens, live grass mats, and water-efficient planting are tailored to establish quickly and adapt across diverse terrains. Sustainable practices—like smart irrigation, organic mulching, and the use of eco-friendly construction materials—further minimize resource consumption and maintenance demands.

These approaches are effectively applied in public parks, institutional campuses, roadside green belts, waterbody peripheries, and heritage zones. Landscaping also plays a key role in larger initiatives like smart cities, campus greening, and urban renewal projects. By combining ecological function with visual appeal and public utility, landscaping becomes more than an art—it is a sustainable development strategy. It fosters healthier, more climate-resilient communities while creating inclusive and livable spaces for current and future generations.

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DNA Vaccine Platform for Emerging Viruses

Innovators
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DNA vaccine platform for emerging viruses

In tropical and subtropical regions, the simultaneous circulation of multiple viruses has heightened the risk of coinfections, where two or more pathogens infect a host at the same time. These coinfections often result in worsened symptoms, immune dysregulation, and greater diagnostic complexity—posing serious challenges for public health systems. Addressing this, our team is developing a bivalent DNA vaccine platform designed to provide immunity against two distinct viral pathogens through a single, combined formulation.

DNA vaccines offer several advantages: stability, safety, and ease of production, making them ideal for rapid deployment during outbreaks. To enhance delivery and immunogenicity, we have developed an in-house liposome-based formulation that encapsulates the DNA vaccine candidate—enabling more efficient uptake and immune activation. Preliminary studies have shown encouraging results, and further in vivo evaluations are underway to assess protective efficacy and immune response.

This platform offers a scalable, non-invasive solution particularly suited for resource-limited settings, where access to healthcare and multiple immunizations may be constrained. By reducing the number of required doses and expanding protection, the bivalent vaccine strategy provides a cost-effective and proactive approach to managing co-circulating and emerging viral threats.

Positioned at the intersection of immunology, molecular biology, and public health, this innovation holds great promise for next-generation vaccine development—tailored to meet the complex challenges of today's evolving infectious disease landscape.

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Antiviral Screening for Dengue & Chikungunya: Fast, Reliable & Accurate Assays

Innovators
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Antiviral screening assays

The Viral Bioassay Facility, established under the DBT-SAHAJ project, offers comprehensive antiviral screening services targeting mosquito-borne viruses, specifically chikungunya and dengue. Utilizing the gold-standard Plaque Reduction Neutralization Test (PRNT), the facility assesses the antiviral potential of natural products, synthetic compounds, or biological samples by quantifying their ability to inhibit viral plaque formation in cell cultures. The assay follows an 8-point serial dilution (10^{2} to 10^{9}), performed in duplicate for accuracy, with IC_{50} values calculated to determine compound potency. Results are benchmarked against known controls, ensuring reliability and reproducibility. Ideal for early-stage screening, this platform helps identify promising antiviral leads and supports downstream development through co-development opportunities and expert technical support. With specialized infrastructure, trained personnel, and validated protocols, the facility provides a robust environment for high-quality antiviral research and therapeutic discovery.

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Molecular Tools for Authentication of Plant Varieties

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Varietal Identification in plants using molecular marker technologies

Accurate identification of plant varieties is essential for agriculture, plant breeding, seed certification, and intellectual property protection. Traditional identification methods, based on observable traits, are often unreliable due to environmental influences and limited ability to distinguish between closely related genotypes. Molecular marker technology offers a powerful alternative by detecting variations at the DNA level. It provides precise, reproducible, and environment-independent identification. Technologies such as Simple Sequence Repeats (SSRs), Single Nucleotide Polymorphisms (SNPs), RAPD, ISSR, and SCoT have proven effective in varietal fingerprinting and genotyping—even at the seedling stage.

These markers enhance the reliability of seed certification systems, enable early detection of genetic purity, and support the legal enforcement of Plant Breeders' Rights. They also improve germplasm management by revealing hidden genetic diversity and help combat fraud in seed trade and plant-based products by enabling traceability.

Unlike conventional approaches, DNA markers ensure high specificity and standardization, making them suitable for national and international regulatory systems. Their cost-effectiveness over time makes them scalable for large breeding programmes and commercial agriculture.

As agriculture shifts toward data-driven, traceable systems, the integration of molecular markers is becoming indispensable. This innovation protects breeder interests, strengthens seed systems, conserves biodiversity, and ensures transparency in global agricultural value chains—marking a major leap forward in sustainable and secure food production.

