ANNUAL REPORT
2022-23

KSCSTE - KERALA FOREST RESEARCH INSTITUTE

KFRI ANNUAL REPORT 2022-23

KSCSTE - KERALA FOREST RESEARCH INSTITUTE
An Institution of Kerala State Council for Science, Technology and Environment
Peechi-680 653 | Thrissur | Kerala
www.kfri.res.in

Cover Image : *Diachea leucopodia* Bull. Rostaf. (White footed Slime mold)
A Myxomycete – first report to Kerala from KFRI Campus, Peechi
Description : A common species distributed worldwide. The fruiting body is gregarious, cylindrical or elliptical; metallic blue, bronze or purple in colour and 0.3 to 2.5 mm tall. The spores are black and 8 to 11 µm diameter.
Collected by : Arun Kumar K.S., Jithin C.K. & Sreejith K.A., Forest Ecology Department, KFRI

Photo credit : Sreejith Sivaraman, Forest Ecology Department, KFRI

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CONTENTS

From the Director's Desk

The United Nations has declared the present decade (2021-2030) as the "Decade on Ecosystem Restoration." This initiative aims to prevent, halt, and reverse the degradation of ecosystems worldwide. Healthy ecosystems are essential for sustainable economic development and combating climate change. They provide resources for various sectors, including agriculture, forestry, fishing, and tourism. Unsustainable exploitation of natural capital can lead to resource depletion and ecosystem degradation. Developmental activities often have a negative impact on ecosystems, destroying them and the services, they provide. The UN Decade on Ecosystem Restoration is a crucial step towards addressing these challenges and ensuring a sustainable future for our planet.

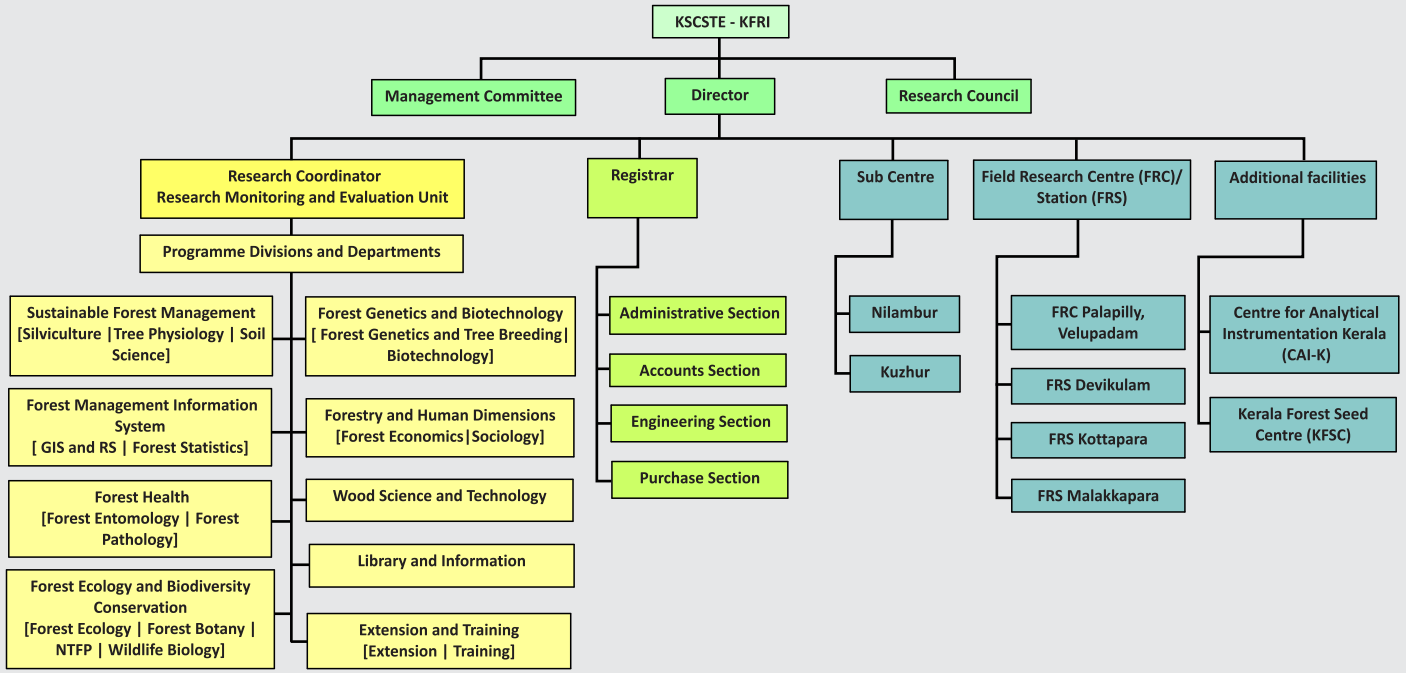
The UN Decade on Ecosystem Restoration presents a unique opportunity to transform fiber, food, and feed production systems to meet the demands of the 21st century and eradicate poverty, hunger, and malnutrition. This can be achieved through innovative and effective landscape management that prevents degradation and restores degraded ecosystems.

Aligned with global policy shifts, KFRI actively engages in research to restore degraded landscapes, augment endemic plant resources, eradicate invasive species, stabilize riverbanks and landslides, and reclaim mangroves. In 2022-23, KFRI had 121 ongoing projects covering diverse forestry aspects, supported by international organizations and Indian government agencies, namely, Food and Agricultural Organization (FAO); United Nations Development Programme (UNDP); ICLEI South Asia; United States Agency for International Development (USAID); Ministry of Environment, Forests and Climate Change (MoEF&CC), Government of India; Department of Biotechnology (DBT); Department of Science and Technology (DST); National Bamboo Mission (NBM); CAMPA-Indian Council of Forestry Research and Education (ICFRE); Airport Authority of India, Govt. of India; National and State Medicinal Plants Boards (NMPB & SMPB); National Highway Authority of India, Govt. of India; Kerala State Council for Science Technology and Environment, Govt. of Kerala; Kerala Forest and Wildlife Department; State Department of Planning and Economic Affairs; Kerala State Biodiversity Board (KSBB); Department of Environment and Climate Change, Govt. of Kerala; Zoological Park Wildlife Conservation and Research Centre, Govt. of Kerala; Local self-government organizations and the KFRI Plan Grants. The institute received Rs. 1518.68 lakhs in grants and utilized funds for research, extension projects, and infrastructure development.

I would like to express my sincere gratitude for the invaluable guidance and unwavering support provided by the Department of Science and Technology, Government of Kerala, Kerala State Council for Science, Technology and Environment, Research Council, Management Committee, and the relentless collaboration and support from the scientists, staff, and students of KFRI.

Dr. Syam Viswanath

ORGANOGRAM


KSCSTE - KFRI
Management Committee
Director
Research Council
Research Coordinator
Research Monitoring and Evaluation Unit
Programme Divisions and Departments
Sustainable Forest Management [Silviculture |Tree Physiology | Soil Science]
Forest Management Information System [GIS and RS | Forest Statistics]
Forest Health [Forest Entomology | Forest Pathology]
Forest Ecology and Biodiversity Conservation [Forest Ecology | Forest Botany | NTFP | Wildlife Biology]
Forest Genetics and Biotechnology [Forest Genetics and Tree Breeding| Biotechnology]
Forestry and Human Dimensions [Forest Economics|Sociology]
Wood Science and Technology
Library and Information
Extension and Training [Extension | Training]
Registrar
Administrative Section
Accounts Section
Engineering Section
Purchase Section
Sub Centre
Nilambur
Kuzhur
Field Research Centre (FRC)/ Station (FRS)
FRC Palapilly, Velupadam
FRS Devikulam
FRS Kottapara
FRS Malakkapara
Additional facilities
Centre for Analytical Instrumentation Kerala (CAI-K)
Kerala Forest Seed Centre (KFSC)

Kerala Forest Research Institute (KFRI) was established by the Government of Kerala as an autonomous Institute on 03 July 1975 under the Travancore Cochin Literary, Scientific and Charitable Societies Act-1955. In 2003, KFRI was amalgamated with the Kerala State Council for Science, Technology and Environment (KSCSTE), an autonomous body along with five other Research and Development Centres. The mandates of the Institute are to conduct research on all aspects of tropical forestry. KFRI has created a strong niche among the leading forestry institutions in the country by conducting problem solving, time bound research in thrust areas addressing the needs of the stakeholders. The Institute has been instrumental in evolving strategies for conservation and sustainable use of forest resources of the State.



The Institute is envisioned to become a Centre of Excellence in tropical forestry to offer scientific backbone for effective conservation of forest ecosystems and sustainable utilization of natural resources for ensuring benefits to the society. The Mission being to provide technical support to facilitate scientific management and utilization of forests for social benefits. It envisages to:

a. Conduct inter/multidisciplinary research on priority areas of tropical forestry including biodiversity conservation, wildlife management, socio-economics, indigenous knowledge, value addition of forest products, participatory forest management and livelihood improvement of forest dwellers/dependents by scientific management of forest resources,

b. Provide technical advice and solutions to practical problems related to forest conservation and sustainable utilization of forest resources, and

c. Disseminate knowledge and information on forest-related matters to end-users, farmers, general public and transfer of technology to stakeholders for social benefits.

Main campus | Peechi

The main campus is located in central Kerala at Peechi, about 20 kms east of Thrissur city in a 28 hectares Reserve Forest area adjacent to Peechi-Vazhani Wildlife Sanctuary. The main campus is an assemblage of offices of International and National Networks, highly sophisticated laboratories, live collections and plant propagation facilities.

KFRI houses a number of experimental research facilities. These include laboratories, collections, networks and helpline, monitoring and centralized facilities. Laboratories include Tissue Culture, Physiology, Wildlife Biology, Soil Science, Molecular Biology, Wood Science and Technology, Biochemistry, Pathology, Entomology, Silviculture, Ecology, Geographic Information System and Remote Sensing. These research laboratories are designed to serve staff, scientists and research scholars as well as researchers from universities, industry, foreign institutions, and other government laboratories. Collections include Arboretum, Bambusetum, Palmetum, Herbarium, Medicinal Plants Garden, Orchidarium, Fernarium, Xylarium, Wildlife museum, Soil Science museum, Teak museum, Butterfly garden, Insect and Microbial collections. For plant propagation and clonal multiplication, there are nurseries, green houses, mist chambers and the Kerala Forest Seed Centre. The secretariats of the International Teak Information Network (TEAKNET) funded by the Food and Agriculture Organization (FAO) of United Nations, the Bamboo Technical Support Group (BTSG) of the National Bamboo Mission, Govt. of India and the Regional Cum Facilitation Centre (RCFC) of the National Medicinal Plant Board (NMPB), Ministry of AYUSH, Govt. of India are housed in the main campus of KFRI. The monitoring facilities are the permanent plots established and maintained in different forest ecosystems and weather stations. A sophisticated analytical instrumentation laboratory - Centre for Analytical Instrumentation - Kerala (CAI-K) - is also located in the main campus. Library, Local Area Network (LAN), training facilities, stores, seminar and conference facilities, field work support (vehicles), staff accommodation, guest house and research scholars' hostels are the centralized facilities of KFRI. A seismic observatory operated and maintained by the National Centre for Earth Science Studies (NCESS) is in KFRI main campus. The Institute has a Sub Centre at Nilambur in Malappuram District and Kuzhur at Thrissur District, Field Research Centre at Velupadam in Thrissur District, and Field Research Stations at Munnar, Kottapara, and Malakkappara.

Sub Centre, Nilambur

The Sub Centre (KFRI Sub Centre) campus is situated in the fringe of the Nilgiri Biosphere Reserve at Nilambur with facilities for laboratory work and field trials in a 43.36 hectares area and is about 140 kms away from the main campus. The KFRI Sub Centre is one of the important green institution in Malappuram District with a rich floral and faunal diversity on the bank of Karimpuzha, a tributary of Chaliyar River. The campus is quite clean, green and free from pollution. The campus is rich in plant diversity with a total of 1643 taxa of angiosperm plants belonging to 840 genera and 152 families. Among these, 1452 taxa represented species (sub species and natural varieties included) while the remaining 191 taxa represented cultivars and hybrids. It may also be noted that the types of existing plant species are dependent upon the local geology, naturally occurring or introduced soils, water availability, and the amount of human intervention. Thus, a range of landscapes from carefully tended areas to areas that have reverted to nature under the influence of the forces that control ecological succession can be seen within the campus. A bambusetum with about 35 species of bamboos are maintained at the Sub Centre. The Sub Centre also houses the famous Teak Museum, Bio-Resources Nature Park, Medicinal and Herbal garden and a model of Butterfly garden.

Sub Centre, Kuzhur

The Sub Centre at Kuzhur, is taken over by KSCSTE – Kerala Forest Research Institute, Peechi as on 01.01.2022, from KSCSTE- Jawaharlal Nehru Tropical Botanic Garden and Research Institute. The Centre was established in 2019 with the financial support of Kerala State Industrial Development Corporation (KSIDC). The Sub Centre, is situated in an area of around 1.27 acres. Presently, the Sub Centre is equipped with a full-fledged 10000 sq. feet Plant Tissue Culture laboratory. The laboratory consists of media preparation, inoculation, incubation and sterilization rooms. The facility has a total production capacity of 5,00,000 plants per annum. The Sub Centre mainly aims at expanding the cultivation of *Pandanus* (screw pines) by providing plantlets of different species of *Pandanus*, suited for different purposes including restoration programs, thereby helping the revival of traditional industries based on the plant in Kodungallur and its surrounding Panchayats. The Sub Centre is currently focused on the production of tissue culture raised plantlets of different species of screw pines (*Pandanus odorifer*, *P. furcatus*, *P. leram*, *P. tectorius*, *P. pygmaeus*), forestry species (bamboo, teak), agriculture crops (banana, ginger), ornamental plants (*Aglaonema, Calathea, Philodendron, Spathiphyllum*, Orchids, Anthurium, spider lilly, *Cordyline*, etc.) and medicinal plants.

The Sub Centre is envisioned to evolve as a Research and Development (R&D) Outreach and Bio-incubation Centre of the Institute. The envisaged activities in a phased out approach include (1) upscaling the facility so as to cater to the extension activities of the research projects and outreach activities of the Institute (2) mass propagation of plant species of commercial importance in line with demand from various stakeholders such as KFRI scientific fraternity, local farmers, R&D institutions, government and public sector enterprises, NGOs, academicians and individual entrepreneurs (3) genetic fidelity testing of tissue culture raised plantlets (QPMs) (4) production of QPMs of tree species and other miscellaneous multipurpose native tree species and medicinal plants in high demand, through nursery established and managed at the Centre (5) training of manpower in plant tissue culture (Training for academicians, internship students and Masters attachment programs) to generate a regular income (6) as a Bio-incubation Centre for start-up entrepreneurs in tissue culture.

Field Research Centre (FRC)

Velupadam: Spread over an area of 47.43 hectares, the Field Research Centre (FRC) at Velupadam in Thrissur District is 36 kms away from the main campus at Peechi. A valuable asset - bambusetum, one of India's largest live collections of bamboos, is the special attraction of Velupadam campus. Nursery and field trials are also conducted at the FRC campus. At FRC, a Common Facility Centre for bamboo enterprises supported by Department of Science and Technology (DST), Govt. of India was established to impart training and technology transfer.

Also initiated was the establishment of replicable bamboo/cane based model business units for entrepreneurs via training, demonstration and transfer of the innovations/ technologies developed or available.

Field Research Stations (FRS)

Malakkappara: This field station is located 170 kms away from the KFRI main campus. The property belongs to Tata Coffee Ltd (TCL) and based on an agreement signed between TCL and KFRI in 2017, it was provided for research purposes of KFRI. It supports field-oriented research activities, mainly to accommodate research personnel attached to the Institute.

There are around 10 permanent plots in Sholayar landscape which represent heterogeneity in altitude, vegetation etc. This includes a 10 hectare plot in tropical wet evergreen forests of Karadishola, where long term ecological monitoring in the context of climate change is going on.

Devikulam: The FRS is located at Devikulam range of Munnar Forest Division in Idukki district. The Station has nurseries and polyhouses for the production and maintenance of seedling stock of different tree species. A germplasm of eucalypts was maintained in this station for the supply of quality planting materials. The seedlings produced from the station were used for restoration programs of Shola forests in high ranges. Now the station is actively involved in raising seedlings of medicinal plants for establishing medicinal plant gardens in the high altitude regions. In addition, the FRS functions as a base camp for personnel in various research projects being implemented in high ranges and also supports various field based experiments.

Kottapara: The FRS is located at Kodanad range of Malayattoor Forest Division in Ernakulam district. The research programmes in this field station commenced in 1989, and initially focused on the production of *Eucalyptus* clones for research purposes and Kerala Forest Department (KFD). Presently, Institute is maintaining a germplasm of teak plus trees, *Eucalyptus* clones and host plants of lac insects in this station. The seedings of major timber tree species including teak are produced in the station.

Organization

The research in KFRI is executed through Departments clustered under Programme Divisions. There are nine Programme Divisions; of them, seven are Research Divisions and two are supporting Divisions. The Research Divisions are: Sustainable Forest Management, Forest Genetics and Biotechnology, Forest Management Information System, Forest Ecology and Biodiversity Conservation, Wood Science and Technology, Forestry and Human Dimensions, and Forest Health. The supporting Divisions are Extension & Training and Library & Information. Administratively, a Programme Coordinator heads a Division and a Head of Department manages each Department within the Division. Divisions having laboratory and other facilities are under a Scientist-in-Charge. The Research Coordinator, who heads the Research Monitoring and Evaluation Unit, oversees the implementation of research programmes, facilitates and monitors research activities in the Institute. The Research Council is the vital body responsible for monitoring and guiding the formulation and implementation of various research programmes in KFRI. It comprises of eminent scientists in the field of forestry research and accomplished forest officials in the country. It also monitors the quality and content of research undertaken by the Institute and provides guidance for improvement.

The Institute is governed by the rules and regulations of the Kerala State Council for Science Technology and Environment (KSCSTE), Govt. of Kerala. The administration and management of the Institute are vested with the Management Committee chaired by the Director as the Head of the Institute and is also responsible for the day-to-day administration and implementation of programmes. Besides basic and applied researches, KFRI also undertakes extension and training activities for transfer of technology and dissemination of information as well as consultancy for end-users and stakeholders. Every year, regular training programmes are conducted by KFRI on different modules of tropical forestry to meet the needs of International, National, and State level stakeholders.

The Administrative and Accounts sections of the Institute coordinated by the Registrar, assist the Director in managing the day-to-day functioning of the Institute. An Internal Auditor scrutinizes financial and expenditure matters of the Institute. The total staff strength of the Institute is 80, which includes 21 scientists, 53 administrative staff and 06 technical staff. In addition, 91 project personnel temporarily attached to various research projects provide the necessary research support.

The Institute is an accredited Research Centre of the Forest Research Institute - Deemed to be University (FRI-DU), Dehradun, Cochin University of Science and Technology (CUSAT), and the University of Calicut for enrolling students for research programmes leading to the award of doctoral degree. Besides, the Institute also undertakes academic attachment programmes for several colleges and Universities at the International, National and State level. KFRI signed an MoU with Ghent University, Belgium. This has opened an official platform for the exchange of researchers including faculties and students between two Institutions, and further to develop collaborative research programs. This has made it formally possible for KFRI to collaborate with Ghent University in their TreeWatch.net program, a global network to monitor hydraulic and carbon dynamics of trees. The Institute has also signed MoUs with the Kerala Agricultural University, Kerala Veterinary and Animal Sciences University, Kannur University, Rajagiri School of Social Sciences as well as various colleges in the State. An Academic Coordinator heads the academic programme of the Institute.

Right to Information (RTI)

The RTI is an Act for implementing the practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, the constitution of a Central Information Commission and State Information Commissions and for matters connected therewith or incidental thereto. An individual may submit a written request to the Public Information Officer for information related to KFRI activities.

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PROGRAMME DIVISIONS

Sustainable Forest Management

The Programme Division comprises of Tree Physiology, Silviculture and Soil Science Departments. Studies of physiological and biochemical aspects of recalcitrant seeds; Development of clonal and seed propagation protocols of Threatened trees/NTFPs/Lesser known wild fruit trees; Development of restoration protocols of Red listed trees; Large scale multiplication and restoration of IUCN Red listed trees, climate change impact study on endemic and threatened trees; Live plants management, etc. comes under the domain of the Tree Physiology Department. Major programmes under progress are (a) Green Kerala Initiative: Restoring IUCN red-listed tree species and ecosystems of Kerala; (b) Development of plantation technology for Jiggat species; (c) Reintroduction of IUCN red listed trees and (d) Ecological studies on post restoration success of threatened plants *in situ*.

The key research areas and current research activities of the Soil Science Department include afforestation and eco-restoration of degraded sites, control of river bank erosion by planting, evaluation of factors affecting plantation productivity and soil nutrient management for important forestry species, composting and biochar technologies for soil amelioration as well as developing nanocomposites for soil applications.

The Silviculture Department plays a pivotal role in the field of forest management and sustainable forestry practices. Mainly focused on conducting research, developing techniques and providing recommendations that aid in the establishment, growth and management of forest ecosystems. The Department is implementing various programmes related to resource augmentation/restoration in forest areas.

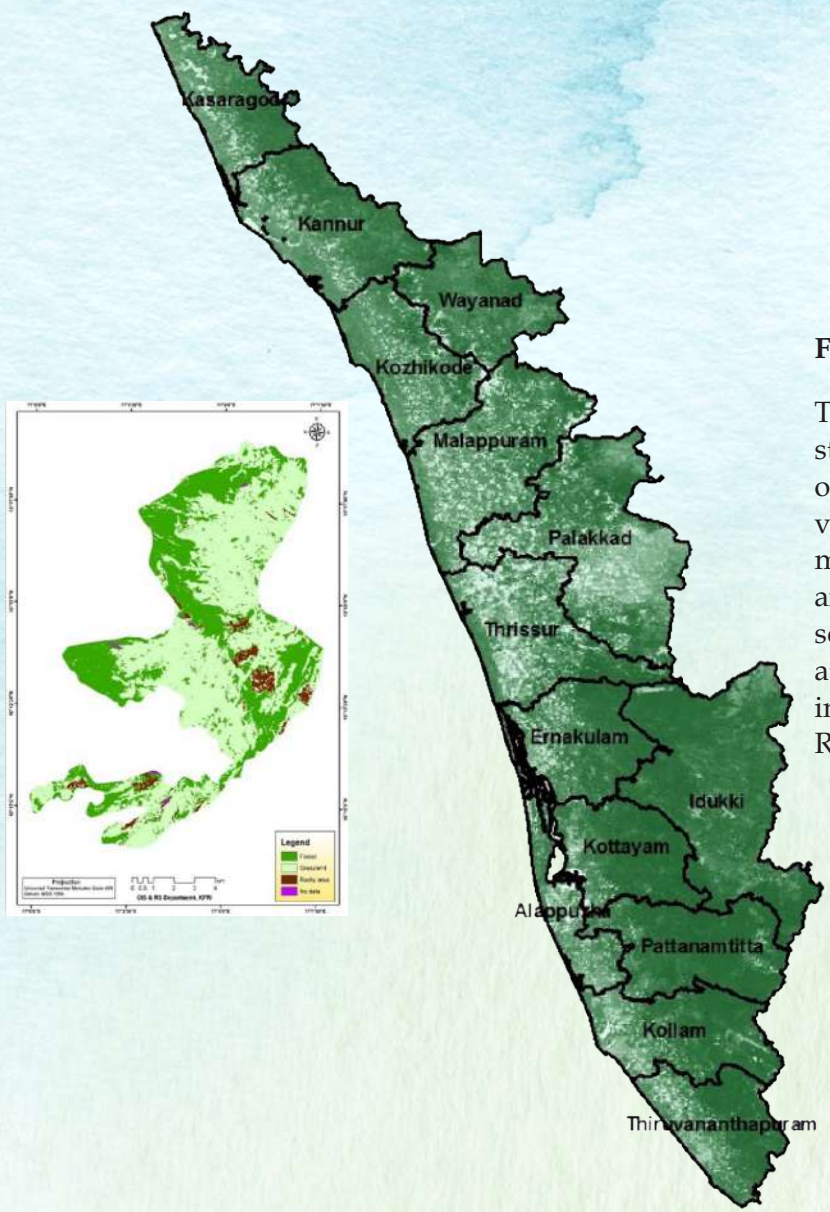
In order to reduce pressure on forest and for increasing the availability of forest resources outside forest areas, several programmes are being implemented in collaboration with various other line departments. Current specific programmes include: eco-restoration, conservation of both species and habitats, resource augmentation and enhancement in both forest and non-forest areas, developing ecologically sustainable high density forest in urban areas, standardization of seed handling protocols and nursery techniques, production of Quality Planting Materials, Environment Impact Assessment studies and various environmental issues, growing stock estimation of commercially important species, promotion of medicinal plants and timber trees in non-forest areas to reduce the pressure on forest, developing conservation plan for the developmental projects, control and management of Invasive Alien Species. Moreover, the Department is working on the rejuvenation of vulnerable habitats like coastal and riparian ecosystems. Regional cum Facilitation Centre of the National Medicinal Plants Board (RCFC-NMPB) is attached to Silviculture Department of KFRI. Two important facilities of the Institute, the Kerala Forest Seed Centre (a joint venture of Kerala Forest Department and KFRI) and Central Nursery are attached to the Department

Forest Genetics and Biotechnology

The Programme Division includes Forest Genetics and Tree Breeding as well as Biotechnology Department with plant propagation, plant tissue culture and molecular biology facilities. The major research areas of the Division are genetic improvement of teak, clonal propagation of forest trees and medicinal plants through vegetative propagation and plant tissue culture, field testing of superior clones, DNA testing, DNA barcoding, population genetics, molecular phylogeny, genomics and transcriptomics.

Major achievements of the Division are the development of efficient mass clonal propagation methods for important forestry crops through macro and micropropagation, cost reduction in micropropagation, genetic improvement, plus tree selection and establishment of clonal seed orchards in teak, population genetic structure of teak and sandal provenances in India, DNA fingerprinting and genetic diversity studies of eucalypts, acacia and teak clones, genetic diversity of captive elephants, molecular phylogeny and biogeography of paleotropical woody bamboos, *Calamus* & dipterocarps and development of institutional capability for DNA barcoding of life forms, draft genome of teak, sandal, *Calamus brandisii* and *Korthalsia laciniosa*, among others. DNA barcoding facility caters to the DNA barcoding requirements of various academicians and researchers in the field.

The current research activities of the Division include development of clonal propagation protocols through micro and macro propagation for important forest tree species, commercial bamboos and medicinal plants, plus tree selection and evaluation of selected clones of teak through multisite testing, genetic improvement and plus tree selection of selected tree species, establishment of seed orchard and clonal hedge garden. The Division also generates genomics and transcriptomic database to develop genome wide DNA markers for predicting gene-ecological zones, adaptive alleles, genetic diversity & structure for sustainable conservation and management of forest genetic resources. The Division further focuses on molecular assay for field detection of sandal spike disease as well as DNA barcoding for biosystematics, certification of bamboos, authentication of non-wood forest products (NWFPs) and timber forensics. The Division also undertakes DNA testing to trace the identity of seized logs in timber theft cases and offer consultancy services for various Government Departments.



Forest Management Information System

The Programme Division uses modern tools of remote sensing, GIS and statistics to advance the science of forest measurements cater to the needs of co-researchers and partners. The Division has been actively engaged in various research activities including forest mapping, biodiversity mapping, ecosystem analysis, resource mapping, and population analysis. The Division uses high spatial, spectral and temporal remote sensing data for characterizing the compositional and functional attributes of forests. The Division partners with various national and international organizations, and also actively involved in training on Remote Sensing and GIS.

Forest Ecology and Biodiversity Conservation

The Programme Division comprises of Forest Botany, Forest Ecology, Wildlife Biology and Non-Wood Forest Products (NWFPs) Departments. The main research areas of the Division are biodiversity evaluation and conservation of fragile ecosystems, rehabilitation and restoration, ecosystem and landscape analysis, population ecology, long-term monitoring of forest ecosystem through permanent plots, human-wildlife interaction and biodiversity inventory and documentation.

The major activities of the Forest Botany Department include floristic documentation of angiosperms and lower groups of plants with a focus on lichens and algae. The important ongoing activities include biosystematics studies on the genus *Terminalia* in India, phenology and seed dispersal of trees in moist deciduous and shola forests, standardization of propagation techniques and development of germplasm for mangrove and bamboo species, biogeography, phylogeny and e-monograph of Arthoniales.

Department of Forest Ecology mainly focus on biodiversity documentation, long-term monitoring of tropical forest ecosystems, plant functional traits, understanding the fundamental ecological and physiological processes of plants and their relations to Climate Change, assessment of conservation status to update IUCN status, applications of Remote Sensing and GIS. The Department has collaborations with national Institutes such as IISc, ICFRE, ISRO etc., international agencies like IUCN, IPBES and international Universities including University of Oxford, United Kingdom; University of Leeds, United Kingdom and Ghent University, Belgium.

Department of Wildlife Biology focuses research under various themes viz., wildlife-human dynamics, biology and conservation of threatened species, surveys and population assessment; ecology, behaviour and conservation of wildlife; citizen science. These include studies on threatened species such as lion-tailed macaque (*Macaca silenus*), bonnet macaque (*Macaca radiata*) and Salim Ali's fruit bat (*Latidens salimalii*), smooth-coated otter (*Lutra Perspicillata*), small-clawed otter (*Aonyx cinerea*), *Cycas annaikalensis*, and Malabar torrent toad (*Blaira ornata*). The Department also manages resources and facilities such as wildlife museum, LAN and Centre for Citizen Science & Biodiversity

Informatics. Extension and outreach activities through wildlife museum education, Centre for Citizen Science & Biodiversity Informatics, Snake Sense, bat for bats, targeted programmes in schools and colleges, etc., publication of popular articles, social media content and talks/lectures, are also conducted by the Department.

Citizen Science also known as participatory science, volunteer-based monitoring, or crowd science is scientific work undertaken by members of the general public, often in collaboration with or under the direction of professional scientists and scientific institutions. Citizen science is recognized as an excellent tool for democratizing science and promoting equitable access to scientific data. Digital tools, especially the camera and GPS applications on smartphones revolutionized participatory science and have the potential to generate big data required for developing policies to address global problems such as biodiversity loss, climate change, etc. The Centre for Citizen Science & Biodiversity Informatics (https://ccsbi.kfri.res.in) is established to support evidence-based policy making in biodiversity conservation by democratizing science. The specific objectives are to: coordinate and co-develop citizen science programmes, generate and collate biodiversity data for science and conservation, organize capacity building workshops for researchers and citizen scientists, and develop public outreach programmes to improve environmental awareness and capacity of citizens to contribute quality data. The recent initiatives of the centre include fruit bat project (https://thefruitbatproject.weebly.com), biodiversity mapping at panchayats & several institutional campuses, Monsoon Croaks, Bioblitzs, etc.

The activities of NWFP Department focuses on phytochemical analysis of NWFPs and other medicinal plants. Major projects of the Department include, (a) Development of biopesticide formulations from plant species of southern Western Ghats (b) Synthesis, characterization and analysis of activated spherical carbon derived from lignocellulosic biomass and (c) Microplastics and phthalate esters in urban water bodies - occurrence, distribution and seasonal variation in selected urban areas of Kerala. In addition to this, Department is actively involved in projects executed by other Departments of the Institute. As part of the project carried out in the Department on identification of suitable alternates for jigat production in incense stick making, a patent application on “Binding matrix for incense sticks or incense cones” was awarded during the period.

Wood Science and Technology

The Division primarily focuses research on various aspects related to wood properties, wood structure, utilization of wood and bamboo resources, timber processing techniques to improve durability/value and pulping characteristics of reed bamboos. Division has facilities such as microscopes, image analyser, UV spectrophotometer, colour spectrophotometer and FT-NIR spectroscope, tree-ring measuring station and bamboo processing and treatment facilities.

Another key area of research is the standardization of preservative treatment processes and examination of properties & structure including anatomical characteristics of bamboo species present in Kerala. The Division also explores various aspects of its utilization and seeks to enhance the value of products derived from these resources. Additionally, the Division offers wood identification services for tropical, temperate, and exotic timbers, catering to various public sectors and judiciary. The well-curated Xylarium plays a vital role in facilitating wood identification for the scientific community.

The Division has undertaken numerous studies pertaining to the wood structure, properties, quality assessment of teak & eucalyptus; application of preservative treatments for species like rubber wood & coconut wood as well as desirable traits & characteristics of *Ochlandra travancorica* along with field trials of accessions with low lignin and mass propagation.

Forestry and Human Dimensions

The Forest Economics and Sociology Departments of the Division mandates to study, review and evaluate (a) policy and management, (b) people and forests, and (c) production, sustainability and conservation. The thematic areas covered are forest management systems, land use, institutional analysis, industry studies, natural forests, plantation economics, productivity of forest plantations, management of natural forests, econometric analysis, demand and supply of wood in Kerala, forestry sector analysis, trees outside forests, bamboo, price fixation of pulpwood, history and human dimensions of forest management, tribal communities, socioeconomics including farm forestry, visitor management in protected areas, NTFPs management, environmental, and social impact assessments, economics of invasive alien species, economic valuation and natural resource accounting including ecotourism development and policy appraisal. The current activities include, research on economic valuation of ecosystem services, market economics covering medicinal plants market in south India, economics of alien invasive species, policy issues, development experiences of selected tribal groups in the Western Ghats, enriching, updating and maintenance of the existing database and repositories, capacity building of decision makers, natural resource managers, local communities and other stakeholders, impart training and create awareness amongst all relevant stakeholders about advances in forestry research.

Forest Health

Forest Entomology and Forest Pathology Departments comprise the programme division of Forest Health. The Forest Entomology Department specializes in monitoring forest insect diversity, managing pests in plantations, addressing new pest outbreaks, and estimating insect functions in natural and urban forestry. With a focus on teak, the dominant timber tree, intensive research has standardized the mass production of the biopesticide *Hyblaea puera*-Nucleo Polyhedrosis Virus (HpNPV) to combat the noxious impact of the teak defoliator and the technology has been transferred to stakeholders. The Department maintains a significant insect collection of more than 1,00,000 specimens, currently being digitized, primarily focusing on the Western Ghats fauna. Research and extension efforts include diversity studies, economic loss reduction procedures, live insectarium maintenance, butterfly garden establishment, and a tree health helpline. Research highlights cover alien invasion management, ecology of Troidini butterflies, morphological and molecular taxonomy of skippers, temporal analysis of Coleoptera distribution, biology of bark and ambrosia beetles, cognitive abilities of weaver ants, and genetic conservation of lac insects. Department also provides technical guidance and identification services to seasonal pest occurrences in various tree species. Facilities include e-DNA and molecular research, soundscape ecology, lac insect research, microscopic imaging, and an insectarium for continuous model insect cultures.

Forest Pathology Department has been working on detection, diagnosis and management of plant diseases in nursery, plantation and natural forests; screening and evaluation of potential microbes from different ecosystems of Kerala for the management of major soil borne forest pathogens; morpho-molecular characterization and *ex-situ* conservation of phytopathogenic fungi causing various fungal diseases in forestry plants & high value medicinal plants, diversity, distribution and morpho-molecular taxonomy of foliicolous hyphomycetous fungi through various externally funded projects. The Department has also been working on the plant growth promoting microbes for high quality bamboo planting production as well as on detection of *Ganoderma* disease in plantations and agro-ecosystems of Kerala. The Department explores the possibilities to manage plant diseases using eco-friendly, cost effective approaches like biofertilizers and biocontrol agents. During the period, the Department has facilitated 12 dissertations and 10 internship programmes.

Extension and Training

Programme Division effectively transfers the expertise and technologies developed in KFRI to different stakeholders. The Division liaises with various users/stakeholders, facilitates the transfer of technology and conducts training programmes in different aspects of tropical forestry such as forest management, forest seed management, medicinal plant cultivation, environmental impact assessment, biodiversity monitoring and evaluation, remote sensing and GIS, root-trainer technology, clonal propagation, tree improvement and statistical application in forestry. The Division has excellent facilities for the conduct of training programmes including lecture halls, trainees' hostel and vehicles for field trips. The Division also liaisons and coordinates technical support to various stakeholders, Departments, researchers, student community, general public and showcases the Institute in various national and state level exhibitions. During 2022-23, KFRI has organized 15 training programmes, participated in 13 Exhibitions and hosted 146 visits, welcoming a total of 5957 visitors.

Library and Information

KFRI Library functions as a full-fledged resource centre on tropical forestry and as a special repository of literature on teak, bamboo and rattan. It also functions as the national level Bamboo Information Centre. The library has a core collection of more than 20,100 books, 2000 back volumes of journals on forestry & allied subjects and caters to the information requirements of scientists, research scholars of the Institute and others, who are interested. During the period, online access to many of the core journals in forestry and allied subjects is made available, which includes both national and international journals. The library has also access to CAB's bibliographic database which covers the major subjects like agriculture, environment, forestry, etc., and gives access to more than 2,20,000 journal articles, conference papers and reports. Online access is made possible to EBSCO database of Environment Complete which contains more than 5.5 million records from 4000 national and international titles as well as more than 250 monographs. The library collections also include many of the valuable reference books, doctoral theses, publications of national and international bodies like Forest Research Institute (FRI), APAFRI, IRGWP, IUCN and IUFRO as well as databases in CDs and DVDs.

Online catalogue of books and back volume collections of the library developed using the software KOHA, open source Integrated Library Management software is made available to access. Digital collections of the library include research reports, scientific papers, Information Bulletins, Ph.D theses, Annual Reports and other documents published by KFRI scientists, which is possible to access through the Intranet library portal developed for the purpose. Collections of Ebooks, Eprints, Indian Forest Records and Bulletins (publications of FRI) and the collections of bamboo, teak and cane literature are also possible to search and download. Digital resources of the library are organized using the software Dspace, an open source repository software. This can be accessed by the scientists and research scholars from their desktops in the institute. The following are the important objectives for creating fully fledged resource centre in tropical forestry.

Indian Forestry Abstracts (IFA)

Indian Forestry Abstracts (IFA) is a new venture of KFRI to present a comprehensive bibliography of current forestry literature published in India, along with an abstract for each citation. IFA is an endeavour to reach Indian forestry research to a wider national and international audience. A large country like India, with its unique forest types and practices need a country specific listing of research publications to make them more inclusive of Indian forestry, Indian institutions and independent researchers working in India. At present, Indian forestry doesn't have an exhaustive bibliographic information system and a single source or portal on forestry related topics where one can approach to have publications brought out by the institutions in India. The work undertaken by the library on compiling information for Indian Forestry Abstracts (IFA) and updation of the website www.ifa.org is to be continued.

Bamboo Information Centre - India (BIC)

Bamboo Information Centre - India was established in 1989 with the financial support of the International Development Research Centre (IDRC), Canada with the purpose of collection, proper documentation and dissemination of bamboo information for easy access to users. The information on bamboo species and published documents from researchers and artisans is consolidated and repackaged and brought to the public. Updating of the website developed for the purpose of achieving the ultimate aim of the project is progressing well. Our next attempt is to create a web portal for all the species of bamboo and collect comprehensive literature about each and every species.

Administrate, Accounts, Purchase, Stores and Engineering Sections

The research activities in KFRI are well supported by its Administration, Accounts, Purchase, Stores and Engineering sections. The Administrative section looks after the day-to-day administrative activities of the Institute. Administrative section headed by Registrar, helps the Director for smooth management of the Institute. All administrative sanctions related to project implementations are handled at Administrative section. The transportation requirements for project implementation, trainings and other logistics are taken care by administrative section. KFRI has a fleet of vehicles including bus, jeeps for off-road high-altitude transport, cars and two wheelers. The financial and accounting management of the Institute is taken care by Accounts section. All financial transactions related to projects implemented by the Institute are handled at the Accounts Section. The Accounts section is responsible for all payments, including payroll. It is also responsible for maintenance of relevant records and accounts and for ensuring effective financial management practice in place. Purchase and Stores sections are involved in the procurement of chemicals, instruments and other stationary requirements of the Institute related to implementation of projects and other administrative activities. The sections also facilitate proper documentation related to import of major instruments and other procurement needs of the Institute. The Engineering section handles civil and electrical works separately. The civil section looks after the implementation of new constructions and maintenance of existing infrastructure. The electrical section is responsible for the installation and maintenance of electrical infrastructure and uninterrupted power supply.

FACILTIES

Arboretum

KFRI Arboretum established in the Peechi campus in 2003 comprising an area of about 5 hectares, currently has 3400 accessions belonging to 195 species under 50 families and 130 genera, with more than 55 taxa endemic to southern Peninsular India. Among the 195 taxa in the arboretum, there are 3 gymnosperms and 192 angiosperms. There are separate collections of wild nutmegs, dipterocarps, and wild edible fruits, among others. It is also recognized internationally by Index Seminum with ID No. 1518 and is also enlisted in the National Network of Botanical Gardens in India. The important trees include *Syzygium travancoricum* Gamble, *Vateria indica* L., *Vatica chinensis* L., *Dipterocarpus bourdillonii* Brandis, *Hopea racophloea* Dyer, *Litsea deccanensis* etc. Various phenophases of tree species are regularly monitored in the arboretum.

Bambusetum

The KFRI-Bambusetum was established during 1988-95 as part of the IDRC Bamboo project at FRC campus Veluppadam. The main objective is for the *ex-situ* conservation of Indian bamboo species and to create awareness and promote the cultivation of bamboo and its products. A total of 375 Accessions (77 species) are represented in KFRI Bambusetum with species collected from the Western Ghats, northeastern States, and Andaman & Nicobar Islands. The recent accessions include *Fargesia dracocephala* T.P.Yi, *Oxytenanthera bourdillonii* Gamble, *Gigantochloa atter* (Hassk.) Kurz ex Munro etc.,

Bioresources Nature Park

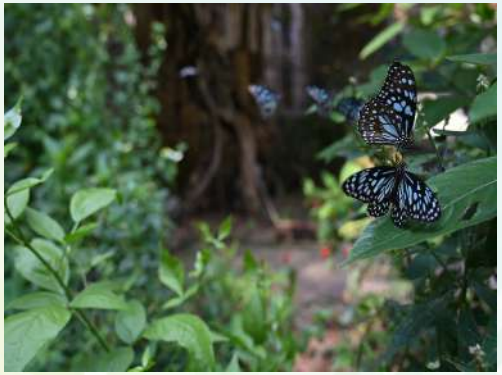
The Western Ghats region of India is one of the hotspots of biodiversity in the world with rich plant and animal

diversities, and some species are endemic to the region. Besides *in-situ* conservation of flora and fauna, *ex-situ* conservation of unique plant and animal wealth of the region as well as education and awareness on biodiversity conservation, management and sustainable utilization, are significant. With this background, the KSCSTE-Kerala Forest Research Institute, with financial support from Department of Biotechnology, Ministry of Environment and Forest, Government of India and Department of Planning and Economic Affairs, Government of Kerala, has established a Bioresource Nature Park at its Sub Centre in Nilambur. In this Park, plants are assembled in thematic areas such as, Orchid House, Fern House, Xerophytes and Succulent House, Medicinal Plants Garden, Herbal Garden, Palms and rattan Garden, Hydrophytes Garden, Butterfly Garden,

Taxonomic Garden, RET Garden and Bambusetum. Bioresources Nature Park is now developed as an *ex-situ* plant conservation area and an important nature education and ecotourism hub in Kerala. The increasing trend of annual visitors indicate that the visitors have acknowledged the educational and recreational values of the Bioresources Nature Park.

Butterfly Garden

The KFRI Butterfly garden is one of the prominent attraction within the KFRI campus which functions as an *ex-situ* conservatory of butterflies. Its primary focus lies in creating and maintaining appropriate habitats by introducing specific host plants for egg laying, larval feeding and adult feeding. KFRI has successfully established three butterfly parks: one at the main campus in Peechi,



another at the Nilambur Sub Centre, and a third in the Ecotourism zone of Thenmala as an institutional initiative. Concurrently, research scholars diligently track the population dynamics of diverse butterfly species within these gardens. Notably, 4,220 individual butterflies from 132 distinct species from 6 families have been documented

through continuous monitoring and field observations. Of particular note are the observations of various natural predators, especially parasitoids. As part of thermal ecology programme, abiotic parameters such as temperature, humidity and precipitation are being documented on a daily basis, which predict the peak abundance and potential emergence periods in a given year. Butterfly garden at Peechi host the most abundant *Nymphalidae* butterflies' year round and the rarest group is *Riodinidae*. The garden has also become a favoured

destination for participants of diverse training and extension programs of the Institute. KFRI is instrumental in establishing Butterfly garden/ parks across the State as part of the environment responsibility programme initiated by government and non-government workplaces and factories.

Centre for Analytical Instrumentation - Kerala (CAI-K)

This is a state of the art analytical instrumentation facility which houses sophisticated analytical instruments required for chemical, environmental and life sciences research. The facility was inaugurated by Hon'ble Chief Minister of Kerala, Shri. Pinarayi Vijayan on 08 November 2018. It is included in the "Special Programmes of KSCSTE "and is a part of "impactful programmes of Hon'ble Chief Minister of Kerala". The facility caters to a wide range of

researchers, students, government and non-governmental institutions and Research & Development labs in sophisticated analyses and instrumentation training. It was established as a collaborative programme of Kerala State Council for Science Technology and Environment (KSCSTE) and Kerala Forest Research Institute (KFRI). The major instruments in the Centre are Gas Chromatograph –Mass Spectrometer (GC-MS), Analytical cum Preparative Binary Gradient HPLC system (HPLC), High-performance thin-layer chromatography (HPTLC), Inductively coupled plasma atomic emission spectroscope (ICP-AES), Fourier-transform infrared (FT-IR) Spectroscope, UV-VIS Spectrophotometer, Real Time PCR and Bench-top X-ray Diffractometer (XRD). In addition to this, a full-fledged water quality analysis lab also functions in the Centre.