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The Centre of Excellence in Nutraceuticals (CoEN) - Traditional Wisdom into Nutraceuticals

Innovators
Dr. Ruby John Anto
Centre of excellence in Nutraceuticals

The Centre of Excellence in Nutraceuticals (CoEN) is a premier research and innovation hub focused on the development, validation, and commercialization of high-quality nutraceutical products. It brings together expertise from food science, biotechnology, pharmacology, and traditional medicine to address global health challenges through the use of natural bioactive compounds. The center's key objectives include identifying and characterizing potent bioactives from plants, marine organisms, microalgae, and traditional formulations; developing safe, effective, and economically viable nutraceutical products supported by scientific evidence; and fostering collaboration between academic institutions, industries, start-ups, and regulatory agencies. CoEN also offers comprehensive services in product formulation, standardization, efficacy testing, toxicity analysis, and regulatory compliance.

Among its upcoming products, the Dasapushpam mix is a traditional polyherbal formulation consisting of ten ethnomedicinal plants native to Kerala, each known for antioxidant, antimicrobial, and immunomodulatory properties. Traditionally used in Ayurvedic and Siddha systems, this formulation supports skin health, immune resilience, and postpartum recovery, and holds cultural significance in pediatric and maternal care. Another key product is the Manjal-Kurumulak (Turmeric-Black Pepper) capsule, combining Curcuma longa and Piper nigrum. Curcumin, the active compound in turmeric, offers anti-inflammatory and antioxidant benefits, while piperine from black pepper enhances its bioavailability by up to 2000%. This synergistic formulation supports digestive health, immune modulation, and protection against oxidative stress-related diseases, including inflammatory bowel disease and colon cancer. Through such initiatives, CoEN bridges traditional knowledge with modern science to create sustainable, scientifically validated, and consumer-friendly nutraceutical solutions.

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Recirculatory Aquaculture System

Innovators
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The Recirculatory Aquaculture System (RAS), integrated with Aquaponics and Moving Bed Bio-Reactor (MBBR) technology, is now being offered as an innovative, service-based model for those seeking sustainable, space-efficient farming solutions. This closed-loop system enables the combined cultivation of fish and vegetables, using advanced filtration and bio-reactor technologies to recycle up to 90% of water. Nutrient-rich water from fish tanks nourishes plants in soilless grow beds, while plants naturally purify the water before it's recirculated—creating a near-zero-waste, emission-free food production cycle. Designed for high-density farming of pellet-fed fish and fast-growing vegetables, the infrastructure includes circular tanks for optimal flow, gravel grow beds with bell siphons, aeration systems, water pumps, and a 2 m^3 biogas unit that produces up to four hours of cooking gas daily. Sludge from the filters feeds the biogas unit, and liquid waste is reused to nourish plants. Optional integrations like black soldier fly larvae units and vertical leaf gardens further cut feed costs and enhance sustainability. With provision for a nursery pond, the system supports up to three fish harvests annually, and a 40 m^2 pond can yield over 3 tonnes of fish per year, ensuring consistent returns. For urban homes and institutions, a compact, fish-free version treats greywater via MBBR and channels it into vegetable cultivation—ideal for rooftops and community gardens. Successfully demonstrated at the IRTC campus, this scalable, organic farming system is now available as a deployable service model, empowering users with resilient, eco-friendly food production and contributing to long-term food and water security.

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Native Plant-Based Riverbank Restoration Techniques

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Bioengineering methods for stream bank stabilization

Stream bank stabilization is crucial for preventing erosion, protecting ecosystems, and supporting sustainable land use. While multiple techniques exist, selecting the most suitable method requires balancing environmental, economic, and social factors. The Kerala Forest Research Institute (KFRI) has developed bioengineering-based stabilization techniques that utilize native plants and trees for effective and sustainable riverbank restoration.

KFRI's bio-stabilization approach focuses on restoring riparian zones using fast-growing native vegetation. These species are chosen for their adaptability, root strength, and ability to thrive in local conditions. By reinforcing the soil structure and reducing surface runoff, these plants help control erosion naturally while also improving soil health and water quality.

This method is environmentally friendly and cost-effective, offering a long-term solution with multiple co-benefits. In addition to controlling erosion, it supports biodiversity by creating habitat corridors for native fauna, enhances ecosystem resilience, and promotes natural regeneration. Moreover, planting native species can provide food and fodder resources, supporting the livelihoods and food security of local communities.

Unlike conventional engineering methods, which often involve concrete structures and high costs, bioengineering emphasizes low-impact, nature-based solutions. It aligns with eco-restoration goals and climate adaptation strategies, making it a sustainable choice for regions vulnerable to ecological degradation.

KFRI's bio-stabilization model demonstrates that integrating ecological principles into stream bank management can achieve both environmental and socio-economic benefits. This approach serves as a replicable model for other regions facing similar riverbank erosion challenges, promoting a balance between conservation and community development.

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Forecasting Viral Outbreaks Using AI & Climate Data

Innovators
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AI-driven model for forecasting emerging viruses transmission and strengthening public health preparedness

Viral fevers remain one of the fastest-spreading health threats globally, with India facing a significant burden each year. Contributing factors include climate change, urbanization, inadequate vector control, and erratic waste management. Seasonal variations in rainfall and temperature further elevate mosquito densities, amplifying the risk of vector-borne and zoonotic virus transmission. To tackle these challenges, we are developing an AI-powered computational model to predict and map the transmission dynamics of emerging viral infections with high precision.

The model integrates real-time epidemiological and environmental data—including temperature, humidity, rainfall, and vector density—into advanced machine learning algorithms. It is designed to forecast outbreak likelihood, identify high-risk zones, and reveal seasonal trends, enabling a shift from reactive to proactive public health strategies. By processing complex datasets, the system generates actionable insights in real-time, supporting better resource allocation, targeted vector control, and early warning mechanisms.

This AI-driven approach enhances disease surveillance and outbreak preparedness, helping health authorities respond faster and more effectively. Beyond prediction, the model offers strategic guidance for public health planning, especially in regions prone to seasonal or climate-sensitive infections.

With the growing threat of viral epidemics in an era of environmental disruption, this innovation presents a scalable, data-driven tool that can play a transformative role in pandemic preparedness, infectious disease mitigation, and public health resilience.

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Multi-Criteria Decision System for Streamlining Urban Mobility

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Optimizing urban transit networks using a multi-criteria approach

The Kerala State Road Transport Corporation (KSRTC) operates a large fleet of 5,164 buses, yet faces operational losses amounting to ₹456.38 crore in 2022–23. The inefficiencies stem from uneconomical routes, high staff-to-bus ratios, unviable depots, and pension burdens. This study aims to optimize the circular city bus network in Thiruvananthapuram using a multi-criteria, graph-theoretical model to enhance efficiency and passenger satisfaction.

The bus network is represented as a weighted directed graph, where nodes denote bus stops and edges represent direct connections. The weight matrix incorporates both inter-stop distances and passenger flow, enabling comprehensive spatial and functional analysis through L-space, P-space, and C-space representations.

Centrality measures—Degree, Betweenness, Closeness, Eigenvector, and PageRank—are used to assess nodal importance. Key transfer hubs like Thampanoor, East Fort, and Palayam are identified based on high centrality rankings. Statistical analysis reveals strong inequality in nodal influence and highlights the need for better interconnectivity.

Network metrics show moderate density but low clustering and global efficiency, indicating poor navigability. While structurally resilient with minimal critical points, the system lacks redundancy. To address this, the study proposes demand-based frequency optimization using ETM and survey-based origin-destination data. Enhancements like bypass routes, express services, and dynamic headway strategies are recommended.

The findings suggest that integrating graph analysis with demand modeling offers a scalable framework for improving public transport performance and can be replicated across other state transport systems for better service delivery and cost-effectiveness.

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Autonomous AI-Powered Drone for Disaster Response & Search Operations

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Autonomous AI-powered drone for search & rescue (SAR) and disaster response

An AI-powered autonomous drone system has been developed to transform disaster response and search & rescue (SAR) operations across challenging terrains. Designed for rapid deployment in scenarios like floods, earthquakes, and landslides, the drone integrates real-time object detection, thermal imaging, and intelligent pathfinding to locate survivors, assess damage, and deliver emergency supplies in hazardous or inaccessible zones. Leveraging advanced computer vision (YOLO/CNN models), it can accurately detect human presence amidst debris, while LiDAR and SLAM technologies enable autonomous navigation even in GPS-denied environments. The drone streams high-definition visual and thermal data in real-time to disaster control rooms, providing critical situational awareness. Equipped with payload delivery capabilities, it can drop first-aid kits, food, and communication devices, reducing dependency on human responders and improving efficiency. Its swarm compatibility allows multiple drones to coordinate during large-scale emergencies. With the ability to deploy in under 15 minutes, this system significantly shortens response time and mitigates risk to rescue personnel. It holds immense potential for scalable deployment across India's high-risk zones, including the Himalayan region and flood-prone coastal areas. To accelerate its real-world application, the project seeks ₹10–15 lakhs in funding for prototype development and certification, expedited regulatory clearances from DGCA, field collaboration with NDRF and armed forces, and subsidized access to key components like LiDAR and thermal sensors. This innovation presents a leap forward in autonomous, technology-enabled disaster resilience for India.

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A Unified Digital Platform for Carbon Credit Estimation and Reporting in Kerala

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Inputs from: Dr. Sruthi K V, CWRDM

A unified digital platform for carbon credit estimation and reporting in Kerala

This first-of-its-kind state-level platform democratizes access to scientifically validated carbon accounting tools based on IPCC methodologies. Built using open-source technologies and aligned with national and global climate frameworks, the portal supports rural communities, local bodies, institutions, and entrepreneurs in understanding their carbon reduction potential. The portal provides an easy way to calculate your emissions in just a few clicks. It works for five main areas: agriculture, forestry, energy, industry, and waste. It even shows how many trees you would need to plant to offset your carbon impact!