The overall performance of the Centre during 2022-23, can be categorized into two aspects, i) routine sample analysis and ii) training programmes. A total of 3157 samples were analyzed during the period from 01 March 2022 to 31 April 2023. The data clearly indicated an increase in the use of the facilities available in the Centre. A total of Rs. 13.238 Lakhs was generated during the period. The income generation was in the order, analytical charges - 79.567 %, Training programmes - 15.326 % and water quality analysis – 5.326 %. Among the users, 64.048 % were of internal users and 35.952 % were external users. The major service of the Centre is sample analysis using different sophisticated analytical instruments. In some cases, preprocessing of the samples is also carried out by the Centre, wherever required. Three internship programmes were conducted during this period and

the candidates were trained in operation, handling, sample analysis, data evaluation, record keeping and maintenance all the analytical instruments available at the Centre.

Central Nursery

Located at the main campus of KFRI at Peechi, Thrissur, the Central Nursery houses one of the largest collections of propagules of native species in India. The collection includes around 300 high demanding species which comes under timber yielding, fruit bearing, avenue and medicinal plant categories. The nursery caters to a large number of stakeholders throughout India. The nursery has the facilities to grow plants in different habitats/climatic pattern by various propagation methods. Hence along with Quality Planting Material production, nursery is engaged in standardisation of nursery techniques of

native, rare, habitat specific and economically important species. Moreover, the facility became an important unit with respect to large scale eco-restoration, resource augmentation and species recovery programmes, which are being implemented in collaboration with Forest Department, AYUSH Department, etc. As the nursery is functioning throughout the year it ensures the timely availability of planting material to the farmers, general public and other departments. Nursery also imparts training on nursery techniques of important forestry species including medicinal plants. Besides the above aspects, the nursery is engaged in handling a number of rare and threatened species from the Western Ghats, related to various research programmes conducted by the Institute. One of the important breakthrough in the research aspect of the nursery is the standardisation of Coir Root Trainers (CRT) in place of plastic containers. Apart from the above, nursery also provides employment opportunities and income generation especially for the women. Over the period, the nursery has become a sustainable model of Quality Planting Material (QPM) production centre as well as a conservation oriented economically viable venture in forestry sector. During the financial year, more than 4 lakhs Quality Planting Materials of 315 native species were developed and distributed. In addition, nursery techniques for 15 commercially important species were standardized. The catalogue of propagules with details are available in the KFRI website.

Herbarium

KFRI herbarium has 19,662 specimens comprising more than 3,182 species from 208 families and is one of the major reference herbaria of forest plants. It was

established in 1982, and internationally recognized by the International Association of Plant Taxonomists with the acronym KFRI. It has an extensive collection of flowering plants of Kerala, representing specimens from protected areas like Eravikulam NP, Aralam WLS, Parambikkulam WLS, and Periyar Tiger Reserve, etc., There is an excellent collection of specimens representing different forest types of medicinal plants, palms, bamboos, rattans. The species' in the herbaria are indexed in alphabetical

order with collection numbers under respective plant families and Bentham and Hooker's system of classification (1867-1883) has been followed for the systematic arrangements. The predominant plant families in the collection are Poaceae (203 spp.), Orchidaceae (185 spp.), Arecaceae (118 spp.), Fabaceae (115 spp.), Euphorbiaceae (108 spp.) and Rubiaceae (90 spp.). The herbarium has more than 96

species of pteridophytes and lichens representing the shola forests of Kerala. For instant access to specimens from any part of the world, all specimens are digitized and can be accessed by botanists and other researchers, free of charge through the data portal at http://kfriherbarium.in/. Recently, a separate section was established exclusively for lichens 1500 specimens from Silent Valley National Park, Sholayar, Kumarakom, Vembanad, Eravikulam, etc.,

Insect Collection

The insect collection housed at KFRI stands as a premier repository of dried specimens, primarily focusing on tropical insects, particularly those from the southern regions of the Western Ghats. This collection, which comprises approximately 100,272 specimens spanning all major insect taxa, serves not only as a vital depository but also to facilitate extensive research. Through vigilant and routine examination of the specimens, the systematic upkeep of the collection is ensured, along with the ongoing efforts to expand the collection. During the reporting period, 24,200 specimens stemming from diverse projects undertaken in the Department were added to the collection. Faculties and students from various national and state institutes collaborate with the state

of the art facility for taxonomic comparisons and analysis. The revaluation and re-labelling process for time-aged labels dating back to the inception year are currently underway, concurrently with a comprehensive revision of the specimens. This facility provides an ideal platform for investigating inter and intra-specific morphological variations within the realm of insects. A visit to the KFRI-Insect collection often sparks a keen interest and a quest about these fascinating creatures. Additionally, the collection also facilitates specimen loans to scientists and researchers, fostering collaborative research endeavours.

Kerala Forest Seed Centre (KFSC)

Kerala Forest Seed Centre (KFSC) established in 2003 as a collaborative venture of KFRI and Kerala Forest & Wildlife Department (KFD), is located in the main campus of the Institute at Peechi. The Centre caters the requirement of a wide range of stakeholders in forestry sector throughout India by providing certified seeds and seed handling techniques as per the standards of International Seed Testing Association (ISTA). Though the major stakeholder is Forest Department, it's service is being extensively utilized by various government and non-government

departments, research institutions, universities, students, entrepreneurs, farmers, etc. KFSC has the storage facilities for tropical seeds, in addition has modern set of equipments to study seed science and technology. Recently, National Medicinal Plants Board, Government of India had sanctioned a megaproject to establish medicinal plant seed centre and seed museum in KFSC and on completion, it will become the first of its kind in India. KFSC is also engaged in developing branded seeds of important species like teak. This has helped to overcome the long unresolved issues related to the timely production of seedlings and plantation development. KFSC is working hand in hand with Forest Departments and Department Central Nurseries, to develop viable seed handling and nursery techniques of many sensitive species/recalcitrant

seeds, including rare and threatened taxa. In addition to supply of seeds, the facility is utilized for research in Seed Science and Technology on tropical forestry species and provides training to forestry professionals, researchers, students and others interested in seeds. The KFSC also provides support to farmers, farmer clusters and farmers' cooperative societies to test, process and store the seeds developed by them for future use. On an average, KFSC is handling around 12-13 tons of seeds/year. During the financial year, 12.55 tons of 61 forestry species have been collected, processed and distributed to the stakeholders throughout India. The catalogue and timely availability of seeds are available in the website.

Medicinal Plants Garden

The medicinal garden at Peechi campus spreads over in 0.6 hectares, consisting of more than 400 species of medicinal plants

including herbs, shrubs, climbers and trees. It is maintained as a reference collection of authentic medicinal plants of Kerala forests. The collection of garden is enriched by bringing plants from wild or through exchange with other botanical gardens. In 2022-23, 101 accessions of 84 spp. were collected, of which 19 species were new introductions. As part of labeling the potted and field plants, 101 labels for 96 species, two display boards and 27 labels for star plants were displayed. As part of QR code preparation of plants, detailed information of 100 species along with images were prepared.

During the period, 1767 individuals comprising 58 groups covering school/college students, researchers and general public visited the garden.

Orchidarium and Fernery

Orchids and ferns are peculiar group of plants with a wide range of economic and conservation importance. The Orchidarium and Fernery are meant to provide artificial habitats for orchids and ferns and helps in the *ex-situ* conservation, multiplication, besides providing materials for study purposes. Though there are about 265 species of orchids and 298 species of pteridophytes recorded from Kerala, some species are known only by their type collections and a few are presumed to be extinct. At present, the Orchidarium/Fernery of KFRI conserves 245 species including Rare, Threatened, Terrestrial, Epiphytic species of Orchids and Ferns, also

maintaining some rare ornamental orchids and Ferns. During 2022-23, eight rare and threatened species of orchids and ferns were added to the Orchidarium. Apart from conservation, popularisation of few native orchids and ferns as wild ornamentals is also going on with the facility.

Palmetum

KFRI Palmetum is established in the year 2000 with a live collection of indigenous and exotic palms representing different

countries. The collection includes a total of more than 332 accessions representing 172 species of palms under 57 genera with 8 species critically endangered, 9 endangered, 8 vulnerable, and 23 near threatened categories as per IUCN standards. The threatened species like *Bentinckia condapanna, Bentinckia nicobarica, Rhopaloblaste augusta, Calamus andamanicus, C. brandisii, Wallichia disticha, W. nana, Korthalsia laciniosa, K. rogersii* as well as mangrove species like

Nypa fruticans are also present in the collection. Palmetum serves as a facility for educating the college, school students, researchers as well as public about taxonomy, economic importance, and conservation of palm resources. Similarly, quality planting materials encompassing 5000 seedlings representing 12 ornamental palms are also available in KFRI Palmetum.

Seismic Observatory

Seismic Observatory at Peechi, located in the campus of KFRI, operated under the aegis of National Centre for Earth Science Studies. This station is one of the 10 permanent stations set up by the Department of Science & Technology (DST) in 1999 [presently funded by Ministry of Earth Sciences (MoES)] for strengthening earthquake monitoring in the Peninsular India and for improving the monitoring of earthquake locations as well as azimuthal coverage in the shield region. The observatory is functioning

well and generating high quality data. The data recorded at Peechi observatory is used for detailed studies of local and regional earthquakes and is also useful for evaluating the seismogenic potential of Peninsular India and especially in the Western Ghats region in Kerala. The data is systematically archived on hard disks/DVDs. The observatory provides data to government agencies as well as other research institutes, which are used for the disaster management planning and various research works. The observatory plays host to a remarkable number of visitors including students and serves as a good educational facility to the public. The regularly compiled data recorded and is sent to the National Seismological database Centre of IMD annually, in MINISEED and SEISAN formats. This station is linked with INCOIS through VSAT connection. Data is also provided to NGRI and NCS seismic database. Details of the tremors from Kerala were given to different government agencies of Kerala including Disaster Management Cell of Kerala, Thrissur, Palakkad and Idukki Collectorates, as per their request. The information provided by the observatory is used by the district administrators for public outreach. Data from this station, along with the data from other stations, can be used for devising new methodologies to ensure safety and security during construction of dams and other major installations. This observatory is also used for training and education purposes.

Soil Museum

The KFRI soil museum is the first of its kind in India dedicated to forest soils and provides valuable information on soil genesis and transformation in the humid tropics, showcases the diversity of forest soil and mineral resources in the State and provides critical inputs for forest management. Different forest ecosystems and other land covers make strong imprints on the soil beneath them and the information on these facilitates improved land management decisions that maintain soil productivity and therefore preserve forest sustainability and long-term ecosystem health. A monolith is essentially a profile representing the

typical soil of a region, with all the basic characteristics preserved intact. It displays vertical sections of the soil from the surface to the bedrock below displaying the various horizontal layers or genetic horizons. Each monolith was dug from the ground and processed for more than a month before being mounted for display. It provides signatures of the vegetation, climate, rainfall, topography, and rocks in a particular region. Any degradation of a forest ecosystem is reflected in the soil profile and can be a valuable tool in forest management and conservation. The museum has a collection of soil monoliths featuring the soils in different types of forests *viz.* shola, grasslands, evergreen, semi-evergreen, moist and dry deciduous, bamboo, teak plantations, degraded forests and agroforestry systems in Kerala. Currently, there are 15 soil monoliths in the museum which depict

the variation in morphological properties of soil beneath different forest ecosystems in the Kerala part of the Western Ghats.

Teak Museum

Teak holds a special position in the world of timber. Kerala has always had a deep involvement with its cultivation and trade. Nilambur, located in Malappuram District of Kerala State, is the place where India's first Teak plantation was raised during the 1840s, paving the way to ensure the steady supply of teak timber in

the face of dwindling resources in natural forests. Thus, Nilambur is now globally known as the home to the earliest plantations of the world and also as the region where finest quality teak is cultivated. Recognizing the historical importance of Nilambur leading to a momentous shift from a purely extraction and regulatory function of forestry to a phase of resource development, KSCSTE-Kerala Forest Research Institute has established a Teak Museum in its Sub Centre campus and it was opened to the public on 21st May 1995. The Teak Museum reminisces the history of teak cultivation and then brings the visitor to the present, where teak still holds sway as the most sought after timber. The displays and exhibits in the Museum explain the numerous facets of teak research that KFRI has undertaken and offer a glimpse of the multifarious uses of teak timber. The artefacts include traditional household objects like the granary, swing cot, cloth-chest, among others. To regale visitors, details are provided on some in the giants of the teak world from Kerala forests. The Museum also has a world class library on teak and an auditorium for audio visual presentations. A Teak Information System (Touch Screen facility) in the Museum also helps the visitors to get information on various aspects of teak tree such as its habit and distribution, history, morphology, cultivation, harvesting, timber utilization, etc.

Tree Health Helpline

The Tree Health Helpline, as its name implies, is dedicated to addressing inquiries encompassing various facets of tree care and well-being. These comprise species and site compatibility, planting guidance, species identification, soil

analysis, fertilizer application, physiological issues, pest and disease management, and the control of invasive species. Furthermore, the helpline extends its expertise to offer consultation services for large-scale afforestation initiatives, contributing to landscape-level endeavours.

The services are delivered by a knowledgeable team of scientists hailing from departments such as Entomology, Pathology, Soil Science, Silviculture, Botany, Wood Science, and Physiology. During the period 2022-2023, a total of 98 inquiries were addressed through the tree health helpline. These inquiries include diverse matters such as tree status inquiries, tree management strategies, pest infestations, fungal concerns, species and site compatibility, species identification, species information, fertilizer application techniques, planting methods, wood quality assessments, parasitic issues, seed availability, and the management of specific problems such as the Ambrosia beetle, which was found to be causing pinholes in fuel pipes of cars, leading to damage. In addition, calls from the public concerning the tree health and management were also addressed through Tree Health Helpline.

Wildlife Museum

The Department of Wildlife Biology has an attached wildlife museum housing a diverse collection of specimens from various taxa found in the Western Ghats. These specimens were gathered through various department projects since 1978. The collection comprises over 1000 specimens of invertebrates, mammals, birds, fishes, reptiles, and amphibians. Noteworthy are the 76 amphibians, which feature the rare *Nasikabatrachus sahyadrensis*, and 95 reptiles, including coral snakes, "big four" venomous snakes, their mimics, and other elusive species. Additionally, 49 mammals, like the little Indian porpoise, flying squirrels, and spiny dormouse, and 8 avian species are showcased. The museum's collection serves graduate and undergraduate training, species identification workshops, and educational programs by

national, state, and local agencies. Its primary aim is to promote morphology-based taxonomy research and education and to establish KFRI as a reference facility addressing wildlife conservation, endangered species recovery, native fish decline, landscape ecology, biodiversity studies, and participatory science in Kerala. The Wildlife Museum is a vital resource for conservation awareness among wildlife and zoology students and forest department trainees nationwide.

Xylarium

Xylarium is a collection of authenticated wood samples that are well-curated and accessible to the scientific community for research, teaching, environmental education, and other programs. The scientific community can access the well-curated Xylarium, a repository of verified wood specimens. The primary purpose of the Xylarium is to display the wood collections for scientific research, education, environmental awareness campaigns, and other Xylarium programs. Founded in 1979, the KFRI xylarium currently houses 815 specimens in its collection. A total of 154 timbers from Kerala, India, and the rest are obtained on a mutual exchange basis from 14 foreign countries. The collection includes representing from countries like Australia (70), China (55), Canada (41), Germany (34), Japan (53), Philippines (30), Brazil (27), Netherlands (46), United Kingdom (32), Myanmar (22), Portugal (38), United States (72), and, lesser-known timbers of Kerala (91). The database for xylariums contains comprehensive information, including family name, species name, KFRI accession number, original wood specimen number (for specimens obtained from other xylariums), collection date, collector(s) name, common name, trade name, herbarium number of the voucher specimen, country, altitude, latitude, longitude, habit, habitat, various notes, and note on collection or accession. The Xylarium of KFRI has been indexed in the *IAWA Index Xylariorum 4.1 (2016)* - a directory of Institutional Wood Collections from around the World.

REGIONAL CENTRES

Bamboo Technical Support Group - South Zone (BTSG)

The Bamboo Technical Support Group (BTSG) South Zone is hosted at KFRI and supported by the National Bamboo Mission of the Ministry of Agriculture and Cooperation to serve as a unit providing support to the National Bamboo Cell in technical and research matters. BTSG-KFRI has been conducting training programs for field workers in various southern states for the last several years. Our training support includes resource enhancement through propagation technology, establishment and management of plantations, value addition of bamboo produce through preservative treatment and proper utilization for various end uses, advice to farmers and State Bamboo Missions on the suitability of species for different regions and land types, etc. Currently BTSG has the following facilities (1) Bamboo Bazar: For marketing bamboo Products, (2) Bamboo Processing Centre: For working artisans & developing innovative products through training programmes, (3) Bamboo Waste Management Unit: For production of Biochar & Compost, (4) Bamboo Agro-Forestry Trails: For promoting bamboo in homesteads cultivation, (5) Bamboo Nurseries: Production of quality planting materials, (5) Germplasm Collections: Identification of superior genotypes, molecular characterization and establishment of germplasm, (6) Bamboo Edible Shoot Processing Unit: For standardizing and production of value-added products from bamboo shoots and (7) Tissue Culture facility: Standardisation of commercially important species. The BTSG website can be accessed through www.bambooinfo.in. The information pertaining to various aspects of bamboo like morphology, taxonomy, plantation and nursery techniques, harvesting and species database, etc., are available. This also helps to gather the details of bamboo farmers, nurseries, artisans and researchers, etc.

Regional Cum Facilitation Centre - Southern Region (NMPB RCFC-SR)

The Regional cum Facilitation Centre-Southern Region (RCFC-SR), one of the seven RCFCs of the National Medicinal Plants Board (NMPB) was established at KFRI in October 2017 to serve as a one stop shop for all matters related to the medicinal plants in the southern region of India. The RCFC-SR provides technical inputs to stakeholders for enhancing their managerial and technical skills, developing agro-technology of medicinal plants, facilitating production and distribution of quality planting materials (QPMs) apart from providing technical assistance to various organizations for formulating project proposals in the priority areas identified by NMPB, and attending to field assessment/evaluation of NMPB projects and other works assigned by NMPB from time to time. The overall objective is to streamline and

strengthen the activities of NMPB in five states (Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, Telangana) and three Union Territories (Puducherry, Lakshadweep, and Andaman & Nicobar Islands). The activities of the RCFC (SR) are monitored periodically by NMPB. RCFC-SR maintains strong linkages with several government and non-government organizations, and farmers' groups for effective implementation of its activities. Close interactions with Departments of Forest, Agriculture and AYUSH help in implementation of several programmes. For effective implementation of various programmes, RCFC-SR associates with financial agencies such as NABARD and other commercial banks; agencies such as Kerala Forest Development Corporation (KFDC), Kerala State Tribal Welfare Department, Kerala Institute of Local Administration (KILA), Ayurvedic Medicine Manufacturers Organization of India (AMMOI); various Universities and research institutions like Tamil Nadu Agricultural University (TNAU), Centre for Medicinal Plants Research (CMPR) of Arya Vaidya Sala, Kottakkal (AVS), CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP), etc.

During the financial year 2022-23, a total of 7 trainings were organized in different States and UTs of southern region, and 701 farmers were given training in medicinal plants farming and exposure to the activities of NMPB and RCFC (SR). With respect to QPM Network, one of the successful initiatives to facilitate sustainable cultivation, 11 new QPM projects were implemented for production of 5,94,000 QPMs of 34 species of the Medicinal plants in the five southern States. Apart from trainings, 10 seminars/workshops were organized. The RCFC-SR team members also participated as resource persons in 22 seminars/workshops organized by other institutions/agencies. As part of monitoring and evaluation, 19 NMPB projects were monitored in Andhra Pradesh, Karnataka, Kerala, Tamil Nadu and Telangana and the reports were submitted to NMPB. The centre expedited submission of 2 Utilization Certificates by various project implementing agencies to NMPB. Collection of market price from the southern region and its trend analysis for the period April 2022 to March 2023 were carried out. It also assisted 10 stakeholders to establish linkages. A documentary entitled '*Sida:A plant for strength*' was prepared. The Centre to its credit has four scientific papers, an information bulletin and an IEC brochure. During the reporting period, the Centre organized 6 meetings and the team members participated in 25 meetings. Overall, 64 extension works and expert services were taken up, apart from providing inputs to NMPB on Parliament Questions.

GLOBAL NETWORKS

TEAKNET (International Teak Information Network)

TEAKNET continued to foster the exchange of information on teak in 2022-2023 through compilation of teak market information, updation of its website and dissemination through periodic release of the online TEAKNET Bulletin and Newsletters. Four issues of the quarterly electronic Newsletter-TEAKNET Bulletin and six bi-monthly ITTO Teak Mekong Newsletters were published by TEAKNET during the period. TEAKNET organized a side event titled "New opportunities of Teak Sector in the post-COVID Scenario" in Seoul, Republic of Korea on 5 May 2022 alongside FAO's XV World Forestry Congress. During 05 – 08 September 2022, TEAKNET along with Forestry Commission - Ghana, FAO of the United Nations, Rome, The International Union of Forest Research Organizations (IUFRO), Vienna. The International Tropical Timber Organization (ITTO), Japan and private sponsors successfully organized the 4th World Teak Conference in Accra, Ghana. This was the first time that World Teak Conference was held in an African nation. The World Teak Conference focused on the current state of knowledge and future challenges for the sustainable development of the global teak sector in a changing world. Five technical documents on broad topical interests to the teak stakeholders (in English and French) were released during the World Teak Conference.

TreeWatch.net

TreeWatch.net is a global network for monitoring tree hydraulics and carbon sequestration in the context of Climate Change. This is a unique tool to understand hydraulic functioning and growth of trees. Dendrometers and sap flow sensors have the potential to detect stress from individual trees (and subsequently forests) in real-time. At a time, when climate change is posing a serious challenge, Kerala Forest Research Institute (KFRI) and Ghent University, Belgium joined hands to study the consequences of climate change on different forest ecosystems, especially mangroves on the coastal areas of the State. With this, KFRI has become the first and only collaborative institution in this network from outside Europe. https://treewatch.net/in-ashtamudi/

RESEARCH AND EXTENSION

Completed Research Projects

Research Report Number 595

Exploration of medicinal plant resources of Lakshadweep Islands with special reference to indigenous knowledge (Sujanapal P, Pius OL)

Lakshadweep Islands, a unique group of low-lying coral Islands belonging to the Lakshadweep Maldives-Chagos-Archipelago, has different terrain, soil and vegetation from the mainland. Phytogeographically the region belongs to Indo-Pacific realm and administratively Lakshadweep is the smallest Indian territory grouped under three clusters, namely Aminidivi, Laccadive and Minicoy with a total of 24 Islands including 10 inhabited ones. The vegetation here can be broadly categorized into coastal or littoral vegetation, coconut palm dominated habitat, mangrove vegetation and herbaceous foreshore vegetation including sea grasses. Based on the topography and lifeforms, the vegetation can again be classified into foreshore, backshore and inland vegetations. The study registered 454 species of vascular plants encompassing 446 angiosperms, 01 gymnosperm and 07 pteridophytes, which include 211 species of medicinal plants, of which 37 taxa are of high commercial value. Among the flora, the diversity of exotic plants is high. Habit wise analysis indicated that herbs are the dominant group followed by trees. Among the angiosperms, species such as *Hermondia nymphoefolia, Guettarda speciosa, Suriana mortima, Pemphis acidula, Lepturus repens* and *Ochrosia oppositifolia* are recorded for the first time from Indian region. A rare tree, *Pemphis acidula* once reported from the Malabar Coast and now been almost extinct from the region is also recorded. The unique occurrence of *Pleurostylia opposita* and *Asplenium nidus* are also noted. Among 211 medicinal plants, 77 are used for indigenous medicine by the Islanders and 16 are consumed as wild edibles. With regard to medicinal plant diversity, Kavaratti dominates with 148 species followed by Androth with 128 species. However, density is high in uninhabited islands. Since Lakshadweep is a remote island with limited facilities, indigenous people develop unique ethnobotanical formulations, like 'Mutta thilam' a traditional medicine made from 'Egg oil', which is used in the treatment of stroke patients.

Research Report Number 596

Compilation of Indian Forestry Abstracts (IFA) - Phase II (Sarojam N, Hussain KH)

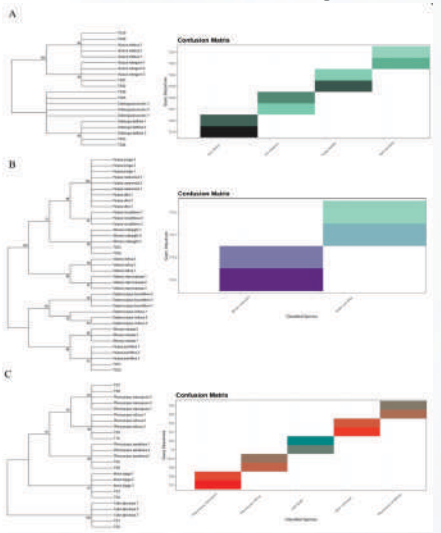
Owing to the absence of a single source or portal on forestry related topics, it is difficult to track the literature published related to forestry by various institutions in India. Researchers mostly depend on the international databases like Commonwealth Agricultural Bureau International (CABI), AGRIS (FAO) and AGRICOLA (USDA) for forestry information. Studies showed that nearly 60 per cent of forestry research in India is not covered by these international databases and hence remain unnoticed broadly. Indian Forestry Abstracts (IFA) is an ambitious initiative, an endeavour to spread Indian forestry research to a wider national and international audience under a common umbrella. IFA is a comprehensive bibliography of current forestry literature published in India, along with an abstract for each citation. No such online abstracting service exists for Indian forestry literature, although international ones are widely consulted. The unique forest types and practices need a country specific listing of research publications to make them more inclusive of Indian forestry, Indian institutions and independent researchers working in India. The purpose of IFA is to compile up-to-date references. Nearly 9600 abstracts have been added in to the database. The database is hosted in a website and is updated periodically and is now available as part of KFRI website to ensure the continuity of services. Website has a very simple interface comparable to google. Search can be carried out through multiple key words.

Research Report Number 597

DNA Barcoding as a promising molecular tool for timber forensics (Suma Arun Dev, Sreekumar VB, Anoop EV)

Extreme difficulties in species identification of illegally sourced wood with conventional tools have accelerated illicit logging activities, leading to the destruction of natural resources in India. In this regard, the first phase of the study primarily focused on developing DNA barcode database for 41 commercial timber tree species which are highly vulnerable to adulteration in south India. The developed DNA

barcode database was validated in the second phase using an integrated approach involving wood anatomical features of traded wood samples collected from south India. Consortium of Barcode of Life (CBOL) recommended barcode gene regions (*rbcL, matK, psbA-trnH* & *ITS*) were employed for developing DNA barcode database. Additionally, we employed artificial intelligence (AI) analytical platform (WEKA) for analysing DNA barcode sequence database which could append precision, speed and accuracy for the entire identification process. Among the four classification (SMO, Jrip, J48, Naïve Bayes) algorithms implemented in the machine learning algorithm (WEKA), best performance was shown by SMO in authenticating unknown traded wood samples. Major advantage of AI is the ability to analyze huge data set with more precision and also provides a large platform for rapid authentication of species, which subsequently reduces human labour and time.



Research Report Number 598

BTSG-Publicity and Extension (Raghu AV, Damodaran TK, Muralidharan EM, Chandrashekara UM, Sarojam N, Raveendran VP, Pillai PKC, Soman CK, Sreekumar VB)

National Bamboo Cell is the prime central agency to implement the project under NBM. To support its activities, Bamboo Technical Support Group (BTSG) has been created in four different zones (south, north, northeast, and west). Kerala Forest Research Institute (KFRI), Peechi, has been approved by the National Steering Committee of the NBM to host BTSG for the South Zone covering Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, Goa and Maharashtra. The corpus of the project being publicity, extension posters/exhibits were prepared for convey the importance of bamboo, uses, seedling production, cultivation methods, suitable species for cultivation, among others.

Research Report Number 599

Phytometabolomic studies in the genus *Embelia* found in Kerala (Raghu AV, Hrideek TK, Muralidharan EM)

*Embelia basaal*Roem.&Schult. *Embelia gardneriana* Wight.

Over the past decade, the application of non-targeted high-throughput metabolomic analysis in biological research has gained momentum as a valuable tool to unveil the biochemical composition in plants. Metabolomics is the science of measuring the pool size of metabolites, which collectively define the metabolome of a biological sample. Plant biologists routinely use comprehensive analyses of plant metabolites to discover responses in line with genetic or environmental perturbations as well as validate initial hypotheses on function and *in vivo* action of gene products. The leaves and fruits of *Embelia* species' have been extensively utilized in Ayurvedic, Homeopathic and modern drug formulations because of the presence of active phytochemical, embelin. Five species of *Embelia* belonging to RET category *viz*., *Embelia ribes* Burm.f., *Embelia tsjeriam-cottam* Roem. & Schult., *Embelia basaal* Roem.& Schult., *Embelia gardneriana* Wight, *Embelia adnata* Bedd. Ex C.B. Clarke are reported from Kerala region of the Western Ghats. A comparative metabolomics of *E. gardneriana* and *E. adnata* is undertaken in the study.

Research Report Number 600

BTSG-Publicity and Extension (Raghu AV)

This project is part of the Annual Action Plan of National Bamboo Mission (NBM), Govt. of India- Bamboo Technical Support Group (BTSG)-South zone with KFRI being approved by the National Steering Committee of the NBM to host BTSG for the South Zone covering Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, Goa and Maharashtra. The project strictly focuses on publicity and extension through posters/exhibits or conveying the importance of bamboo, uses, seedling production, cultivation methods, suitable species for cultivation, among others.

Research Report Number 601

Evaluation of indigenous methods of nursery techniques for medicinal plants (Raghu AV)

Effect of indigenous methods of seed germination on selected medicinal plants, such as, *Embelia ribes, Streospermum colais, Celastrus paniculatus* and *Oroxylum indicum* were studied at Kerala Forest Research Institute, Peechi, during the period 2013-15. Seeds were collected, processed and pre-treated with indigenous organic formulations like panjagavyam, cow dung slurry, cow's urine, cow's milk, and rice water. All the experiments were followed as per ISTA rules. The treated seeds were subjected to germination trials. The results were compared with control where no pre-treatments were given. Among these experiments, cow dung slurry treatment showed a positive response in *E. ribes* and *C. paniculatus*. While, in the other species like *O. indicum* and *S. colais*, water soaking and panjagavyam treatments produced remarkable results. Indigenous treatments resulted in an enhanced seed germination and uniform seedling emergence among the studied species. Therefore, it can be inferred that the traditional Indian practices hold relevance and applicability in seed based propagation methods.

Research Report Number 602

Population ecology of the lion tailed macaque in Silent Valley National Park, its buffer zones and Muthikulam High Value Biodiversity Area (Sreekumar VB, Ramachandran KK, Vijayakumaran Nair P, Suganthasakthivel R)

The status, distribution and population characteristics of the lion-tailed macaque (LTM) (*Macaca silenus*) in Silent Valley and its adjacent areas in the Nilgiri Biosphere Reserve (NBR) studied over the last two decades, indicates the total population of the lion-tailed macaques as over 500 individuals distributed in 30 separate troops. In NBR, the LTM is now present only in the Kerala region of the Biosphere Reserve. Being habitat specialists, the macaques are restricted to canopied wet evergreen forests between the elevation range of 600

to 1500 meters above mean sea level. The present study conducted during the period 2013 to 2016 highlighted that only 300 sq.kms evergreen forests are available for the survival of the macaques in NBR, of which 20 per cent lies in the Kerala region. The Nilgiri meta-population has three subpopulations *viz*., Silent Valley, New Amarambalam and Muthikulam. Among the subpopulations, the Muthikulam subpopulation is completely isolated from the Silent Valley population due to forest cover loss in the Attappady region. The New Amarambalam subpopulation is feebly connected with the Silent Valley subpopulation. There is a need to generate more scientific data about the potential habitats connecting Silent Valley and New Amarambalam Forests and the lion-tailed macaque population. Without proper scientific knowledge and management, very little change in the region may trigger the complete isolation of the New Amarambalam population from the Silent Valley population.

Research Report Number 603

Resolving species complexes using molecular systematics: a case study of few taxa in the Western Ghats (Sreekumar VB, Sujanapal P, Suma Arun Dev)

Molecular systematics, a recent fastest-growing discipline of taxonomy, includes the identification of species by comparison of specific DNA regions and understanding the evolutionary relationships. Identification of species using morphological characteristics alone in angiosperm taxa may be quite challenging, especially in the case of 'species complexes', which show extreme environmental plasticity, homoplasy, among others. The taxa selected were from the genera *Syzygium- Eugenia* complex and high-altitude bamboos (*Arundinaria*). The genus *Arundinaria* includes temperate woody bamboo species found in South Asia, Africa and Madagascar. There are several endemic species of the genus *Arundinaria* in the Western Ghats and the status of this group needs molecular identification to confirm species status. Another species complex is *Syzygium* and *Eugenia* in which several species are morphologically similar and the placement of taxa within each group also needs investigation. In this context, the objectives were to develop a DNA barcodes for the species and to resolve the taxonomic complexities. The study analysed

species discrimination ability of different barcode regions, *rbcL, matK, psbA-trnH, psbK-psbI* and *rpoC* in *Syzygium,* and *trnC-rpoB, rps16-trnQ, trnG- trnT, rpl16, rps16* and *ndhF* in *Arundinaria* using distance-, tree-, and similarity- based methods. This study recommends the use of *matK* as a potential barcode for species discrimination in *Syzygium*. In the tree-based analyses of *Syzygium* and *Eugenia, mat*K gave more resolved topology in which multiple accessions of all species formed well-defined clusters with higher bootstrap support and good posterior probability value and have to be considered as different genera. In the case of high-altitude bamboos, because of these morphological differences and unresolved topology in the phylogenetic tree, relationships among these 6 genera (*Kuruna, Fargesia, Indocalamus, Semiarunideria, Pseudosassa, Arundinaria)* remain unresolved, and more samples and gene regions have to be analyzed to resolve the complexity.

Research Report Number 604

Strengthening of Tissue Culture Lab (Suma Arun Dev, Muralidharan EM)

The Plant Tissue Culture laboratory of the Institute, established two decades ago, necessitated an upgradation of its infrastructure. With the financial support received from National Bamboo Mission (NBM), Govt. of India, the facility has been strengthened to meet the current research targets in the field of Plant Tissue Culture. The laboratory is well equipped with laminar flow, autoclave, electronic balance, refrigerator, vertical deep freezer, centrifuge, microbial hot mixer, PCR Thermal Cycler and nano spectrophotometer (purchased through the project) to undertake and standardise micropropagation protocols in various bamboo species and other forest tree species with reproductive constraints that require a large number of propagules in a limited time span. With this, the facility can perform the genetic fidelity testing which is essentially required in mass micropropagation programs to assess the true-to-type nature of the tissue culture raised plantlets.

Research Report Number 605

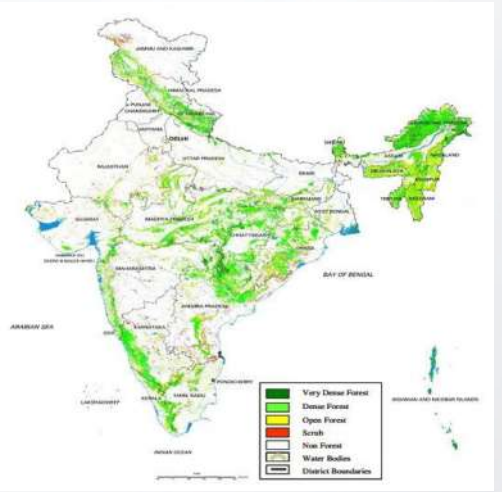
Detection and eradication of giant African snail (*Achatina fulica* Bowdich) in Kerala (Sajeev TV)

The Giant African snail (*Achatina fulica*) is one of the top tropical invasive species listed by the International Union for Conservation of

Nature (IUCN) as one of the world's 100 most invasive species. The snail is a pest to agriculture and a menace in human habitation. It was a major problem in Konni, Pathanamthitta district in Kerala in 2010. The problem was filed in Ombudsman Court and was handed over to KFRI for studying the issue. This project was undertaken in the above context to detect the snail infested sites in the state and to control the population. Detection of snail infested sites was made possible through interactions facilitated by the media. A total of 110 infested sites were recorded from the state of Kerala for the period 2011-2014. Maxent model was run using the presence localities in order to locate potential distribution of the snails in the State. Ernakulum District had the highest potential distribution while Idukki had the least. Public and local governing bodies were alerted about the suspected sources. Posters and notices were sent to the localities which fall under high and medium risk of infestation and also to places which were presently infested. Pathways for the spread of *A. fulica* were detected and measures were taken to control the spread by notifying the concerned authorities and giving awareness to the public. The technical support was given to the infested panchayats for the control of the snail. Screening for best lethally active molluscicides was done by testing both chemical and plant extracts. Tobacco Decoction Copper Sulphate (TDCS) mixture was found to be efficient in killing the snail with least environmental impacts. This mixture has been recommended for use all over the state and is currently being practiced in many places.

Research Report Number 606

Preparation of protocols for availing carbon finance from forests of Kerala (Sajeev TV)

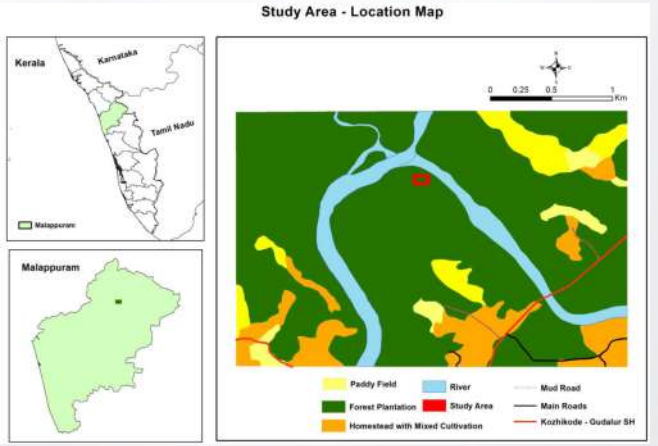


Unequivocal scientific evidence shows that, since the industrial revolution, the burning of fossil fuels and the destruction of forests have caused the concentrations of heat-trapping greenhouse gases to increase significantly in our atmosphere, at a speed and magnitude much greater than natural fluctuations would dictate. If concentrations of greenhouse gases in the atmosphere continue to increase, the average temperature at the Earth's surface could grow from 1.8 to 4 °C by the end of this century. Protecting forests can both mitigate climate change and secure the ecosystem services, people depend on. Forest play a pertinent role in the carbon cycle as trees

absorb carbon dioxide from the atmosphere during photosynthesis and, in the process of growing, transform it to the solid carbon that makes up their bark, wood, leaves and roots. When trees are cut down and burned or left to decompose, the solid carbon chemically changes back to carbon dioxide gas and returns to the atmosphere. In the case of timber harvesting, only a fraction of the harvested trees makes it into long-term wood products, such as, houses, chairs and tables. As much as 20 per cent of usable timber volume that was extracted from a typical hectare was never removed and instead left to rot in the forest. Furthermore, less than 35 per cent of the timber that made it to the sawmill was actually converted into usable boards. Hence, the majority of the forest vegetation ends up as waste, and whether burned or left to decay, emits carbon dioxide gas as it breaks down. It is estimated that forests and other terrestrial systems annually absorb approximately 2.6 gigatons of carbon (GtC), or 9.53 gigatons of carbon dioxide equivalent ($GtCO_2e$), while deforestation and degradation of forests emit approximately 1.6 GtC (5.87 $GtCO_2e$), for net absorption of 1GtC (3.67 $GtCO_2e$). Forests therefore play an important role in carbon cycle. The global carbon cycle act as both a "sink" and a "source" (emitting carbon dioxide). The 1.6GtC emitted by deforestation and degradation of forests accounts for 17.4 per cent of total emissions from all sectors, more than the emissions of the entire global transportation sector. Thus, policy and economic incentives to curb deforestation and forest damage have the potential to enhance the natural functioning of the world's forests in sequestering, or storing, carbon and to reduce their role as a source of emissions.

Research Report Number 607

Demonstrating the effect of controlling teak defoliator on volume increment in teak in the Permanent Plot established at Nilambur (Sajeev TV)



Two permanent demonstration plots of half a hectare each of teak plantation were established in 1993 at Panayamgode, Nilambur North Forest Division. This is in order to get the exact and unsurpassed estimate about the benefits of control measures against *Hyblaea puera* attack on teak plantation. While routine management practices were adopted in both the plots, teak trees of one of the plantations were protected by pesticide application while those in the other plot were left unprotected. In the current report, the tree measurement data collected during the period 1994 - 2013 were analysed. Tree height, GBH, tree stocking and

tree forking of the two plots were analysed to get the accurate figures. Tree height was measured by using Suunto Optical Reading Clinometer. It is used to measure a point's degree from horizontal and a surface slope in per cent or slope angle. Girth at Breast Height (GBH) was calculated using a measuring tape at 1.37 meters above, from the ground. Tree forking and broken tree in the unprotected plot is 9.8 per cent, while it is 2.4 per cent in protected plot. Tree survival is 6 per cent more in protected land compare to the unprotected area. At the end of the experiment period, an average additional increment of 3.3 cm in GBH and 1.5 m in height is attained by the trees in the protected land. The analysis concluded that protecting teak trees from *Hyblaea* attack is worthwhile when considering and comparing the quality and quantity of teak wood from protected and unprotected plots.

Research Report Number 608

Development of a farming system based cyber extension model for the state of Kerala (Sujanapal P)

While notable changes are observed in all developmental sectors, agriculture sector is still lagging behind in viable farmer friendly and cost effective technologies. A computer based knowledge processing systems with updations can connect rural farmers with the far placed experts and thus resolve their queries. Development of such extension methods team up with cell phones and media can also act as a training tool. An extension tool with perspectives of individual disciplines like Plant Pathology, Entomology, Horticulture, Plant Breeding, Farm Management, etc. was designed utilizing the data of field problems of each crops and enterprises. Research group with an expert from each discipline prepared the fact sheets and finalized through a 5-tier validation. Software was developed with 16 major modules, such as, Crop technology bank (with 9 modules of field crops, cash crops, spice crops, vegetable crops, flower crops, fruit crops, medicinal plants, tuber crops and tree crops), Veterinary guide (with 9 dimensions - breeds, rearing, feeding, housing, breeding, health care, products, institutions and programmes), Online clinic (includes pesticide calculator, water calculator, economic calculator), and other services (like soil health card, contact an expert, etc.), Agribusiness window (opens the entrepreneurship side of agriculture), Knowledge bank (covers topics and concepts of recent origin), Market advisor takes care of various aspects of agricultural marketing), Extension desk (protects information on various extension related topics together with credit and insurance) and Extension resource library (protected with login facility form a place for keeping materials for extension workers). The components of information and decision supporting system includes variety selector, fertilizer advisor, irrigation advisor, pest doctor, pesticide calculator, economic analyzer, market analyst, product gallery, management guide and credit manager. As it is a team work of diverse experts from various

institutions, the work on the botany and phytogeography of the selected crops has been entrusted to KFRI and the report contains the details of 140 fruit crops, 53 spice crops, 110 vegetable crops, 444 medicinal crops and 633 garden plants, which were incorporated in the software.

Research Report Number 609

Spatial distribution and invasive dynamics of invasive alien weed, *Mimosa diplotricha* in the Kerala part of Western Ghats (Sajeev TV, Sankaran KV)

Invasive Alien Species (IAS) is a significant component of human caused global environmental change, second only to habitat destruction. Invasion by IAS results in economic loss to the tune of US$ 1.4 trillion annually, close to 5 per cent of the global GDP. The growing human population and the ever increasing transcontinental travel and transport have increased the scales of movement of non- indigenous organisms and the chances of invasion. The major invasive plants in India include *Chromolaena odorata* (L.) King & H. Rob., *Lantana camara* L., *Parthenium hysterophorus* L., *Mimosa diplotricha* C. Wright var. *diploticha Sauvalle* and *Mikania micrantha* Kunth. Of the major invasive alien plants recorded from India, the *Mimosa diplotricha* var. *Diplotricha* is a recent occurrence. Thorny mimosa is a menace to agriculture systems, forest plantations, natural forests, and wetlands. Thick growth of mimosa prevents the regeneration, reproduction and growth of indigenous species in all infested areas. In Kerala, it is a major menace in the fringes of natural forests, agricultural systems, plantations, homestead gardens, open areas, disturbed sites, along road sides and railway tracks. The study covered the distribution of mimosa – district wise, altitude wise, and habitat-wise. The results highlighted Idukki and Palakkad districts as having the highest percentage of infestation, Malappuram, Kollam, Thrissur and Kozhikode districts having over 20 per cent infestation and Thiruvananthapuram, Kasaragod and other districts with over 10 per cent infestation. Idukki and Palakkad districts had diverse elevation regimes of heavy infestations. The study has further assessed the impact of the IAS, identified and documented natural enemies of *Mimosa diplotricha* in native and exotic ranges and discusses as to whether taxonomical isolation causes invasiveness in exotic range and enemy release hypothesis on invasiveness.