The platform integrates real-time calculators with dynamic report generation capabilities in PDF and Excel formats, providing both lay users and professionals with usable outputs. Each domain module—be it for afforestation, organic waste management, diesel usage reduction, or low-carbon technologies—includes annotated assumptions, emission factors, and calculation notes for transparency and traceability.

This service is hosted online and can be used by anyone—villages, schools, local bodies, NGOs, and individuals. You can download your results as a report and plan better actions for a greener future. By making carbon knowledge simple and accessible, this tool helps all of us contribute to a cleaner, healthier Kerala.

Beyond computation, the portal also enables project registration, district-wise aggregation, and impact visualization, making it a strategic tool for green credit mobilization, policy planning, and climate finance readiness in Kerala.

This innovation represents a leap toward data-driven environmental governance, local capacity building, and climate entrepreneurship, paving the way for Kerala's transition to a low-carbon economy.

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Specialized Water Resource and Environmental Services by the Centre for Water Resources Development and Management (CWRDM)

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Specialized water resource and environmental services

CWRDM offers an extensive suite of technical and analytical services essential for water and environmental management across sectors. Its Water Quality Analysis facilities support detailed assessments of chemical, microbiological, effluent, and construction-related parameters for both drinking and construction-grade water. Stable Isotope Analysis of hydrogen, oxygen, and carbon is available for hydrological tracing and environmental forensics.

Field-based services include Mobile Water Quality Testing, Vertical Electrical Sounding (1D), and Electrical Resistivity Tomography (2D) for groundwater exploration, bedrock mapping, aquifer profiling, and contaminant pathway studies. Geomatics Lab services offer geospatial analysis including land use/land cover mapping and wetland studies.

The Soil Testing Laboratory provides physico-chemical profiling of soils, including macro- and micronutrients, texture, field capacity, and bulk density. Meteorological data from CWRDM's Kottamparamba Station supports agro-climatic planning through rainfall, temperature, humidity, and wind speed observations.

Facilities include a Hydrological Instrumentation Lab (for soil moisture, sediment, and flow measurements), Groundwater Modelling (for flow and contaminant transport), and Geotechnical Testing (for permeability and soil texture). The Ecosounding Unit offers hydrographic survey and depth profiling for aquatic resource assessments.

The Centre also provides access to Survey of India toposheets, Total Station Surveying, and Carbon Footprint Assessment services. It offers NABET-accredited Environmental Impact Assessment (EIA) for river valley projects and provides Water Budgeting Guidelines tailored for local-level water resource planning.

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Decision support system for technology valuation

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Intellectual property (IP) in form of patentable technology, legally protectable trademarks and designs, copy right and others have increasingly been emerging as most important assets, not only for the large, medium and small companies, but also for the research and educational institutions. Valuation of the technologies developed through R&D in research institutions is a prerequisite for initiating technology transfer and commercialization activities. In this regard, a Decision Support System (DSS) has been developed to valuate the intellectual assets including new technologies developed in public research system. The DSS will assess the value of the technology based on different methods. The developed algorithm calculates the value of the technology considering many factors such as category of technology/product, its cost of development, market conditions and future cash flows. The software will fetch data from the data base if specific data on royalty rate, depreciation, bank rate etc. are not available. A new matrix was also developed and integrated in the DSS for fixing the range of royalty. The output will be available in pdf format with the details of the value of the technology. This valuation tool will be helpful to the researchers/ research mangers/ tech transfer officers during the negotiation with commercial firms and entrepreneurs. The DSS is useful in the event of licensing, sale of IP/technology, mergers, acquisitions, infringement law suits, financing, securitization, taxing, reporting, strategic planning and R&D. This can further aid in addressing strategic issues relating to technology pricing, commercialization and planning marketing strategies.