Research Report Number 610

Tree flora of Kerala (Sujanapal P)

Trees are the pillars of the Earth's ecosystem and they have a pivotal role in stabilising life on the planet earth. Identification of trees in tropical forests has always been a challenge. The enormous height of the trees, inconspicuous flowers, short flowering period, etc. make the task highly difficult. One of the 'weaknesses' of conventional plant taxonomy is the excess use of technical terms in the identification of keys and description of species, which makes the floras useful only to the Botanists. Computer aided multi-entry identification keys (TREE ID *version 2.0*) are very convenient than any conventional flora/dichotomous keys and are useful for an array of end users from various stakes to those who are not familiar with botanical jargons. *TreeID version 2.0* is a menu driven user-friendly computer aided tree identification multi-entry program based exclusively on field and vegetative characters. This menu-driven software provides interactive key characters through illustrations and photographs, make the mission easy for botanists and non-botanists as well. Quality photographs of various parts of the plants provide chances for the users for final verification. Among the 5460 flowering plants of Kerala, 827 are trees. Of these, 291 are endemic to India. Recent studies showed that 111 species of trees are under various threat categories of IUCN. The populations of many of the critically endangered trees are extremely low and known only by a few individuals. Tree flora of Kerala is also rich in exotics and around 180 species are under this category. Many of the palms attain the habit of trees and are literarily known as tree palms. Apart from serving as a computer aided identification software, extraction of all the related information of a particular plant is also possible through this software and thus it heralds a new era in resource management and conservation.

Research Report Number 611

Handbook on mangroves and mangroves associates of Kerala (Sujanapal P)

Mangroves are the rainforests by the sea and their origin trace back to 114 million years ago. The origin of the word 'mangrove' from 'mangue' and 'grove' dates back to 1613 and obscurely connected with Senegalese, Portuguese and English. World over, the mangroves cover about 14 million hectares in the coastal areas of tropics and subtropics. Indo-Malaysian region is considered as the cradle of evolution of the mangroves. The Sunderbans, sprawled over India and Bangladesh form the single largest block of mangroves in the world. Over the past few decades, the mangrove area has drastically diminished globally due to a variety of anthropogenic activities. In India, the total area of mangroves is estimated to be 6,740 sq. km, which is about seven per cent of the world's mangrove area. Indian

mangroves can be broadly divided into East coast deltaic, comprising 80 per cent and the rest the West-coast non-deltaic scattered from Kutch to Kerala. A recent estimate shows that the mangroves in Kerala is restricted to 25.05 sq. km, of which 53.35 per cent is under private ownership. Though the remaining land is owned by Government, its existence is in dilemma due to developmental activities. It is observed that the alteration of land for developmental activities along coastal regions of Kerala have gained a greater momentum in the recent years, since they fall within the hotspots of industry, commerce, population, farming, tourism, etc. Projections and scenarios indicate that there will be a sharp decline in mangroves area within a very short time span. Therefore, urgent measures have to be taken up to protect these habitats which otherwise would jeopardize the biodiversity and coastal ecosystem. Strict adherence to the existing rules and wide awareness programmes are the immediate steps towards their conservation.

Research Report Number 612

Exploration of medicinal plant resources of Panju islands of Maharashtra (Sujanapal P, Pius OL)

Panju islands consist of three islands with one inhabited and the other two uninhabited in the Vasai creek and form one of the important mangrove ecosystems in the region. The two uninhabited islands were found to be fully covered with mangroves and the inhabited islands have a mix of mangrove and other vegetation. Mangroves play a significant role in safeguarding and maintaining the ecological balance of Mumbai by acting as a bio-shield around this metropolitan city. Major mangrove species in the islands are *Avicennia marina, Ceriops togal* and *Bruguiera gymnorrhiza.* As part of the medicinal plants resource survey, detailed floristic exploration was carried out in these islands during 2016-17. Along with medicinal plant documentation, unique indigenous knowledge was also recorded as it is important for resource utilisation and holistic development of these islands. The floristic exploration resulted in the documentation of 214 species of vascular plants. Out of 214 species, 96 are medicinal plants. Ethnobotanical information on 32 species was also collected during the study. As the younger generation is engaged in other activities in the islands and the nearby city, the knowledge is fast draining from the community. Many species recorded from the islands are used in classical medical systems like Ayurveda, Unani and Siddha. *Salvadora persica* is a commercially high demanding species common in the area. A taxonomic assessment revealed that Fabaceae is the dominant family followed by Euphorbiaceae. Herbs are dominant in habit groups, followed by trees, shrubs and climbers. Among the 18 true mangroves in south India, 11 species were reported from the area. As the area holds higher density and diversity of true mangroves and mangrove associates, the conservation of these unique groups of plants is important to protect the area from natural calamities.

Research Report Number 613

Establishment of herbal gardens in selected 100 schools of Palakkad and Malappuram districts of Kerala (Sujanapal P, Pandalai RC, Raghu AV, Raveendran VP)

A herbal garden reflects the long-standing tradition of conservation and rich heritage in our time-honoured health care and livelihood. It is contradictory that the demand of medicinal plants is increasing day by day and at the same time the traditions and culture associated with them are fast disappearing. Establishing a medicinal plant garden is an opportunity for conserving this valuable asset while spreading the knowledge. Medicinal plant garden in schools is of prime importance, since it imparts knowledge and awareness among younger generation along with a pleasant and healthy atmosphere in campus. A systematic approach was followed for the fulfilment of the objective to establish medicinal plants garden in the 100 schools of Palakkad and Malappuram districts of Kerala.

Research Report Number 614

Rehabilitation of two industrially important endangered species *Santalum album* (Chandanam) and *Saraca asoca* (Asokam) in homesteads of Palakkad and Malappuram districts of Kerala (Sujanapal P)

Santalum album (Chandanam), a small to medium-sized semi-root parasitic tree, which is commonly known as sandal and is a highly priced wood all over the world. Though the species is widely distributed in India, they are mainly concentrated in dry forests and habitats of Kerala, Karnataka and Tamil Nadu. Marayoor forest in Kerala is considered as the potential seed source of high quality sandalwood. Seeds were collected from the plus trees of sandal from Marayoor forests during March-April. Collected seeds were processed and classified in KFRI Seed Centre. After pre-sowing treatment, seeds were sown in vermiculate. Seeds sprouted after 15 days (60 % germination) and these seedlings (50 % survival) were transplanted to polythene bags after one month. Since fungal infestation is higher in sandal, prophylactic treatments were carried out time to time. By following a systematic approach, a total of 60,000 Sandal seedlings were raised in the Central Nursery of KFRI and distributed to the beneficiaries in Palakkad and Malappuram districts. *Saraca asoca* (Asokam) is an evergreen tree and a highly threatened medicinal plant of ornamental value. International Union for Conservation of Nature and Natural resources has red-listed this species under threatened category. Due to overexploitation, the species is almost extinct from our natural habitat. In south India, the populations exist in homesteads, temples, garden, etc. and planted populations are there in some forest area. The highly recalcitrant nature of seeds makes it difficult for long term storage. Therefore, asokam seeds were collected

from public on payment basis and ensured their involvement through advertisement in dailies. During the period, around 3000 kg of Asokam seeds were collected. These seeds were directly sown into specially prepared nursery beds and dibbled to polybags for getting seedlings. Though the seeds are recalcitrant with hypogeal germination, 80-90 per cent germination was observed. A total of 75,000 seedlings were raised in the Central Nursery of KFRI and distributed to beneficiaries in Palakkad and Malappuram districts.

With the collaboration of State Medicinal Plants Board, brochures of selected species were prepared for distribution. Seedlings were distributed through various Schools, NGOs, Clubs and various other government departments. As part of the School Herbal Harden programme, 100 schools were selected in Palakkad and Malappuram districts and around 50 schools were selected for seedling distribution based on their request. Their performance in school herbal garden programme was also considered during the selection. Number of seedlings ranging from 100-500 were distributed to each school at the ratio of one seedling per student in special functions.

Research Report Number 615

Assessment of medicinal plant resources of northern Kerala (Sujanapal P, Sivaram M)

The assessment of medicinal plant resources of Northern Kerala covered seven districts of Kasaragod, Kannur, Wayanad, Kozhikode, Malappuram, Palakkad and Thrissur. The study looked into (i) the growing stock of medicinal plants, especially commercially important, Rare and Threatened species (ii) analyzed the density, distribution and regeneration status of medicinal plants, and (iii) prepared a comprehensive database and accession retrieval system for the medicinal plant resources available for developing suitable strategies for resource enhancements, measuring extractivism, conservation, etc. All the above has been published as a comprehensive district-wise seven voluminous reports for further reference and policy intervention. The district level report depicts district specific highlights pertaining to medicinal plants, identified commercially important annuals that are potential inter crops, species suitable for large scale cultivation, aesthetic enhancement, habitat conservation, proper management of agro-ecosystems & scientific land use pattern, linkages with Ayurveda industries and conserving of the natural population.

Research Report Number 616

Large scale restoration of *Dysoxylum malabaricum* Bedd ex Hietn and *Coscinium fenestratum* colebr, two endangered and important medicinal plants of the Western Ghats (Sujanapal P)

Owing to its location, Kerala State occupies the most biodiversity rich areas in the Western Ghats. This region is the centre of endemic, rare and threatened species. Many of these species are commercially high demanding and exploited for various purposes. Endemic species *Dysoxylum malabaricum* and *Coscinium fenestratum* are two commercially high demanding and highly threatened medicinal plants with restricted distribution in a few patches of evergreen forests in the entire Western Ghats region. *D. malabaricum*, the Indian White Cedar, is a Red Listed habitat specific endemic tree widely used in Ayurvedic preparations. Habitat loss, low occurrence of reproductive individuals, a high degree of inflorescence predation, premature fruit abscission, high-level seed infestation, habitat specificity and recalcitrance cause its rarity. The other species *C. fenestratum,* a slow-growing dioecious woody climber restricted to evergreen forests, become endangered mainly due to habitat destruction and overexploitation. The other threats faced by the species is the reduction in mature individuals of both sexes before attaining reproductive stage, premature fruit abscission, high level of dormancy, poor regeneration, etc. Population survey showed that Sholayar forest areas in Vazhachal Forest Division, Orukomban areas in Parambikulam Tiger Reserve are the major localities of *C. fenestratum*, while *D. malabaricum* follows a sporadic distribution pattern in a few patches of evergreen forests in Kottiyur Reserve forests, Periya forests, Vazhachal forests, Parambikulam forests, Neryamangalam forests, Goodrical reserves, etc. Population survey showed that the population of *C. fenestratum* is seriously declined and only 45 mature female individuals could be located during the study. The total number of mature individuals including males are around 107. Seeds are orthodox type with an average 45 per cent germination in GA3 treatment. Due to its extreme rarity, vegetative propagation was attempted but the survival was very poor. A total of 41,500 healthy seedlings of *D. malabaricum* were outplanted in Manjaviruthupara and Thammanpara forest areas of Vazhachal forest range and 10,500 healthy seedlings of *C. fenestratum* were outplanted in Shoringal forest areas in Sholayar forest range. Frequent monitoring and evaluation revealed 90 per cent survival rate for *C. fenestratum* while *D. malabaricum* showed only 40 per cent of survival rate, mainly due to grazing by deer.

Research Report Number 617

Studies on pattern of usage of pesticides and their impact on the ecosystem of plantation and adjacent areas in GEF-Munnar landscape project area (Jayaraj R, Sandeep S)

The primary focus of the project was to understand the land use pattern and assess the soil and water quality in the GEF – Munnar landscape spanning over eleven Grama Panchayaths in Idukki, Ernakulam and Thrissur districts. The existing land use pattern covered

forest lands (59.50 %) followed by tea plantations (9.96 %), mixed crops (8.70 %), cardamom plantations (6.23 %), eucalyptus plantations (3.24 %), waterbodies (2.86 %), teak plantations (2.32 %), sandalwood plantations (1.98 %), rubber plantation (1.42 %), bamboo plantations (1.16 %), built-up land (0.95 %), forest settlement (0.90 %), seasonal crops (0.49 %), sugarcane plantation (0.16 %), oil palm plantations (0.097 %) and cashew plantations (0.009 %). Soil (248 samples), water (248 samples) and tissues (5 samples) were collected from the study area for quality assessments. The texture of soil was found to fall under three types: sandy loam, loamy sand and sandy clay loam. The soil reaction varied from moderate to strongly acidic and had moderate to high amounts of organic carbon (> 0.75 %). The highest organic carbon was observed in eucalypts plantations (6.42± 1.14 %) followed by natural forests (4.48± 0.65 %), while sugarcane plantations had the lowest organic carbon percentage (1.33± 0.21 %). In general, the soils were low to medium in available nitrogen, high in available phosphorus and medium to low in available potassium. With respect to the secondary nutrients, the soils were medium in available magnesium and low in available calcium and sulphur. The soils had adequate amounts of micronutrients and were devoid of any heavy metals. Water quality assessments indicated that the dissolved oxygen (DO) levels were stable in all plantations and forest areas, except in seasonal crops cultivated areas of Kanthalloor. Total hardness and total dissolved solids were within permissible limits in all the analyzed samples. However, irrespective of land uses, the turbidity levels were higher than the acceptable levels (>1 NTU) and all the water samples were found contaminated with coliforms. The high concentrations of particulate matter in the water bodies of the region may affect their light penetration, ecological productivity, recreational values, and habitat qualities. Pesticide residues were not detected in any of the analyzed soil, water or tissue matrices collected from the region. The study recorded 64 amphibians and reptiles from the region which included 33 species of amphibians belonging to 9 families and 15 genera and 31 species of reptiles belonging to 11 families and 24 genera. Among the identified species, 7 are categorized as threatened by IUCN and ~ 85% of the amphibians and ~ 45% of reptiles recorded species were endemic to the Western Ghats. The study indicated that the region has a rich forest cover with ample floral and faunal diversities and moderate to

high soil fertility and water quality. The area was found to have no heavy metal or pesticide pollution.

Research Report Number 618

Socioeconomic assessment of workers at Kerala Forest Development Corporation plantations - Gavi Division (Anitha V)

The study has been an attempt to study the socioeconomic conditions with respect to vulnerability and poverty levels of the resident workers of Gavi Division that comes under the eco-tourism project of the Kerala Forest Development Corporation located in Pathanamthitta District, Kerala. The study used a sustainable livelihoods framework that provided a structure for poverty analysis, as an effort to conceptualize livelihoods in a holistic way, capturing the complexities of livelihoods and coupling them with the constraints and opportunities they are subjected to. It has linked the socioeconomic and ecological considerations in a cohesive, policy-relevant structure and acted as a powerful tool for identifying the key drivers of poverty, and the potential interrupters that provided pathways out of poverty. As people-centric, it has considered the assets (pentagon-human, social, natural, physical and financial) that poor people needed in order to sustain an adequate income to live. The study largely depended on socioeconomic assessment, livelihood potential, vulnerability assessment based on exposure, sensitivity and adaptive capacity indices and multidimensional poverty approach based on both incidence and intensity of poverty. The Multidimensional Poverty Index (MPI) of 0.031 reveals that the community is deprived in just 3 per cent of the total potential deprivation. However, despite this low MPI score, they are not having a good quality/standard of life. They suffer from lack of education, poor infrastructural and housing facilities, lack of sanitation, unclean and scarce drinking water and little medical facilities. The Community Based Vulnerability Index of 2.63 indicated high levels of poverty. Among the three Settlements, Kochupamba (2.84) is in the most miserable condition, followed by Meenar (2.64), whereas, Gavi was the least vulnerable (2.39). However, all the three settlements can be classified as having high levels of susceptibility to poverty. They are exposed and sensitive to wild animal conflicts, changing weather patterns, unclean drinking water and sanitation facilities, climate change related factors, growth of invasive alien plant species and reduced cardamom production and low wages. Adaptive capacity is observed to be low despite the existence of Kudumbasree and other local social groups. Lack of women

empowerment and the poor internet facilities along with less transportation services have rendered them with less scope of socio-economic development. These issues can be addressed by means of providing sustainable infrastructural facilities, and through programmes like financial and digital awareness campaigns, women empowerment initiatives, skill based workshops for youth, and other vocational training schemes for the residents with focus on social development.

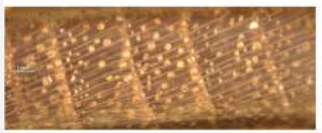
Research Report Number 619

Impact of climate change on growth dynamics of tropical tree species in the Western Ghats region as evidenced from dendroecological studies (Thulasidas PK)

In this study, the tree-ring width chronology of teak was tested against the rainfall and temperature to understand the impact of climatic events on tree growth in the tropical Moist Deciduous Forests of the Southern Western Ghats region of Kerala. As part of the objectives of the project, a tree-ring measuring station was established in the Wood Science laboratory of KFRI. Teak (*Tectona grandis* L.f.) is the candidate species selected for the tree-ring studies as it produces dated growth rings to the exact calendar year of growth. Altogether eleven tree-ring sites were selected and studied. These study locations include 5 natural teak forests and nearby 6 silviculturally managed teak plantations of harvestable age (altogether 11 sites). Among the 05 natural teak tree-ring chronologies, Parambikulam (PKMN) has the longest tree-ring index (273 years), which is from AD 1742 to 2014 followed by Nilambur (NBRN) (236 years) spanning AD 1779 to 2014. Natural teak in all the five stations shows consistently narrow ring-width indicating slow growth of trees irrespective of adequate rainfall received. The raw ring-width data and tree-ring index of teak from 11 locations clearly showed the initial fast growth of teak as evidenced by wider rings upto 20 -25 years of growth irrespective of natural or plantations. The study on the influence of temperature and rainfall on tree-growth clearly showed that ring–with pattern (growth rate) for 114 years (1901-2014) did not show any declining trend. In fact, the growth remains stable (RWI >1) for teak plantations in the state of Kerala in consistent with temperature and rainfall. Growth of teak being stable for the past 114 years, the same pattern of growth is anticipated in future climate changes; hence developing an aggregate climate model for long-term prediction was


Extraction of increment cores of natural teak at BH level by using increment borer


Increment cores in wooden groves with its transverse axis up for view of ring boundaries


Growth-ring of teak: macro image

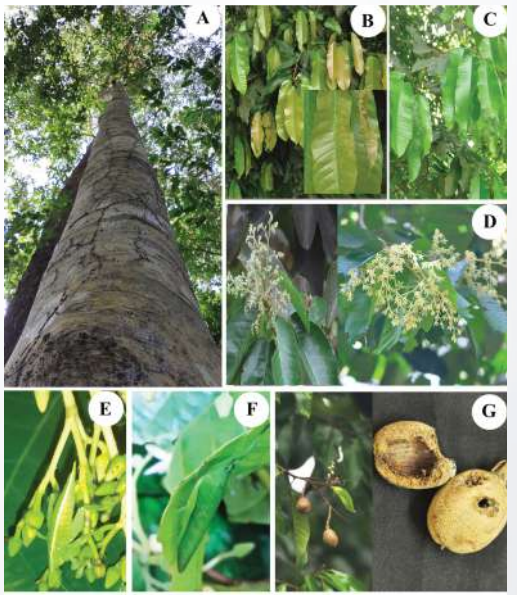

Polished Teakwood disc from managed plantation for ring-width measurement

not attempted. The impact of climate change, especially rainfall and temperature do not have any deleterious effect on the productivity of teak plantations in the State of Kerala as per the present study; influence of other ecological disturbance factors does not come under the purview of the present study.

Research Report Number 620

Population dynamics of selected endemic and threatened trees in the protected areas of Kerala: Temporal analysis in the context of climate change (Jose PA, Sreejith KA)

The study addresses population dynamics covering phenology, reproductive biology and biotic interactions of ten endemic and threatened trees, namely, *Canarium strictum, Dysoxylum malabaricum Garcinia cambogioides var cambogioides* (Syn. *Garcinia morella*), *Gluta travancorica, Knema attenuata, Myristica malabarica. Myristica beddomei, Ochreinauclea missionis, Persea macrantha* and *Vateria indica* which were studied during the period 1995-2003. This was taken as past data for the present study (2019-2022) on a comparable level and was studied at two Protected Areas (PAs), Shendurney and Peechi- Vazhani Wildlife Sanctuary of Kerala in order to understand the effect of climate change on functional dynamics of targeted species. The phenology calendar prepared for each species indicated considerable variation from the past data in the form of advancement, delay or extended phenophases. The high intensity rainfall in short durations during 2018 and 2019 caused abnormal flowering in *Ochreinauelea missionis* during September, instead of the consistent flowering in March-April. Similarly, *Myristica beddome, Myristica malabarica* and *Krema attenuata* distributed in evergreen to montane forests, displayed 2-3 months of advanced flowering. Delayed and extended flowering behaviour as an adaptation to facilitate natural regeneration in the onset of South West monsoon was observed in *Gluta travancorica*. The advanced flowering of *Persea macrantha* in moist deciduous ecosystems is linked with the increase in atmospheric temperature. The temporal reproductive biological analysis revealed extended stigma receptivity period along with increase in pollen count among *G. travancorica, G. campogioides, K. attenuata, M. beddomei, C. strictum*, *D. malabaricum, O. missionis, P. macrantha* and *V. indica.* The flower opening & anthesis of *G*



V. indica: A. habit; B&C. stages of flushing; D. stages of flowering; E&F. flower predators; G. fruiting phenology/ damaged fruits.

travancorica, G. campogioides, M. malabarica, K. attenuata and *M. beddomei* indicated a change in time from night & early mornings to day time. Fruit/seed predators were observed in *Canarium strictum, Dysoxylum malabaricum, Knema attenuata, Ochreinauclea missionis* and *Persea macrantha* and insect pests during fruit phenology in *Dysoxylum malabaricum*. The change in population dynamics and subsequent adaptive strategies being evolved could be treated as a part of resilience of the target species towards climate change.