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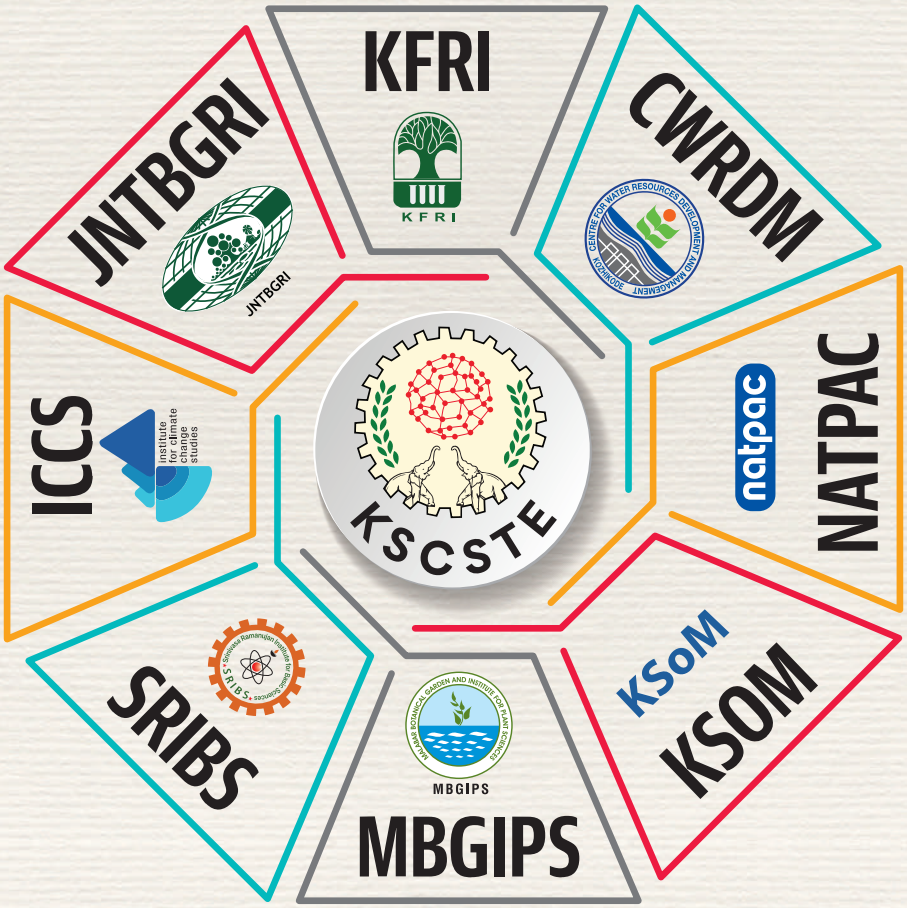
THE KERALA STATE COUNCIL FOR SCIENCE, TECHNOLOGY AND ENVIRONMENT (KSCSTE)

The Kerala State Council for Science, Technology and Environment (KSCSTE) is an autonomous organization under the Kerala Government's Science and Technology Department. As one of India's leading State Science Councils, it plays a crucial role in advancing scientific progress and sustainable development in Kerala. KSCSTE supports research and development by funding innovative projects and establishing advanced research facilities. It promotes scientific literacy through science fairs and public awareness campaigns, and encourages innovation across various sectors, including biotechnology, biodiversity and environmental conservation. Additionally, KSCSTE manages eight dedicated R & D centers each focusing on specific scientific domains, by providing strategic guidance, monitoring progress and ensuring effective policy implementation. Through its diverse initiatives and strong engagement with the scientific community, academia and the public, KSCSTE significantly shapes Kerala's future by propelling Kerala to a Knowledge Economy.



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KSCSTE R&D
Institutions at a Glance

Centre for Water Resources Development and Management (CWRDM), Kozhikode

Established in 1978 and brought under KSCSTE in 2003, the Centre for Water Resources Development and Management (CWRDM) is a premier research institution dedicated to water management in Kerala's humid tropical context. Located in Kozhikode, CWRDM focuses on scientific research, technology development, and policy support in key areas such as hydrology, watershed management, irrigation, water quality, and climate resilience. The institute has specialised divisions including Hydrology and Climatology, Land & Water Management, Ecology and Environment as well as for training and outreach. It also hosts a National Isotope Facility, NABL-accredited water lab, and a Centre of Excellence for Water-Related Disaster Management. CWRDM has completed over 180 projects and published extensively in the field of water science. It offers training programmes, consultancy services, and collaborates with government agencies, academic institutions, and local self-governments to implement sustainable water solutions. CWRDM plays a pivotal role in ensuring Kerala's water security and capacity building in integrated water resource management.

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Kerala Forest Research Institute (KFRI), Thrissur

The Kerala Forest Research Institute (KFRI) headquartered at Peechi, Thrissur, was established in 1975 and merged into KSCSTE in 2002. With satellite centres in Nilambur and Palapilly, KFRI addresses tropical forestry research, biodiversity conservation, wood and bamboos science, forest biotechnology, forest ecology, and climate change adaptation. Its multidisciplinary team engages in scientific management of natural resources, restoration of degraded forest lands, community forestry, seed technology (via the Kerala Forest Seed Centre), and policy advisory support. Over five decades, KFRI has completed hundreds of projects, filed scientific patents, awarded doctoral degrees, and collaborated internationally (e.g., with Ghent University) on mangrove resilience and climate impact assessments. The institute offers training, outreach programmes, and acts as a key scientific resource for Kerala's forest governance and sustainable ecosystem stewardship.