Research Report Number 621

Bamboo shoot processing facility (Jayaraj R, Muralidharan EM)

The study assessed the nutritional and anti-nutritional levels in ten bamboo species comprising industrially important as well as ornamental bamboos grown in Kerala to judge their potential as a sustainable food source. The species' evaluated include *Bambusa balcooa* Roxb., *Bambusa bambos* (L.) Voss, *Bambusa vulgaris* Schrad (green and yellow), *Bambusa wamin* E.G. Camus (Buddha bamboo), *Cephalostachyum pergracile* Munro, *Dendrocalamus giganteus* Munro, *Dendrocalamus strictus* (Roxb.) Nees, *Gigantochloa atroviolacea* Widjaja (Black bamboo) and *Gigantochloa manggong* Widjaja. The key nutritional parameters, moisture, ash, carbohydrate, protein, fat, fiber, vitamin C and total cyanogen content (TCC) were analyzed. *D. strictus,* and two ornamental species - *B. vulgaris* and *G. atroviolacea* - were found to be rich in protein, fibre and Vitamin C that could be used as a good food source in terms of nutrition. In these species, shoots after 14 days of emergence recorded maximum outturn (74 %) and minimum wastage. The distribution of Total Cyanogen Content (TCC) was found to vary within shoots itself. Among the species studied, the highest content was found in the apex region and lowest at the basal portion of the fresh shoots. Appropriate selection of species and judicious harvest of emerging shoots at correct stage can maximize outturn of edible portion in harvested shoots, which would help cultivators to make it a commercial venture. The shoot processing facility was established with the required basic infrastructure including boiling pans, dicers, induction cooker, pressure cooker, fumigation chamber, cabinet dryers, vacuum freeze dryer and Fourier Transform Infrared spectroscope (FT-IR). Preparation of two value added products *i.e.,* (i) bamboo shoot flakes and (ii) bamboo shoot powder from different bamboo species - was standardized at

the facility. In addition, training was imparted on preparation of local cuisines with bamboo shoots to the participants of Green Skill Development Programme (GSDP) of the Ministry of Environment Forests & Climate Change, Govt. of India. The established facility is now functional for use by different stakeholders.

Research Report Number 622

Evaluation of *Ochlandra* germplasm mass propagation and field trials of elites (Thulasidas PK, Muralidharan EM, Pandalai RC)

The reed bamboos (*Ochlandra* spp.) of commercial importance to pulp, paper and cottage industries are known to occur in the forests throughout the Western Ghats region in India. In an earlier project sponsored by CSIR-NIMITLI, reed bamboo populations of low lignin/higher cellulose, more suitable for pulp industry, were identified from reed brakes in forests of Kerala and the accessions are maintained in the KFRI field germplasm collection in the Field Research Centre at Palappilly. Multi-locational clonal evaluation of the elites were conducted to evaluate the stability of the measured wood properties to environmental conditions. In 2012, a field trial plot was established in the KFRI Field Station at Kottappara in Malayattoor Forest Division, Ernakulam District in a one-hectare area with rhizome offsets and culm cuttings. However, after 07 months of establishment, wild elephants raided and damaged the well-established plot, which was finally abandoned. At the same time, new areas in the Western Ghats were also surveyed for locating additional *Ochlandra* populations of low lignin/high cellulose plant materials. The major finding of the present study is that the chemical properties of low lignin/high cellulose content reported earlier could not be ascertained in the present study as the same property varies and lignin was reported above average in all the accessions studied with average value of 22 per cent and cellulose 65 per cent as against the earlier reported average value of 19 per cent for lignin and 72 per cent high cellulose. *Ochlandra* germplasm established at FRC Palappilly was utilized to study the culm production pattern for maintenance of clump for optimum harvest. The culm production varies from year to year consistent with the rainfall pattern. The quality of culm deteriorated after two years of age, gradually dried out in the clump. It is therefore recommended to carry out selective harvesting of reeds before 3 years retaining a proportion (¼ of the total number) of immature ones to maintain minimum number of culms in the clump. Once

harvested, subsequent harvesting of culms can be carried out in alternate years as and when the culm matures for better clump management as observed in the present study.

Research Report Number 623

Evaluation of *Ochlandra* germplasm, mass propagation and field trials of elites-Phase II (Thulasidas PK, Muralidharan EM)

The present study evaluated morphological as well as fibre characteristics and variation in lignin/cellulose and silica content in the culms of elite *Ochlandra* accessions from the field trials established by KFRI at the Hindustan Newsprint Limited factory site at Velloor, Kottayam as part of a collaborative study on reed bamboos for selecting elite accessions of low lignin/high cellulose content for eco-friendly good quality paper production. The study examined the feasibility of early prediction of physico-chemical characteristics of the *Ochlandra* suitable for pulp and paper industry, from the field trial established. A total of 15 accessions of *Ochlandra travancorica* from the field trial plot were harvested at the age of 3, 6, 12 and 24 months to study anatomical and physico-chemical properties. Kraft pulping trial was also conducted. Clonal propagation through micro and macropropagation was attempted to produce large-scale planting materials for plantation establishment. Vegetative propagation using culm cuttings and hormone application gave poor results. Micropropagation was also attempted as an alternative clonal propagation method but latent endophytic fungal contamination and poor rooting of shoots were a major constraints to producing plants. The pulping trial of 1 year and 3 month-old samples did not show any significant differences with regard to the bulk and basic densities and the values were closer to the normal reeds. For effective clump management and effective silvicultural management of *Ochlandra*, selective harvesting of culms aged 2 years may be carried out for pulp and paper production retaining ¼ of the older culms in the clump for sustaining growth. Subsequent harvesting may be permitted in alternative years without causing damage to the newly emerging culms. The field trial study revealed that the lignin/cellulose and silica content vary with age, location and climate and the property is not environmentally stable to be recommended for large-scale mass multiplication of selected accessions. The lignin/cellulose and silica content of culm samples of the same age indicated that these properties are unstable and changes with environmental factors like locality, rainfall and soil.

Research Report Number 624

Wildlife friendly and organic certification for cash crop plantations of Kerala Forest Development Corporation (Balakrishnan P, Jayaraj R)

Organic and wildlife-friendly farming systems in both agriculture and plantation sectors are known to support more biodiversity than their conventional counterparts. Such systems are key for the conservation of several species outside forests. However, the productivity in such systems are comparatively less than the intensively managed systems. To compensate such losses, selling the products at higher prices after obtaining the organic and wildlife-friendly certifications is a common practice globally. The Cardamom and coffee plantations of Kerala Forest Development Corporation (KFDC) located at Gavi, contiguous to the Periyar Tiger Reserve is a biodiversity rich area, and has the potential to receive these certifications because of the organic and wildlife-friendly management practices. The study carried out during the period from October 2021 to March 2022, identified and mapped the potential wildlife habitats and found that plantations interspersed among natural vegetation are rich in native wildlife. The study recorded 18 mammal species, 109 birds, 20 reptiles, 31 amphibians, 58 butterflies, 51 moth species and 29 odonates. There are no pesticide residues reported from the soil and water samples analysed. The chemical profile of the area is healthy and on par with the existing standards. The study also analysed potential threats (plastic and waste disposal) to wildlife in the area, road kills, deadwood collection, spread of invasive alien species, human-wildlife interactions, stakeholder knowledge and perspectives on wildlife, and suggested mitigation measures to make the area more wildlife-friendly. The study highlights that the plantations of KFDC Gavi Division are well qualified for the organic and wildlife-friendly certifications and thereby contribute to the conservation of the biodiversity of area along with the development of the local community.

Research Report Number 625

Participatory NTFP yielding medicinal plants resource enhancement: Capacity building through protocols for propagation, enrichment planting and management practices of ten high demanding medicinal plants of the Western Ghats, Kerala (Jose PA, Sujanapal P, DFO Vazhachal)

The unscientific harvest of NTFP-yielding medicinal plants has led to the dwindling of populations in their natural habitat. The decline of these species largely caused population reduction and affected the day-to-day lives of tribal communities. The corpus of the study aimed to enrich the available resources of selected target species *viz. Canarium strictum, Cinnamomum verum, Garcinia gummi-gulla* var. *gummi-gulta, Gmelina arborea, Hydrocarpa pentandrus, Oroxylum indicum, Machilus glaucescens, Sapindus trifoliate, Spondias pinnata, Symplocos acuminata,* after developing vegetative and seed propagation protocols, large-scale multiplication and planting of seedlings on a participatory approach with the Tribal Vana Samrakshana Samithi (VSS) members as the primary beneficiaries. The vegetative propagation protocols of each species through stem rooting and air layering methods were standardized along with the effect of auxins and control sets at nursery conditions. Seed protocols including initial moisture content, critical moisture content, seed category, seed pre-treatments for early and improved germination and ideal storage practices were developed for each species. Altogether 19,000 established polybagged seedlings of target species were produced and planted in four forest ranges of Vazhachal Forest Division, Kerala, namely, Charpa, Vazhachal, Sholayar and Kollathirumed by the tribal VSS members. The post-planting maintenance including casualty planting and seedling survival monitoring was also carried out along with the stakeholders and recorded a survival performance of 36 per cent after the first two years of planting. One day of hands-on training was imparted on sustainable harvesting of NTFP yielding trees, that included vegetative and seed propagation methods, plant production, field planting, and monitoring to forty-four VSS members of Vazhachal Forest Division as part of awareness and conservation of sustainable management of NTFP resources. A training brochure in the Malayalam language titled *Thadiyithara vanavibhava sasyangalude prafanana margangalum susthira upayoga reethikalum pariseelana paripadi* was prepared and circulated among the participants. The seedling germplasm of the target species was deposited at ICAR-NBPGR Regional Station. Vellanikkara, Thrissur and IC Nos. of each target species obtained from the NBPGR, New Delhi.

Research Report Number 626

Scientific support to an Interpretation Centre on shola grassland ecosystem at KFDC, Vagamon (Sreejith KA)

In Kerala, typical shola forests (elevation above 1800 m MSL) are found only in Eravikulam National Park, Shola National Park and Silent Valley National Park. The shola grassland ecosystem mosaic consists of rolling grasslands with shola fragments restricted to sheltered folds and valleys in the mountains separated from the grasslands. The forest is made up of evergreen native trees which are dwarf and the hill slopes are covered with native grass species. This shola-grassland ecosystem is well known for its rich biodiversity and high levels of endemism and it also acts as a source of water for people in the mountains and plains. Due to being geographically restricted, these habitats are among the ecosystems that are most vulnerable to global change agents, such as, habitat destruction, climate change and species invasion. It is important to understand the ecological significance of these ecosystems not only due to the unique biodiversity they possess but also by the hydrological service they provide in terms of protecting the headwaters of rivers. The proposed Interpretation Centre (IC) will help acknowledge and create awareness on the importance and significance of the shola-grassland ecosystem to a wider general public. The IC needs to be scientifically structured in order to effectively convey the ecological significance of these ecosystems. The current study aimed to provide scientific support for the IC on the shola-grassland ecosystem at KFDC Vagamon. The study thus: (a) reviewed and documented the existing literature available on the shola grassland ecosystem of the Western Ghats to date, (b) combined information on various aspects of the shola grassland ecosystem to contribute to the IC, and (c) inventoried the proposed location for the IC to document the biodiversity and mapped the location in order to suggest the suitable location for its construction. Accordingly, recommendations were provided for the proposed shola Interpretation Centre.

Research Report Number 627

Evaluating carbon sinks of selected Kerala Forest Development Corporation plantations for availing carbon credits (Sandeep S)

Carbon credits are components of national and international attempts to mitigate the ever increasing concentration of atmospheric greenhouse gases (GHGs). The carbon stored in *Tectona grandis* and *Acacia mangium* plantations of Marottichal, Mannamangalam Range, Thrissur maintained by KFDC was estimated following standard protocols. The carbon storage was estimated with respect to five pools namely, above ground biomass, below ground biomass, dead wood, litter and soil carbon. The teak and acacia plantations of Marottichal was formerly a *Eucalyptus* plantation. During 2008, 10 ha land was converted to teak plantation. Later during 2009 and 2010, additionally 11.02 and 13.54 ha were converted to teak plantation.

During 2014, 20 ha of *Eucalyptus* plantation was replanted with *Acacia mangium*. Leakage emissions in this case was taken as zero as no displacement of agricultural land, secondary emissions or displacement of animals or cattle was found at these sites. The soil carbon was observed to be gradually decreasing down the soil profile. The maximum soil carbon were found in surface layers. The teak plantations were found to store 93.91 t C ha^{-1} in the 2008 plantations, 106.8 t C ha^{-1} in the 2009 plantations and 91.5 t C ha^{-1} in the 2010 plantations encompassing the different pools. The carbon storage in the *Acacia* plantation was estimated to be 90.03 t C ha^{-1}.

Research Report Number 628

Establishment of a Herbal Garden as a peri-urban green space of Nilambur, Malappuram District, Kerala (Sujanapal P, Chandrashekara UM)

It is estimated that over 75 per cent of the world population relies mainly on plants and plant extracts for health care. Furthermore, over 40 per cent of the entire plant species are being used for medicinal purposes. Of the 2,50,000 higher plant species on earth, more than 80,000 are medicinal. In India, about 7,000 species are used for their medicinal values by traditional communities. For instance, the State of Kerala has a rich tradition in Ayurveda and traditional health practices. The State consumes a large quantity of medicinal plants and most of which are obtained from the wild. Over the years, the availability of medicinal plants is getting diminished due to excessive extraction from their natural habitats. Besides medicinal uses, several plants have cultural and ecological values. However, these plants have become rare due to land conversion for various purposes. Further, peoples' knowledge on medicinal plants and plants used in rituals is very poor, especially in the younger generation. Therefore, conservation of medicinal plants as well as the associated traditional knowledge is imperative. In this background, an Institutional Herbal Garden has been established in the KFRI Sub Centre, Nilambur (76° 15 28 E longitude and 11° 18 14 N latitude) for *ex-situ* conservation and awareness creation of medicinal plants and its traditional usages.

Research Report Number 629

Characterization and quality assessment of bark/gum of alternative species for Jiggat production (Jayaraj R, Sreekumar VB)

India is one of the largest incense stick producing countries which has both domestic and foreign markets. Incense sticks play an important role in many of the religious rituals, customs and beliefs worldwide. The key raw materials used for making incense sticks include, binding material (jiggat), sawdust, charcoal and bamboo sticks. In incense stick industry, pulverized bark of the plant, jiggat (*Litsea*

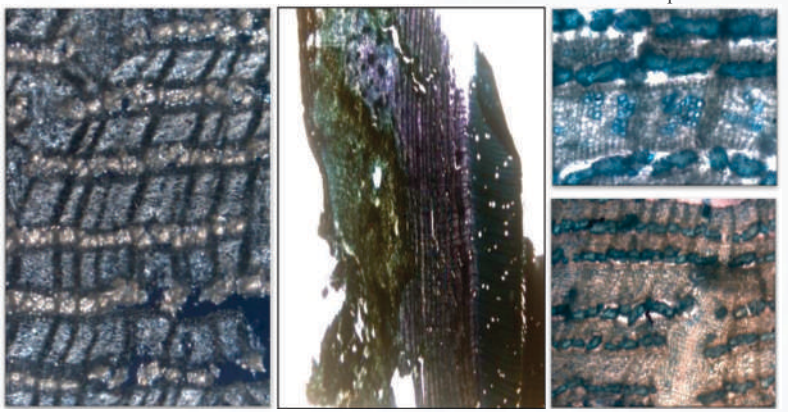
glutinosa) (Lour.) C.B.Rob, is currently being used for binding matrix preparation, wherein the bark powder acts as an adhesive used to make the ignitable matrix on the stick. As this jiggat producing plant species is under threat due to overexploitation, there is a need to search for alternate plant species for substituting *L. glutinosa* and to reduce the extraction pressure on jiggat producing plant species. The present study evaluated the adhesive nature of bark from 22 different resin or gum producing plant species looking for an alternate source for jiggat. In the initial analysis, the physicochemical parameters - moisture content, ash content, pH content, solubility, sulfated ash, acid-insoluble ash and water soluble ash were studied to understand the basic nature of bark powders. The bark powders of these plants were used for making incense sticks and cones following standard procedures using charcoal, sawdust and bark powders. Among the plants evaluated, *Litsea deccanensis* Gamble, *Grewna tilufolia* Vahl. and *Bombax ceiba* L. were found to be most promising for making incense sticks. As an alternative to the wood sawdust and charcoal, we have used bamboo sawdust and bamboo charcoal. Perfect incense sticks and cones were prepared out of the bark powders of *L. deccanensis*, *G. tilufolia* and *B. ceiba*, when used as adhesive material along with bamboo sawdust and bamboo charcoal. The physicochemical studies of the three selected species were carried out. Burning time of incense sticks prepared out of these adhesive materials was significantly higher and carbon monoxide production was lower than that available in the market. Among the 22 species evaluated, bark powder of *L. deccanensis, G. tilufolia* and *B. ceiba* was found to be ideal as an adhesive material for the preparation of binding matrix in incense stick making and could be used as alternative for *L. glutinosa.*

Research Report Number 630

Investigating growth impact of *Epipremnum pinnatum* cv. *aureum* on host trees: A case study in *Tectona grandis* at KFRI Peechi campus.

(Jose PA, Shambhu Kumar)

The impact of epiphyte, *Epipremnum aureum* (money plant) growth on *Tectona grandis*, growing in the campus of Kerala Forest Research Institute, Peechi was studied. Total of 894 host trees were assessed, of which dominant interaction was noted among reproductive individuals having GBH ranging from 100-200 cm. About 39 per cent of interactions were recorded in the premises of germplasm collection/garden areas indicating the increased soil moisture availability which favoured epiphytic growth. Anatomically, sclerification of cells, cells without



cytoplasm, deactivation of phloem cells adjacent to the cambium and irregular patterns of meristematic cells along with high crystal deposition proved bark damage of the host trees owing to this interaction. A decrease in the moisture and macronutrient contents in the soil of host trees points towards the absorption/sharing of the same by the epiphyte. The *in vitro* culture of seeds in the aerial root extract of the epiphyte showed retardation of seedling growth, indicating an allelopathic effect of the epiphyte. Additionally, a latent pathogenic endophyte was isolated from the trailing aerial roots of the epiphyte. The pathogen was morpho-molecularly identified as *Aspergillus pulvericola*, producing mycotoxin (Ochratoxin), which may cause negative impact on the host. Thus, the cumulative effects of these multiple negative factors of the epiphyte adversely impacted the health of teak trees. Complete mechanical removal of the epiphyte from the teak trees could be the best practice to overcome the adverse effect on host. Though the present study revealed negative effects of the epiphyte on the growth of teak trees, further studies need to be taken up for understanding the impact of the epiphyte on the health of other host trees.

ONGOING RESEARCH PROJECTS

PROJECTS FUNDED BY INTERNATIONAL AGENCIES

(Title, Principal Invetigator, Funding agency)

1. Development of management protocols for restoring degraded forests in Vazhachal – Parambikulam CFR area using native plant species and NTFPs., Dr. TV Sajeev, World Wide Fund for Nature India
2. Services for (i) developing training materials and (ii) identification of forest pest and disease specimens to support the strengthening of the institutional capacity on forest health in Myanmar., Dr. TV Sajeev, Food and Agriculture Organization of the United Nations

PROJECTS FUNDED BY NATIONAL AGENCIES

(Title, Principal Investigator, Funding agency)

1. Network project on conservation of lac insect genetic resources, Dr. TV Sajeev, Ministry of Agriculture, Govt. of India
2. Establishment of a Herbal Garden as a peri-urban green space of Nilambur, Malappuram District, Kerala, Dr. P Sujanapal, National Medicinal Plants Board, Govt. of India
3. Demographic survey and restoration of two endangered variants of '*Daruharidra*', *Berberis tinctoria Lesch*. and *Coscinium fenestratum* (*Gaertn*.) *Colebr*. in Western Ghats., Dr. P Sujanapal, National Medicinal Plants Board, Govt. of India
4. Biodiversity characterization at community level in India using Earth observation data, Dr. KA Sreejith, Department of Biotechnology, Ministry of Science & Technology, Govt. of India
5. *Ex-situ* conservation of threatened and endemic species and spreading conservation education and awareness through improvement of infrastructural facilities in the Bioresources Nature Trail Botanical Garden of KFRI Sub Centre, Nilambur, Dr. GE Mallikarjuna Swamy, Ministry of Environment, Forest and Climate Change, Govt. of India

6. Participatory NTFP yielding medicinal plants resource enhancement: Capacity building through protocols for propagation, enrichment planting and management practices of ten high demanding medicinal plants of Western Ghats, Kerala, Dr. PA Jose, National Medicinal Plants Board, Govt. of India

7. Genome wide and geospatial approaches for enhancing the adaptive potential of threatened rattan resources in India, Dr. Suma Arun Dev, Department of Biotechnology, Ministry of Science & Technology, Govt. of India

8. Assessment of adaptive genetic diversity in teak and sandalwood to guide conservation and genetic improvement efforts, Dr. Suma Arun Dev, Department of Biotechnology, Ministry of Science & Technology, Govt. of India

9. Studies on diversity, distribution and morpho molecular taxonomy of foliicolous hyphomycetous fungi of Peechi Vazhani Wildlife Sanctuary Kerala, Dr. Shambhu Kumar, Science and Engineering Research Board, Department of Science & Technology, Ministry of Science & Technology, Govt. of India

10. Conservation, improvement, management and promotion of Sandalwood (*Santalum album* Linn.) cultivation in India (AICRP-3)., Dr. Suma Arun Dev, CAMPA-ICFRE, Govt. of India.

11. Establishment of a Medicinal Plant Seed Centre cum Seed Museum at Kerala Forest Research Institute, Peechi, Thrissur, Kerala., Dr. P Sujanapal, National Medicinal Plants Board, Govt. of India

12. Tropical ecosystem vulnerability to the changing climate: An ecophysiological study from Forests of Southern Western Ghats., Dr. KA Sreejith, Science and Engineering Research Board, Department of Science & Technology, Ministry of Science & Technology, Govt. of India

13. Molecular systematics, geospatial modelling and conservation of the genus *Terminalia* L. in India., Dr. VB Sreekumar, Science and Engineering Research Board, Department of Science & Technology, Ministry of Science & Technology, Govt. of India

14. ISRO Geosphere Biosphere Programme (IGBP) - 'Modelling Forest Phenological Parameters from Time Series Remote Sensing Data., Dr.K.A. Sreejith , ISRO Geosphere Biosphere Programme (IGBP), Govt. of India.

15. Developing organo-lime nanocomposites on graphene microstructures extracted from humic acids, Dr. S Sandeep, Department of

Biotechnology, Ministry of Science & Technology, Govt. of India.

16. Long Term Ecological Observatories (LTEO)- Monitoring forest structure and dynamics in relation to climate change across different biogeographic Zones in India (Kerala part), Dr. KA Sreejith, Ministry of Environment, Forest and Climate Change, Govt. of India.

17. Biogeography, phylogenetic studies and development of e-monograph for the Arthoniales (lichenized fungi) in India., Dr. Siljo Joseph, Department of Science and Technology - INSPIRE Research Grant, Govt. of India.

18. Kannadipaya special bamboo weaved mat product- scientific, technical and marketing interventions for tribal empowerment. Dr. AV Raghu, SEED, Department of Science and Technology, Govt. of India.