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KSCSTE - JNTBGRI

Jawaharlal Nehru Tropical Botanic Garden & Research Institute (JNTBGRI), Thiruvananthapuram

JNTBGRI, formerly the Tropical Botanic Garden & Research Institute, is a 300 acre research institution located in the Western Ghats at Palode, approximately 40 km from Thiruvananthapuram city. Formally integrated into KSCSTE in 2003, it serves as a premier botanic garden dedicated to tropical plant biodiversity, conservation biology, plant biotechnology, phytochemistry, and ethnomedicine. Housing thousands of plant species—including rare, endangered, and endemic taxa—its mission encompasses bio prospecting for herbal drug development, sustainable use of plant resources, and value addition through agro processing. JNTBGRI supports national and international collaborations and publishes peer-reviewed research in ethnobotany and folk practices via the Journal of Traditional and Folk Practices (JTFP), jointly with KSCSTE and funded by the Ministry of AYUSH. The institute also functions as a key reference centre for plant identification, germplasm conservation, and capacity-building in biodiversity and sustainable utilization strategies.

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National Transportation Planning and Research Centre (NATPAC), Thiruvananthapuram

The National Transportation Planning and Research Centre (NATPAC), established in 1976 under KELTRON and later repositioned under the Kerala State Council for Science, Technology & Environment (KSCSTE), is Kerala's premier R&D centre for multi-modal transportation systems—including road, rail, inland water, and air transport. Headquartered at the K. Karunakaran Transpark, Akkulam, Thiruvananthapuram, NATPAC also maintains a regional office in Kozhikode. NATPAC's research and consultancy portfolio spans highway engineering, traffic and transport planning, road safety, transport economics, public transport studies, techno economic feasibility, and water transport systems, among other domains. The centre uses geoinformatics, GIS, crash data systems, and pavement engineering techniques to advise state and national transportation projects. Notable contributions include the feasibility study for the Thiruvananthapuram monorail/metro proposals, and the initial planning framework for the Thiruvananthapuram–Kasaragod Coastal Highway project. NATPAC also hosts ongoing industry-facing initiatives like the TransPedia Research Talk Series, with sessions scheduled well into 2025, reflecting its active role in knowledge dissemination and policy dialogue.

www.natpac.kerala.ac.in 0471-2779200
contactus.natpac@kerala.gov.in

Malabar Botanical Garden & Institute for Plant Sciences (MBGIPS), Kozhikode

The Malabar Botanical Garden & Institute for Plant Sciences (MBGIPS) is an R&D institution under KSCSTE dedicated to the conservation, documentation, and research of aquatic and lower plant biodiversity in Kerala's Malabar region. Originating as a botanical garden in 1991 and elevated to an R&D centre in 2015, it now boasts the largest collection of aquatic plants in India, preserving over 400 species along with bryophytes, pteridophytes, medicinal and aromatic plants. Recognised by the Botanic Gardens Conservation International and designated by India's Ministry of Environment as a "Lead Botanic Garden" for aquatic plant conservation, MBGIPS also serves as a research centre affiliated with the University of Calicut and a UN University Regional Centre of Expertise in education for sustainable development. It actively conducts taxonomic research, ex situ conservation, ethnobotanical studies, training programmes, and public awareness initiatives through seminars and guided garden visits. The institute further houses a specialised herbarium with type specimens and authentic collections supporting scientific documentation and environmental stewardship in the Western Ghats

www.mbgips.in malabarbot.garden@gmail.com 0495 2430939

KSoM

Kerala School of Mathematics (KSoM), Kozhikode

The Kerala School of Mathematics (KSoM)—a joint initiative of KSCSTE and the Department of Atomic Energy—commenced operations around 2007–2009 to establish a centre of excellence in mathematical research in Kerala. Situated in Kozhikode, it offers an Integrated MSc–PhD programme, hosts post doctoral researchers, and regularly conducts colloquia, seminars, workshops, and international-level events in research areas such as analytic number theory, Teichmüller theory, and complex analysis. KSoM's mission is to sustain a vibrant environment where mathematicians from India and abroad collaborate and mentor emerging researchers in pure and applied mathematical sciences. The institution offers modern infrastructure including research offices, lecture halls, and library facilities; it also plays a central role in reviving Kerala's historical mathematical tradition. It fosters talent through student enrichment camps and outreach, and positions Kerala on the map of international mathematical research.

www.ksom.res.in director@ksom.res.in 0495 2809000

Srinivasa Ramanujan Institute for Basic Sciences (SRIBS), Kottayam

The Srinivasa Ramanujan Institute for Basic Sciences (SRIBS) was constituted in January 2012 (as part of the Ramanujan 125th birth centenary celebrations) and inaugurated in February 2013. It operates from Kottayam at the Rajiv Gandhi Institute of Technology campus under KSCSTE. SRIBS is a capacity building institute promoting research and pedagogy in pure sciences—Mathematics, Physics, Chemistry, and Biology. Its mandate includes organising lectures, workshops, summer schools, and outreach to nurture scientific curiosity among students and early-career researchers. Despite its ambitious mission, media reports have noted infrastructure and operational challenges, including limited permanent facilities and reliance on rented spaces even years after inception. SRIBS continues to engage eminent scientists, including Nobel laureates, on its advisory board to foster collaborations and elevate basic science research in Kerala. Through alliances with universities and government institutions, SRIBS aims to instil scientific temper and elevate Kerala's contribution to foundational scientific knowledge.