PROJECTS FUNDED BY STATE AGENCIES

(Title, Principal Invetigator, Funding agency)

1. Genetic improvement of selected tree species- phase I: plus tree selection, standardization of the propagation techniques, establishment of seed orchard and clonal hedge garden, Dr. AV Raghu, Kerala Forest and Wildlife Department, Govt. of Kerala

2. Evaluation of selected clones of teak through multisite testing to identify site specific clones for large scale plantation, Dr. M Amruth, Kerala Forest and Wildlife Department, Govt. of Kerala

3. Developing a conservatory of palms and bamboos in the proposed Zoological Park at Puthur, Thrissur., Dr. VB Sreekumar, Thrissur Zoological Park Wildlife Conservation & Research Centre

4. Reassessing insect assemblage after three decades to decipher climate change induced impact in southern Western Ghats., Dr. TV Sajeev, Directorate of Environment and Climate Change, Govt. of Kerala

5. Medicinal plants- on call Help Centre and Farm Library (An SMPB, Kerala initiative), Dr. AV Raghu, State Medicinal Plant Board, Govt. of Kerala

6. Production of organic manure from weeds and organic wastes, Dr. Sandeep S, Kerala Forest and Wildlife Department, Govt. of Kerala

7. Scoping study to develop people-inclusive livelihood-based governance strategy for the long-term conservation of mangrove forests of Kerala., Dr. S Sandeep, Kerala Forest and Wildlife Department, Govt. of Kerala

8. Triparty action plan for the reintroduction of Red plants of Kerala, Dr. PA Jose, Kerala Forest and Wildlife Department, Govt. of Kerala

9. Monitoring eco-restored sites at Chembikunnu in Wadakkanchery Range., Dr. S Sandeep, Kerala Forest and Wildlife Department, Govt. of Kerala.

10. Land tenurial assessment of mangrove forests in Malappuram and Ernakulam districts, Kerala., Dr. V. Anitha, Directorate of Environment & Climate Change, Govt. of Kerala

11. Otters outside protected areas: population assessment & conflict mitigation through stake holder participation, Dr. P. Balakrishnan, Kerala Forests & Wildlife Department, Govt. of Kerala

12. Demand & Supply of teak resources in Kerala, Dr. V. Anitha, Kerala Forests & Wildlife Department, Govt. of Kerala

13. Identification and database development of dye-yielding plants in Kerala with emphasis on natural food colourants, Dr. Deepu Sivadas, Kerala State Biodiversity Board, Govt. of Kerala

PROJECTS FUNDED BY KFRI PLAN GRANTS

1. Evaluation of clonal teak plantations with particular reference to growth and wood properties, Dr. AV Raghu

2. Establishment of Nodal Centre of Alien Invasive Species research and management, Dr. TV Sajeev

3. Studies of the effect of elicitors and precursor feeding on *in vitro* production of secondary metabolites and plant growth in *Oroxylum indicum*, Dr. AV Raghu

4. Sophisticated analytical instrumentation facility, Dr. R Jayaraj

5. Development of protocol for rapid detection of *Ganoderma* disease in plantations and agro-ecosystems of Kerala, Dr. GE Mallikarjuna Swamy

6. Assessing landslide vulnerablility of forest systems in Kerala and developing restorstion protocols, Dr. Sandeep S
7. Diversity and dynamics of a tropical forest ecosystem in Southern Western Ghats in the context of changing climate, Dr. KA Sreejith
8. Sclaing up of protocol *in vitro* tuberization for production of quality planting material of two tuber yielding medicinal plants and promotion of organic home-stead farming as an income generation opportunity for rural women in Kerala (Phase I), Dr. AV Raghu
9. Developing long term monitoring tools and strategies for mitigating human-wildlife conflicts in Kerala (Phase I), Dr. P Balakrishnan
10. Standardization of vegetative propagation techniques of selected bamboo species and its field performance evaluation in different agro climatic region of Kerala- Phase- I, Dr. VB Sreekumar
11. Genetic improvement of teak- phase II: locating plus trees, establishment of clonal multiplication area and clonal evaluation trials., Dr. AV Raghu
12. National Children's Science Congress (NCSC) assessing goals' impacts after 25 years in Kerala, Dr. AV Raghu
13. Identification of gender specific SNPs in *Coscinium fenestratum* through comparative transcriptomics, Dr. Suma Arun Dev
14. Community structure, habitat associations and conservation of bats along the land-use gradients in Kerala in the context of climate change and emerging zoonotic diseases., Dr. P Balakrishnan
15. Kanadipaya (special bamboo weaved mat product) - studies on physio-chemical and microstructure properties of special Bamboos used in weaving by tribal communities in Idukki District, Kerala, Dr. AV Raghu
16. Ecological studies on post restoration success of threatened plants *in situ*., Dr. PA Jose
17. Diversity and seasonal variation of fresh water algae in the selected water bodies of degraded and non-degraded evergreen forests of Kerala, Dr. VB Sreekumar

18. Assessment of socio-economic and cultural uses and potential for popularisation of *Dendrocalamus stocksii* and *Munrochloa ritchiei*, two bamboo species endemic to the Western Ghats., Dr. M Amruth

19. Establishment and maintenance of the Centre for Citizen Science & Biodiversity Informatics, Dr. P. Balakrishnan

20. Micro plastics and phthalate esters in urban water bodies occurrence, distribution and seasonal variation in selected urban areas of Kerala, Dr. R Jayaraj

21. Synthesis, characterization and analysis of activated spherical carbon derived from lignocellulosic biomass, Dr. R Jayaraj

22. Diversity and distribution of Myxomycetes in a tropical wet evergreen forest ecosystem and their response to climate change, Dr. K A. Sreejith

23. Development of eDNA technology for detecting faunal invasion and modelling of biological invasion in aquatic ecosystem of Kerala., Dr. TV Sajeev

24. Tourist-lion- tailed macaque interface in Nelliampathy hills and its implication on conservation and management (Phase 1), Dr. R. Suganthasakthivel

25. Standardization of preservative treatment process for selected economically important bamboo species of Kerala, Dr. Shweta B Kukreti

26. Carbon stocks and soil organic carbon saturation deficit under different forest types of Kerala., Dr. P Badole Shrikant

27. Transcriptome, methylome and small RNA analysis to identify chronological age of flowering in bamboos, Dr. Suma Arun Dev

28. Screening and evaluation of potential microbes from different ecosystems of Kerala for the management of major soil borne forest pathogens, Dr. Shambhu Kumar

DETAILS OF ONGOING EXTENSION PROGRAMMES

(Title, Principal Investigator, Funding agency)

1. Regional-cum-facilitation Centre for sustainable development of medical plants (Southern Region), Dr. P Sujanapal, NMPB,

Ministry of Ayush, Govt. of India

2. Design and conduct of forestry training programmes, Dr. AV Raghu, KFRI Plan Grants
3. Design and conduct of Extrain & Outreach Programmes, Dr. KV Mohammed Kunhi, KFRI Plan Grants
4. Forestry extension and conservation education programmes, Dr. AV Raghu, KFRI Plan Grants
5. Establishment of a block bamboo plantation at Kozhikode Dermatology hospital campus., Dr. Muhammed Kunhi, Kerala State Bamboo Mission
6. Urban forestry interventions to mitigate heat islands in Kochi, Kerala., Dr. TV Sajeev, India Resources Trust, New Delhi
7. Registration of kanadipaya (special bamboo weaved mat product) for Geographical Indication tag, Dr. AV Raghu, KFRI Plan Grants
8. Production and supply of quality seedlings of selected medicinal plants., Dr. AV Raghu, State Medicinal Plants Board, Govt. of Kerala
9. Video documentation and production of a short video on the activities of Kerala State Council for Science Technology and Environment (KSCSTE) and its R & D Centers, Dr. AV Raghu, KSCSTE
10. Upscaling of *in vitro* plantlet production facility at Kuzhur for teak and selected species of bamboos, Dr. Suma Arun Dev, Kerala Biotechnology Commission (KBC), Govt. of Kerala
11. Maintenance of butterfly garden at KFRI campus and establishment of new gardens in schools, Dr. TV Sajeev, KFRI Plan Grants
12. Long Term Ecological Observatories (LTEO)-Field Station (Kerala part), Dr. K. A. Sreejith, MoEF&CC (Ministry of Environment, Forest and Climate Change), Govt. of India
13. Green Kerala Initiative: Restoring IUCN Red- listed Tree Species and Ecosystems of Kerala., Dr. P A Jose, Kerala State Council for Science, Technology and Environment (KSCSTE).
14. 35th Kerala Science Congress., Director, Kerala State Council for Science, Technology and Environment (KSCSTE)

15. Establishment of insectarium and insect model systems with special focus on tropical forestry, Dr. Jithu U Krishnan, KFRI Plan Grants

DETAILS OF ONGOING CONSULTANCY PROJECTS

1. DNA testing of wood samples, Dr. Suma Arun Dev, Police Inspector Meenangady Police Station (Meenangady Cr.319/21)
2. DNA testing of wood samples, Dr. Suma Arun Dev, Police Inspector Meenangady Police Station (Meenangady Cr.400/21)
3. Services for laboratory maintenance of Ambrosia beetles and response study over suitable material for automobile fuel pipes, Dr. T V Sajeev, Hyundai

DETAILS OF ESTABLISHMENT AND MAINTENANCE PROJECTS

SUB-CENTRES, FIELD RESEARCH CENTRE & FIELD RESEARCH STATIONS

1. Maintenance of Forest Seed Processing Unit, Dr. P Sujanapal
2. Bamboo Processing Centre, Dr.VB Sreekumar
3. Maintenance of Field Research station at Devikulam, Dr. KA Sreejith
4. Maintenance of Field Research Station, Kottapara, Ernakulam, Dr. AV Raghu
5. Field Research Centre (FRC), Palappilly-Eco Tourism and Conservation Awareness Programmes, Dr. AV Raghu
6. Maintenance of Malakkapara Field Station, Dr. KA Sreejith

FACILITATION OF RESEARCH, ADMINISTRATION & ACADEMICS

7. Tree Health Help Line, Dr.TV Sajeev
8. LAN, Internet and Website, Dr. P Balakrishnan
9. Research Monitoring and evaluation Unit, Research Coordinator
10. Digital Archiving of Administration Records and Multimedia Services for Public Relations, Registrar

11. Strengthening and Capacity Building in Administration, Registrar
12. Mathrubasha-Facilitating/ Strengthening the Application of Mathrubasha (Malayalam) in Office Use, Registrar
13. Research Management, Registrar/ Research Coordinator
14. Updation of KFRI library Portal, George K.F
15. Academic Coordination Cell, Dr. V Anitha
16. Journal of Bamboo and Rattan, Dr. S Sandeep
17. Compilation of Indian Forestry Abstracts (IFA) Phase III, Dr. KF George
18. Enhancing the KSCSTE-KFRI scientific community's academic identity and research impact through the Indian Research Information Network System, Mr. VR Arun

FACILITIES

19. Maintenance of Compost and Biochar production, Dr. S Sandeep
20. Maintenance of Plant Tissue Culture Facility, Peechi, Dr. Suma Arun Dev
21. Establishment and Maintenance of Weather Observatories in KFRI Campuses, Dr. KA Sreejith
22. Maintaining Permanent Plots-Phase II, Dr. KA Sreejith
23. Maintenance and upscaling of *in vitro* plantlet production facility at Kuzhur, Dr. Donald James

COLLECTIONS & NURSERIES

24. Maintenance and Enrichment of Microbial Collection, Dr. GEM Swamy
25. Maintenance of Herbarium, Dr. VB Sreekumar
26. Enrichment of insect collection, Dr. TV Sajeev

27. Enriching of live collections of Orchid and Ferns, Dr. CK Adarsh
28. Enrichment and maintenance of Medicinal Plants Garden at Peechi Campus, Dr. PA Jose
29. Maintenance of Palmetum & Arboretum, Dr. VB Sreekumar
30. Maintenance of Bamboo Nursery, Dr. V. B. Sreekumar
31. Maintenance of live collections at FRC Palapilli, Dr. VB Sreekumar
32. Strengthening and enriching Institute Central Nursey , Dr. P Sujanapal
33. Commercial Nursery-Palappilly, Dr. AV Raghu
34. Monitoring of Teak Experimental plots, Clonal Multiplication Area (CMA) and production of superior clonal plants, Dr. AV Raghu
35. Establishment of germplasm of two commercially important bamboo species –*Dendrocalamus stcoksii* and *Psuedoxytenanthera ritchei* in Kerala for cultivation and promotion at Sub centre., Dr. GE Mallikarjuna Swamy

MUSEUMS, BIORESOURCE NATURE PARK & GARDENS

36. Maintenance of Wildlife Museum, Dr. P Balakrishnan
37. Maintenance of Soil Museum, Dr. S Sandeep
38. Maintenance and enrichment of Bio-Resources Nature Park, Dr. GE Mallikarjuna Swamy
39. Campus Garden Development, Dr. PA Jose
40. Maintenance of KFRI Xylarium and Wood Museum, Dr. VB Sreekumar

TRAINING PROGRAMMES

1. **GSDP-Certificate Course on Propagation & Management of Bamboo**
   Duration : 16 March to 27 April 2022.
   Funding agency : Ministry of Environment, Forest and Climate Change (MoEFCC), Govt of India

2. **GSDP-Certificate Course on Value addition & Marketing of NTFPs (Plant Origin)-Bamboo Craft**
   Duration : 16 March to 25 May 2022.
   Funding agency : Ministry of Environment, Forest and Climate Change (MoEFCC), Govt of India

3. **One-day training programme on "Oushadhasasyangal- Krishiparipalanavum Vilaveduppum" (Medicinal plants: Cultivation and harvesting)**
   Duration : 25th April 2022
   Funding agency : State Medicinal Plant Board (SMPB), Kerala

4. **National workshop on Herpetology**
   Duration : 6- 8, May 2022
   Funding agency : Aranyakam Nature Foundation

5. **Awareness training program on conservation and management of mangroves at Payyannur Municipality**
   Duration : 21st June 2022
   Funding agency : Payyannur Municipality

6. **Awareness training program on conservation and management of mangroves at Kasargode Municipality**
   Duration : 22nd June 2022
   Funding agency : Kasargode Municipality

7. **Voluntary Certification of Medicinal Plants Produce- One Day Workshop on GAP for Collectors and Consultants**
   Duration : 2nd September-2022
   Funding agency : Quality Council of India in collaboration with KSCSTE-KFRI and State Medicinal Plant Board (SMPB), Kerala

8. **Training Programme on Mangrove Conservation and Propagation for the staff of the Social Forestry Wing of the Kerala Forest Department**
   Duration : 22nd September 2022.
   Funding agency : Kerala Forests and Wildlife Department

9. **One-week Compulsory Training Course for IFS Officers on Conservation and development of Medicinal Plants and benefit sharing with Local Communities**
   Duration : 17-21 October 2022,
   Funding agency : Ministry of Environment, Forest and Climate Change (MoEFCC), Govt of India

10. **Hands-on-Training – 'Fundamentals of GIS and Remote Sensing'**
    Duration : 3 – 7 January, 2023
    Funding agency : KFRI (Self sustainable mode)

11. **Hands-on – Training on '"Tools and Techniques used to understand the climate change response of plants" for 170 students from IIT, Palakkad**
    Duration : January 14-15, 2023
    Funding agency : KFRI (Self sustainable mode)

12. **One Week Orientation Training Programme for the Newly Recruited Managers of the KFDC**
    Duration : 16th – 20th January 2023
    Funding agency : Kerala Forest Development Corporation (KFDC)

13. **Training cum Exposure visit on Cultivation of Medicinal Plants, Utilization of Harvest, Value Action and Marketing for farmers from Odisha**
    Duration : 22-26 February 2023
    Funding agency : State Medicinal Plant Board (SMPB), Odisha

14. **Training Course on Bamboo Processing, Product Development, and Entrepreneurship Skill Development for SCST Population**
    Duration : 24 Jan to 08 Feb 2023
    Funding agency : Kerala State Council for Science, Technology and Environment (KSCSTE)

15. **Internship Training Programme in Analytical Instrumentation**
Duration : 3 Months (3 Batches)
Funding agency : KFRI (Self sustainable mode)

SEMINARS / WEBINARS ORGANIZED

1. Talk on "Human-Animal Interactions in India", by Dr. A.J.T. Johnsingh, Former Dean, Wildlife Institute of India on Dec 12, 2022.
2. Talk on "Wildlife Conservation in India", by Dr. A.J.T. Johnsingh, Former Dean, Wildlife Institute of India on Dec 12, 2022.
3. Talk on World Soil Day by Dr. Kunhamu T K, Professor, Kerala Agricultural University on 5 December 2022.
4. Pararaksha - First Aid training for KFRI office staff on Emergency Situations by Sri. Basheer, Daya Hospital, Thrissur – 3 Parts - 8 Nov 2022, 29 Nov 2022 and 3 Dec 2022.
5. Kadarivu – Knowledge and Experience on the Forests of Kerala. Invited Talk by Sri. A.O. Sunny (Rtd ACF) Kerala Forest and Wildlife Dept on 24 Nov 2022.

ENDOWMENT AWARDS

Dr. C. Chandrasekharan Memorial Endowment award

The 12th Dr. C. Chandarasekharan Memorial award of the year 2021 was awarded to Mrs. Divya Soman, Ph.D. at KFRI in a function held on 13th September 2022 coincided with the death anniversary of Dr. C. Chandrasekharan. The Memorial lecture titled 'Challenges in management and conservation of forests in Kerala' was delivered by Sri. P.K. Kesavan IFS, Principal Chief Conservator of Forests & Head Forest Force, (Rtd.), Kerala Forest and Wildlife Department, Thiruvananthapuram.

WEBSITES OF KFRI

- KSCSTE – Kerala Forest Research Institute - www.kfri.res.in
- Indian Forestry Abstracts - ifa.kfri.res.in
- RET Plants - retplants.kfri.res.in
- Invasive Alien Species Nodal Centre - iasnodalcentre.kfri.res.in
- Invasive plants - invasiveplants.kfri.res.in
- Centre for Citizen Science & Biodiversity Informatics- ccsbi.kfri.res.in
- i-STED-KFRI Bamboo/Cane Entrepreneurship Development Programme - bamboo-cane.kfri.res.in
- Centre for Analytical Instrumentation – Kerala (CAI-K)- www.caik.res.in
- Journal of Bamboo and Rattan - www.jbronline.org
- KFRI Herbarium - www.kfriherbarium.in
- Bamboo Technical Support Group – KFRI - www.bambooinfo.in

PUBLICATIONS

Research articles

1. Balakrishnan P, Das KSA, Patel B, Sivaraman S (2022) Predation of Indian giant flying squirrel and Travancore flying squirrel in the Western Ghats, India. Mammalia. https://doi.org/10.1515/mammalia-2021-0097.
2. Bindu TN, Balakrishnan P, Sajeev TV, Sudheendrakumar VV (20220) Role of soil and larval excreta in the horizontal transmission of the baculovirus HpNPV and its implications in the management of teak defoliator *Hyblaea puera*. Current Science 122(11): 1321-1326.
3. Bindu TN, Balakrishnan P, Sajeev TV, Sudheendrakumar VV (2022) Seeding baculovirus HpNPV in the epicentre populations of teak defoliator, *Hyblaea puera* to prevent large-scale outbreaks. Current Science 122(7): 812-818.
4. Biswas S, Daimari R, Islary P, Nayaka S, Joseph S, Upreti DK, Sarma P (2022) New additions to the lichen biota of Assam from Dhubri district, northeastern India. Journal of Threatened Taxa 14(5): 21084-21090.
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35. Rakshitha R, Thankachan A, Amruth M, Hrideek TK, Raghu AV (2023) Challenges and prospects in indigenous communities practicing medicinal plants cultivation: a case study from Attappady valley, Kerala, India. In: Proceedings of the 35th Kerala Science Congress, 10-14 February, Kutikkanam, Idukki, KSCSTE, Govt. of Kerala.
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37. Unnikrishnan R, Dev SA, Jayaraj R, Balakrishnan S (2022) Integrated approach to combat illicit trade and conservation of medicinal plants. In: 20th IUFRO Tree Biotech and the 2nd FTMB Conference, 07–09 July.
38. Samana S, Risana R, Mufeeda KT, Shambhu Kumar (2023) Pathological investigation of mycopathogens associated with leaf spot disease of *Terminalia elliptica* – a well-known timber and medicinal tree. In: International Conference on 'Emerging Trends in Microbiology', Feb 28-Mar. 01, Department of Botany, MLK PG College, Balarampur, UP, India, p. 144.
39. Sarath P, Balakrishnan S, Unnikrishnan R, Bhasker TR, Dev SA (2023) Genomics and transcriptomics for conservation and management of forest genetic resources. In: Proceedings of the 35th Kerala Science Congress, 10-14 February, Kutikkanam, Idukki, KSCSTE, Govt. of Kerala, pp. 191-192.
40. Shambhu Kumar (2022) Fungal diversity, conservation and prospecting in current perspectives, to be presented in Association of Microbiologists of India - 62nd International Conference on "Microbes and Society: Current Trends and Future Prospects", Sepr. 21-23, University of Mysore.
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43. Sofiya S, Mufeeda KT, Mukundan SK, Kumar S (2023) Molecular detection and diagnosis of plant pathogens associated with leaf blight disease of *Lagenandra ovata* – an endemic plant to Western Ghats. In: International Conference on 'Emerging Trends in Microbiology', FEB. 28 - Mar. 01, Department of Botany, MLK PG College, Balarampur, UP, India, p.156.
44. Soman D, Anitha V, Viswanath S (2023) From cognition to economic valuation of cultural ecosystem services - a perspective. In: Asia Consultative Workshop on 'Ecosystems and Nature-Based Solutions', 15-17 Mar., KSCSTE-Kerala Forest Research Institute. Jointly organized by IUCN Commission on Ecosystem Management & KSCSTE Kerala Forest Research Institute.
45. Sreeja CS (2022) Effect of elicitors and precursors on the production of secondary metabolites in in vitro cultures of *Oroxylum indicum*. In: National Seminar on -"Biotechnology, Environment and Conservation", 25-26 August, St. Dominic College, Kanjirappally.
46. Sreeja CS, Raghu AV (2022) Characterization of phenolic compounds in different parts of the species *Oroxylum indicum* by liquid chromatography coupled with mass spectrometry analysis. In: Rameshkumar KB and Dan VM (Eds). Proceedings of National Seminar on Fundamentals and Applied Dimensions in Plant Sciences, KSCSTE- JNTBGRI, Thiruvananthapuram, Kerala, India, 66p. ISBN No: 978-81-955043-0-5.
47. Sreekumar VB (2022) Rattan. Global Priority species. In Africa Bamboo and Rattan congress (ABARC2022), 20 -22 April, Yaounde, Cameroon.
48. Sreeraj KB, Bibina PB, Sreejith KA, Sreekumar VB (2023) Freshwater algal diversity in a tropical wet evergreen forest, Sholayar, Kerala. In: Proceedings of the 35th Kerala Science Congress, 10-14 February, Kutikkanam, Idukki, KSCSTE, Govt. of Kerala, pp. 288.
49. Sreeraj KB, Sreekumar VB, Sreejith KA (2023) Diversity of the genus *Cosmarium* (Desmidiaceae) from the tropical wet evergreen forest, Sholayar, Kerala. In: International Symposium on 'Plant Taxonomy, Ethnobotany, and Botanic Gardens', 13-14 Feb, Botanical survey of India, Kolkata, p. 113.
50. Sreekutty K, Sajeev TV, Suganthsakthivel R (2022) Ups and downs of *Prosopis juliflora* (Swartz) DC invasion into Kerala through the Palakkad Gap. In: National Conference on 'Bioinvasions, Trends, Threats and Management' 03-04 Dec., Kerala State Biodiversity Board, Thiruvananthapuram, p.78.