www.sribs.kerala.gov.in sribs.kscste@gmail.com 0481 2500200

Institute for Climate Change Studies (ICCS) Kottayam

The Institute for Climate Change Studies (ICCS), constituted as an autonomous R&D centre under the Department of Environment, Government of Kerala (registered in 2014), serves under KSCSTE's umbrella from its Kottayam campus Its vision is to bolster Kerala's climate resilience through science-driven mitigation, adaptation strategies, and state-specific climate services. ICCS focuses on monitoring climate-sensitive sectors—hydrology, agriculture, water resources, health, fisheries, and tourism—producing vulnerability assessments, sectoral climate profiles, and anticipatory climate statements for policy planning. The institute spearheads research projects in paleoclimate reconstruction, hydrological modelling, river basin studies, air quality, and aerosol impacts, and collaborates extensively with academic institutions, government departments, and international bodies. ICCS additionally conducts training programmes, workshops, and stakeholder engagement events—such as joint climate workshops with SRIBS—to bridge climate science knowledge gaps and support climate-aware decision making across Kerala

www.iccs.res.in office.iccs.res.in 0481 2574705

Centre of Excellence in Microbiome (CoEM), Thiruvananthapuram

The Centre of Excellence in Microbiome (CoEM) is an initiative by the Government of Kerala under the Kerala State Council for Science, Technology and Environment (KSCSTE), in partnership with the Kerala Development and Innovation Strategic Council (K-DISC) and scientific mentorship from the Rajiv Gandhi Centre for Biotechnology (RGCB). CoEM serves as a platform to promote research and entrepreneurship in microbiome science, adopting a One Health approach that integrates human, animal, plant, aquatic, and environmental systems. Currently operating from the KINFRA Film & Video Park, Kazhakoottam, Thiruvananthapuram, the centre will be permanently relocated to Bio 360 Life Science Park at Thonnakkal. Its primary goals include fostering interdisciplinary collaboration, mapping microbiome data using big data and AI technologies, and supporting innovation through startup creation. CoEM emphasizes translational research and the development of microbiome-based diagnostics, therapeutics, and interventions. It leverages advanced multi-omics platforms such as genomics, proteomics, metabolomics, culturomics, and bioinformatics to understand microbial interactions and predict novel biomarkers. The centre promotes academic-industry linkages and aims to deliver discoveries to society through entrepreneurship and public engagement. With its guiding motto "Microbes for Life," CoEM envisions becoming a national leader in microbiome innovation, sustainability, and health-focused research.

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Centre of Excellence in Nutraceuticals (CoEN)

The Centre of Excellence in Nutraceuticals (CoEN) is a pioneering initiative of the Government of Kerala under the Kerala State Council for Science, Technology and Environment (KSCSTE), supported by the Kerala Development and Innovation Strategic Council (K-DISC). Located at the Bio360 Life Science Park in Thonnakkal, Thiruvananthapuram, and currently operating from the Institute of Advanced Virology, CoEN aims to position Kerala as a national hub for nutraceutical innovation. CoEN focuses on developing functional foods, dietary supplements, and therapeutic compounds derived from Kerala's unique biodiversity—spanning the Western Ghats and rich aquatic ecosystems. The centre brings together research institutions, start-ups, and industries to create novel nutraceutical interventions targeting lifestyle diseases, metabolic disorders, cardiovascular conditions, and cancers. It also promotes validation of biological safety and efficacy, and supports entrepreneurship through start-up incubation. Strategically located near major research institutions and transit hubs, CoEN benefits from seamless collaboration, research translation, and efficient distribution. The initiative integrates modern nutritional and pharmaceutical sciences with traditional knowledge and indigenous practices. Under the nodal oversight of KSCSTE and with industrial partnership from the Kerala State Industrial Development Corporation (KSIDC), CoEN envisions transforming Kerala into a global leader in evidence-based, sustainable health and wellness solutions.

9447617861 cs.coen@kerala.gov.in

IRTC

IRTC (Integrated Rural Technology Centre)

The Integrated Rural Technology Centre (IRTC), established in 1987, is an autonomous R&D institution under the grant-in-aid of KSCSTE. Situated in Mundur, Palakkad, IRTC is committed to applying science and technology for rural development and sustainability. The centre has carved a niche in areas like solid and liquid waste management, water conservation, renewable energy technologies, organic farming, and rural engineering. IRTC is well known for its community-centric and field-oriented approach, translating research into real-world impact. The centre actively engages in development and demonstration of appropriate technologies, capacity building programmes, and technical consultancy to local self-governments. IRTC's initiatives in decentralized waste management systems and eco-friendly sanitation have gained wide recognition across Kerala. Its innovative work in GIS-based planning, rural housing, and low-cost construction methods has been pivotal in sustainable rural infrastructure development. IRTC's multi-disciplinary teams work collaboratively with academic institutions, NGOs, and government agencies. With a vision to ensure technology access to the grassroots, the centre aims to bridge the gap between science and society. Through inclusive development strategies, IRTC continues to empower rural communities and contribute to the state's vision of a green and equitable economy.

www.irtc.org.in 0491- 2832324

STIC
(Sophisticated Test and Instrumentation Centre)

The Sophisticated Test and Instrumentation Centre (STIC), located at Cochin University of Science and Technology (CUSAT), Kochi, is a premier institution under the grant-in-aid of KSCSTE. Established to support advanced research and industrial applications, STIC provides state-of-the-art analytical and testing facilities for scientists, researchers, industries, and academic institutions. STIC is equipped with sophisticated instruments such as scanning electron microscopes, atomic absorption spectrometers, X-ray diffractometers, and thermal analyzers. These facilities are crucial for high-end research in material science, biotechnology, chemistry, nanoscience, and engineering. The centre plays a vital role in strengthening the R&D infrastructure of the state by offering expert services in sample analysis, material testing, quality control, and failure analysis. Besides analytical services, STIC also conducts training programmes, workshops, and hands-on sessions to build technical expertise in instrumentation and research methodology. It serves as a technical backbone for institutions lacking in-house facilities, thereby democratizing access to scientific tools and promoting collaborative research. By supporting both academia and industry, STIC plays a catalytic role in fostering innovation and ensuring quality in research outputs. Its commitment to service excellence and scientific advancement has made it a cornerstone of Kerala's science and technology ecosystem.

www.sticindia.com 0484- 2575908

MSSRF-Kerala (M.S. Swaminathan Research Foundation - Community Agrobiodiversity Centre)

The M.S. Swaminathan Research Foundation's Community Agrobiodiversity Centre (CAbC), located in Wayanad, Kerala, is a grant-in-aid institution under KSCSTE. Founded in 1997, CAbC is dedicated to the conservation and sustainable utilization of agrobiodiversity with a strong focus on empowering indigenous and tribal communities in the Western Ghats region. The centre works on in-situ and ex-situ conservation of plant genetic resources, traditional knowledge documentation, and community-based conservation strategies. It has played a pioneering role in promoting community seed banks, climate-resilient agriculture, and value-added processing of underutilized crops. CAbC's participatory research model integrates traditional ecological knowledge with modern science to ensure food and nutritional security. MSSRF Kerala engages in field research, training, and policy advocacy, especially in areas of climate change adaptation, sustainable farming, and ecosystem restoration. Its work has influenced biodiversity conservation practices and sustainable livelihoods, especially among small and marginal farmers. It also collaborates with national and international bodies to promote agrobiodiversity governance and climate-smart agriculture. Through its holistic, grassroots-level interventions, MSSRF-CAbC exemplifies how science can support conservation while enhancing rural resilience. The centre remains a key institution in advancing Kerala's vision for sustainable development and biodiversity-based livelihood security.

www.mssrfcabc.res.in 04936204477

S & T Partner Institution

The Institute of Advanced Virology (IAV)

The Institute of Advanced Virology (IAV), located at the Bio 360 Life Sciences Park, Thonnakkal, Thiruvananthapuram, is a premier research institution under the Science & Technology Department, Government of Kerala. It was established in 2019 by KSCSTE, in response to the 2018 Nipah virus outbreak, with the vision to strengthen the state's virological research, surveillance, and outbreak response capacity.

IAV is envisioned as a Centre of Excellence in virology, aligned with global standards. It is affiliated with the Global Virus Network (GVN) and comprises eight specialized divisions, including Clinical Virology, Viral Diagnostics, Vaccine Research, Antiviral Drug Development, Viral Epidemiology and Public Health, and Virus Genomics and Bioinformatics.

The institute currently operates as a BSL-2+ facility, with ongoing upgrades toward BSL-3 capability. It is equipped to handle and diagnose over 80 types of viral pathogens such as Nipah, Zika, Chandipura, Influenza, and emerging zoonotic viruses. IAV played a crucial role during recent health scares by offering rapid viral diagnostics within the state—dramatically reducing response time compared to external labs. In 2025, IAV launched mobile outbreak investigation units and a specimen collection van, enhancing field-level epidemic surveillance and diagnostics across Kerala. The institute also fosters translational research through collaborations with startups and academic institutions, and offers training programs in modern virology. IAV stands as a critical pillar in Kerala's preparedness against viral diseases and in strengthening public health resilience through scientific excellence.

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