51. Sujanapal P, Sumod M, Chandrashekara U, Pillai PKC (2022) Seed properties and germination studies in *Berberis tinctoria* Lesch. an endangered medicinal plant: Implications for conservation and cultivation. In: International Conference on Modernization of Traditional Indian medicine: Industrial perspective', Patanjali Research Institute, Haridwar, p. 158.
52. Surya S, Mufeeda KT, Kumar S (2023) Assessment of biocontrol potential of rhizosphere fungus *Talaromyces muroii* against the *Curcuma longa* leaf blight pathogen, *Colletotrichum gloeosporioides*. In: International Conference on 'Emerging Trends in Microbiology', Feb. 28 - Mar. 01, Department of Botany, MLK PG College, Balarampur, UP, India, p. 177.
53. Balakrishnan S, Dev SA, Ramasamy Y, Unnikrishnan R (2022) Teak genomics for conservation and timber verification. In: Tree improvement, Genetics, Silviculture and Stand Management. In: 4th World Teak Conference, 05-08 Sept., Accra, Ghana.
54. Viswanath S (2022) Comparative study on growth, biomass and wood quality of 25-year-old teak managed under three agroforestry practices. In: 4th World Teak Conference, 05-08 Sept., Accra, Ghana.
55. Unnikrishnan R, Balakrishnan S, Dev SA, Jayaraj R (2023). Diagnostic DNA markers to assess market adulterants and gender based resource augmentation in *Coscinium fenestratum* (Gaertn.) In: Proceedings of the 35th Kerala Science Congress, 10-14 February, Kutikkanam, Idukki, KSCSTE, Govt. of Kerala, pp. 24-25.
56. Unnikrishnan R, Balakrishnan S, Jayaraj R, Sujanapal P, Dev SA (2022). Integrated approach for quality assurance of medicinal plants in Western Ghats. In: 9th World Ayurveda Congress and Arogya Expo, 08-11 Dec., Panjim, Goa.
57. Paul A, Jayaraj R (2022) Biochemical and histological changes induced by *Strychnos nux-vomica* leaf extract on tobacco cutworm, *Spodoptera litura*. In: 'International Seminar on 'Plant Chemistry, Gene Prospecting and Clinical Biology', Kerala Academy of Sciences, Thiruvananthapuram and Department of Chemistry, Mar Ivanios College, Thiruvananthapuram, ISBN No.: 978-81-959794-0-0.
58. Paul A, Jayaraj R (2023) Biochemical responses of the tobacco cutworm, *Spodoptera litura* on exposure to *Cocculus laurifolius* extracts In: Proceedings of the 35th Kerala Science Congress, 10-14 Feb., Mar Baselios Christian College of Engineering and Technology, Kuttikkanam, Idukki.

Training Manuals Published

1. Jayaraj R, Sandeep S (Eds) (2022) Training Manual for Training Programme in Analytical Instrumentation – Edition-IV, June 2022, Centre for Analytical Instrumentation – Kerala (CAI-K), KSCSTE - Kerala Forest Research Institute.
2. Jayaraj R, Sandeep S. (Eds) (2022) Training Manual for Training Programme in Analytical Instrumentation – Edition-V, October 2022, Centre for Analytical Instrumentation – Kerala (CAI-K), KSCSTE - Kerala Forest Research Institute.
3. Jayaraj R, Sandeep S. (Eds) (2023) Training Manual for Training Programme in Analytical Instrumentation – Edition-VI, March 2023, Centre for Analytical Instrumentation – Kerala (CAI-K), KSCSTE - Kerala Forest Research Institute.

ACADEMIC PROGRAMMES

DOCTORAL DEGREE AWARDED April 2022-March 2023

RINI VIJAYAN KP – 20/06/2022
In vitro studies for production of secondary metabolites and phytochemical characterization in medicinally important genus *Embelia brum* F
Degree of Doctor of Philosophy in Botany
Faculty of Science, University of Calicut
(Notification No.275035/RESEARCH-C-ASST-1/2021/Admn, Dated 28.07.2022).
Supervising Guide - Dr.A.V. Raghu

SANDEEP DAS – 22/08/2022
Ecology and behaviour of amphibians of Eravikulam National Park, with special reference to bush frogs.
Degree of Doctor of Philosophy in Zoology
Faculty of Science, University of Calicut
(Notification No.46557/RESEARCH-C-ASST-1/2022/Admn, Dated 25.09.2022).
Supervising Guide -Dr.P.S. Easa

RAJKUMAR KP – 12/09/2022
Herpetofaunal diversity in swamp (Vayal) ecosystems in Periyar Tiger Reserve, Western Ghats.
Degree of Doctor of Philosophy in Zoology
Faculty of Science, University of Calicut,
(Notification No.46551/RESEARCH-C-ASST-1/2022/Admn, Dated 20.10.2022).
Supervising Guide - Dr.P.S. Easa

VISHNU PS - 25/10/2022
Pedogenesis and geochemical transformations in forest ecosystems of the Western Ghats of Kerala.
Degree of Doctor of Philosophy in Environmental Studies
School of Environmental Studies, Cochin University of Science and Technology (Notification No. CUSAT/EXAM(T).A3/61270/202,Dated 31.10.2022).
Supervising Guide - Dr.S. Sandeep

DIVYA SOMAN - 03/02/2023
Assessment of ecosystem services from Parambikulam Tiger Reserve.
Degree of Doctor of Philosophy in Environmental Studies
School of Environmental Studies, Cochin University of Science and Technology,
(Notification No. CUSAT/ EXAM(T).A3/6015812021, Dated:10.02.2023).
Supervising Guides – Dr. Syam Viswanath & Dr.V. Anitha

ONGOING DOCTORAL PROGRAMMES

FOREST RESEARCH INSTITUTE – Deemed to be University

1. Diversity and abundance of tree-microhabitats and its potential as indicators of vertebrate diversity in tropical rainforests of the Western Ghats (Bharati Patel – Reg.No.-17PHD436 - 01.03.2018 to 31.08.2023)
2. Geochemistry of carbon storage under continuous teak rotation in Southern Western Ghats (Panchami Jaya - Reg.No. -19PHD550 - 01.03.2020 to 31.08.2025)
3. Integrative taxonomic studies on skippers (Lepidoptera: Hesperidae) of Southern Western Ghats (Athulya C - Reg.No. -19PHD612 - 01.09.2020 to 31.08.2025)
4. Unravelling phenotypic plasticity, local adaptation and population genetics divergence of *Korthalsia laciniosa* (Griff.) and *Korthalsia rogersii* Becc. in Andaman & Nicobar Islands. (Sarath P - Reg.No. -20PHD626 -01.03.2021 to 31.08.2026)

COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY

1. Carbon dynamics in mangrove systems of Kerala (Harishma K.M. - Reg.No. -5228 -18.07.2016 to 17.07.2022)
2. Molecular fingerprints and geo-chemical interaction of organo-nano composite from Forest floor humic acid in the Western Ghats, Kerala (Ninu Jose M. - Reg.No. -5432 -29.03.2017 to 28.03.2023)
3. Seasonal influence on phenology of woody species in a tropical wet evergreen forest of Southern Western Ghats, India (Thasini V.M. - Reg.No.-5457-31.08.2017 to 30.08.2023)
4. Bioactivity and mechanistic studies of selected medicinal plants for their potential application as biopesticides (Alina Paul -Reg.No.-5615 -20.12.2017 to 19.12.2023)
5. Soil carbon pool and its dynamics in the systems of Kerala Western Ghats (Binsiya.T.K. K - Reg.No.-6021 -08.04.2019 to 07.04.2025)
6. Invasive alien plants in tourist locations of Kerala: Pathways, spread and impact (Karthika M Nair - Reg.No.-6190 -21.11.2019 to

20.11.2025)

7. Exploring the antioxidant activity of humic substances in composts and development of nanocomposites for environmental and health benefits (Faniya Toby -Reg.No.-6173 -21.11.2019 to 20.11.2025)
8. Temporal analysis of distribution and morphometry of Coleoptera in Kerala part of Western Ghats (Thushar Naduvalloor - Reg.No.-6191 -21.11.2019 to 20.11.2025)
9. Faunal interactions of Invasive Alien Plants: Case studies on *Lantana camara L., Mimosa diplotricha Sauvalle,* and *Mikania micrantha Kunth* in Kerala (Premdas.S -Reg.No.-6192 -21.11.2019 to 20.11.2025)
10. Chemistry and geochemical interactions of organo-clay nano composites developed on humic acid microstructure (Navya M - Reg.No.-6395 -31.03.2021 to 30.03.2026)
11. Phthalate release from plastic fragments and microplastics degradation in Kole Wetlands of Thrissur and its role in fresh water contamination (Blaise Jose K - Reg.No.-6620 -23.12.2021 to 22.12.2026)
12. Population genetics and genomic approaches for conservation and management of *Santalum album* Linn (Reshma Bhasker T - Reg.No.-6636 -15.12.2021 to 14.12.2026)
13. Socio hydrology of Northern Thrissur district, Kerala (Anand Zacharias -Reg.No.-6724 -28.12.2021 to 27.12.2026)

UNIVERSITY OF CALICUT

1. Studies on variability, phenology and management methods of the alien invasive tree, *Senna Spectabilis* (D.C.) Irwin & Barneby in Kerala, India (Muraleekrishnan K.- Reg.No.- 2607 -22.01.2016 to 21.01.2022, 22.10.2022 -21.10.2023)
2. Study on the impact of allelochemicals of *Senna spectabilis* (DC.) Irwin and Barneby invasion in Wayanad, Kerala (Suby -Reg.No.-4605 -22.03.2018 to 21.03.2024)
3. Ecophysiology of mangroves in Kerala: An enquiry through plant functional traits. (Abdulla Naseef- Reg.No.-13122 -09.11.2018 to

08.11.2024)

4. Plant - frugivore interaction and seed dispersal syndromes in Shola forests of the Western Ghats, India. (Nimisha E.S. - Reg.No.-13743 - 19.11.2018 to18.11.2024)
5. Effect of elicitation and precursor feeding on the production of Oroxylin A. Chrysin and Baicalein in *in vitro* cultures of *Oroxylum indicum* (L.) Kurz (Sreeja C.S. - Reg.No.-13744 -19.11.2018 to 18.11.2024)
6. Ecophysiological and biochemical studies on seed viability loss in *Dysoxylum malabaricum* Bedd. and *Persea macrantha* (Nees.) Kosterm.- two threatened tree species of Western Ghats, Kerala (Vidya P.R. -Reg.No.-2811 -26.02.2018 to 25.02.2024)
7. A study on population dynamics of two threatened *Myristica* species of Western Ghats, Kerala in the context of climate change (Anuraj K- Reg.No.-7467 -23.05.2019 to 22.05.2025)
8. Studies on plus tree selection, genetic variability and wood properties of the endemic tree species *Artocarpus hirsutus* Lamk. (Moraceae) in Kerala (Sinny Francis- Reg.No.-8082- 23.05.2019 to 22.05.2025)
9. Studies on variability, growth performance and wood properties of selected clones and plus trees of teak (*Tectona grandis*. L.f.) in Kerala (Preetha B- Reg.No.-8083 -23.05.2019 to 22.05.2025)
10. Morphological and molecular taxonomy of skippers (Lepidoptera: Hesperiidae) in Kerala (Rakhi K.R - Reg.No.-1052 -31.12.2019 to 30.12.2025)
11. Studies on clonal propagation and seed germplasm storage with reference to domestication of *Baccaurea courtallensis* (Wight) Mull.Arg. and *Flacourtia montana* J. Graham - two wild edible fruit trees of Western Ghats, Kerala (Rasmi C.K - Reg.No.-2046 - 03.02.2020 to 02.02.2026)
12. Ecology of Troidini butterflies (Lepidoptera; Papilionidae) in Kerala (Anju M.S - Reg.No.-2049 -03.02.2020 to 02.02.2026)
13. Investigation on application of nanobionics on accumulation of biomass and biosynthesis of compounds in *Holostemma adakodien* K. schum in *In-vitro* (Sangeeth Chandran - Reg.No.-3206 -14.02.2020 to 13.02.2026)

14. Community structure and habitat use of rodents in a tropical forest of the southern Western Ghats, India (Sreejith Sivaraman - Reg.No.-6627 -23.06.2021 to 22.06.2027)

15. Foraging ecology of Bonnet Macaque along the anthropogenic gradients: Food traits perspective (Sheheer T A - Reg.No.- 7276-20.05.2021 to19.05.2027)

16. Investigation on physio-chemical, microstructure properties and molecular characterization of special bamboos used in weaving by tribal communities in Idukki district, Kerala (Anjana N - Reg.No.-7652 -27.07.2021 to 26.07.2027)

17. Distribution diversity and properties of two endemic bamboo species *Dendrocalamus stocksii* (Munro) M.Kumar, Remesh & Unnikrishnan and *Munrochloa Ritchie* (Munro) M. Kumar & Remesh in Kerala (Muhsina Moosa - Reg.No.-15544 -08.10.2021 to 07.10.2027)

18. Variation in plant functional traits along an elevation gradient in a tropical forest ecosystem (Arun Lal M - Reg.No.-13795 -14.06.2022 to 13.06.2028)

19. Morphological, anatomical and molecular chracterization of two endemic bamboo species *Oxytenanthera bourdillonii gamble* and *Oxytenanthera monadelpha (thw.) Alst* in Kerala (Krishnapriya K.R - Reg.No.- 15267 -20.07.2022 to 19.07.2028)

20. Diversity and seasonal variation of fresh water algae in the protected forests of central Kerala, Western Ghats (Bibina P B - Reg.No.-15582 -25.07.2022 to 24.07.2028)

21. Distribution ecology and status of golden jackal (*Canis aureus*) in Kannur district of Kerala (Navya K K - Reg.No.-20932 -26.10.2022 to 25.10.2028)

22. Community ecology and ecosystem services of bats along elevational and land-use gradients in the Southern Western Ghats (Nithin Divakar - Reg.No.-2348 -09.01.2023 to 08.01.2029)

ACADEMIC ATTACHMENT PROGRAMMES

- **Master's attachments, including Under graduates (72 No's**.) covering Environmental Science, Ecology, Geology, Zoology, Botany, Forestry, Microbiology, PGDFM, Biochemistry, Biotechnology, Chemistry, Disaster Management, Climate Change Adaptation, Geography, Economics, Entomology, RS and GIS have been successfully completed.
- **Academic Internships (51 Nos.)** covering B-Arch, Biotechnology, Botany, Environmental Science, Microbiology, affiliated to different Universities and Colleges have been successfully completed.

INSTITUTIONAL COMMITTEES

RESEARCH COUNCIL

(Council (M) Order No.83/2020/KSCSTE, Thiruvananthapuram, Dated: 03 /11/ 2020

Chairman
Dr. N. Krishnakumar IFS (Rtd.)
Former Head of Forest Force, Tamil Nadu Forest Dept.
G/03/01, TAISHA (AIS quarters)
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Institute of Forest Genetics & Tree Breeding
Indian Council of Forestry Research & Education
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Coimbatore – 641 002

Dr. K. V. Sankaran
Former Director, KFRI
TCDC Expert FAO
'Manasi', Convent Road
Shornur, Palakkad – 679 121

Shri. P. K. Kesavan, IFS
Principal Chief Conservator of Forests &
Head of Forest Force, Forest Headquarters
Vazhuthacaud, Thiruvananthapuram - 695 014
(Permanent invitee)

Dr. S. Pradeep Kumar
Member Secretary
Kerala State Council for Science Technology &
Environment, Sasthra Bhavan, Pattom P.O
Thiruvananthapuram - 695 004
(Permanent invitee)

Prof. Dr. Raman Sukumar
Centre for Ecological Sciences
Third Floor, Biological Sciences Building
Indian Institute of Science, Bangalore 560 012

Dr. R.V. Varma
Former Chief Scientist KSCSTE - KFRI
Former Chairman
Kerala State Biodiversity Board
Lakshmipuram, Royal Avenue
Thrissur – 680 020

Dr. A.J.T. Johnsingh
Former Dean, Wildlife Institute of India
Magnolia 101, Easter Gardenia Apartments
Sahakara Nagar, Bangalore – 560 092

Dr. Syam Viswanath
Director
KSCSTE-KFRI
Member & Ex-Officio Convener

MANAGEMENT COMMITTEE
(Council (M) Order No. 37/2020/KSCSTE, Thiruvananthapuram, Dated 04/03/2020)

Chairman
Dr. Syam Viswanath
Director
KSCSTE – KFRI

Members
Dr. S. Pradeep Kumar
Member Secretary
Kerala State Council for Science, Technology & Environment (KSCSTE)

Dr. Samson Mathew
Director
KSCSTE - National Transportation Planning & Research Centre - NATPAC

Additional Secretary
Science &Technology Department, Govt. of Kerala

Dr. V. Anitha
Senior Principal Scientist
KSCSTE - KFRI

Dr. T.V. Sajeev
Registrar (i/c)
KSCSTE – KFRI
Member & Convener

CONSULTATIVE GROUP FOR FORESTRY RESEARCH MANAGEMENT (PROGRAMME ADVISORY GROUP)

The Principal Chief Conservator of Forests & Head of Forest Force	…	Chairman
The Additional PCCF (D&P) & Disciplinary Authority	…	Member
The Additional PCCF (FMIS)	…	Member
The Additional PCCF (Development)	…	Member
The Additional PCCF (WP&R)	…	Member
The Additional PCCF (E&TW)	…	Member
The Additional PCCF (Administration)	…	Member
The Additional PCCF (Southern Region)	…	Member
The Additional PCCF (Protection)	…	Member
The Additional PCCF (Vigilance)	…	Member
The Additional PCCF (Northern Region)	…	Member
The Additional PCCF (BDC)	…	Member
The Additional PCCF (IHRD)	…	Member
The Additional PCCF (SA&NO)	…	Member
The Principal Chief Conservator of Forests Wildlife & Chief Wildlife Warden	…	Member
The Principal Chief Conservator of Forests (Social Forestry)	…	Member
The Principal Chief Conservator of Forests (Vigilance)	…	Member
The Principal Chief Conservator of Forests (Dev. & PFM)	…	Member
The Chief Conservator of Forests (Protection)	…	Member
The Chief Conservator of Forests (FMIS)	…	Member
The Chief Conservator of Forests (HRD)	…	Member
The Chief Conservator of Forests (Administration)	…	Member
The Chief Conservator of Forests (Vigilance)	…	Member
The Chief Conservator of Forests (Social Forestry)	…	Member

The Regional Chief Conservator of Forests (North)	…	Member
The Regional Chief Conservator of Forests (South)	…	Member
The Conservator of Forests (Biodiversity)	…	Member
The Deputy Conservator of Forests (Research) North	…	Member
The Deputy Conservator of Forests (Research) South	…	Member
The Managing Director, Kerala Forest Development Corporation	…	Member
The Associate Dean, Forestry Faculty, Kerala Agricultural University	…	Member
The Director, Jawaharlal Nehru Tropical Botanic Garden & Research Institute, Palode	…	Member
The Director, Institute of Forest Genetics & Tree Breeding, Coimbatore	…	Member
The Managing Director, Oushadhi, Thrissur	…	Member
The Director, Center for Earth Science Studies, Thiruvananthapuram	…	Member
The Director, Center for Water Resources Development and Management, Kozhilode	…	Member
The Director, Rajiv Gandhi Center for Biotechnology, Thiruvananthapuram	…	Member
The Director, Medicinal Plant Research Center, Arya Vaidya Sala, Kottakkal	…	Member
The Managing Director, Kerala State Wood Industries Ltd., Nilambur	…	Member
The Managing Director, Kerala State Bamboo Corporation Ltd.	…	Member
The Director, Salim Ali Center for Ornithology and Natural History, Coimbatore	…	Member
Director, Kerala Forest Research Institute, Peechi	…	Member
Joint Director (Science & Technology Promotion), KSCSTE,TVPM	…	Member
Research Coordinator, KFRI, Peechi	…	Invitee
All Scientists of KFRI	…	Invitees
Programme Coordinator, Training & Extension Division, KFRI	…	Convener

INTERNAL COMMITTEES

(Ref :Proceedings of the Director # DR20/KSCSTE-KFRI/2020-1 dated 22/10/2021)

1. INTERNAL RESEARCH GROUP (IRG)

Director	…	Chairperson
Research Coordinator	…	Convener
Dr. Suma Arun Dev	…	Assoc. Convener
All Scientific staffs	…	Members

2. FINANCE COMMITTEE

Director	…	Chairperson
Research Coordinator	…	Member
Two elected members from IRG	…	Member
Section Officer (Accounts)	…	Member
Registrar	…	Convener

3. PURCHASE COMMITTEE

Dr. V. Anitha	…	Chairperson
Dr. P. Balakrishnan	…	Member
Dy. Registrar (Accounts)	…	Member
Section Officer (Purchase)	…	Member
Registrar	…	Convener

4. ACADEMIC PROGRAMME ADVISORY COMMITTEE

Dr. V. Anitha	…	Chairperson
Dr. TV. Sajeev	…	Member
Dr. R. Jayaraj	…	Member
Dr. M. Amruth	…	Member
Dr. Suma Arun Dev	…	Convener
Respective Research Guides	…	Invitees

5. EQUIPMENT / INFRASTRUCTURE DEVELOPMENT COMMITTEE

Dr. Suma Arun Dev	…	Chairperson
Dr. S. Sandeep	…	Member
Dr. KA. Sreejith	…	Member
Mr. PI. Shareef.	…	Member
Superintendent (Stores)	…	Member
Section Officer (Purchase)	…	Convener

6. LIBRARY ADVISORY COMMITTEE

Librarian	…	Chairperson
Dr. TV. Sajeev	…	Member
Dr. M. Amruth	…	Member
Section Officer (Purchase)	…	Member
Section Officer (Accounts)	…	Member
Dr. VB. Sreekumar	…	Convener

7. WEBSITE & SOFTWARE HARDWARE COMMITTEE LAN

Dr. P. Balakrishnan	…	Chairperson
Dr. AV. Raghu	…	Member
Dr. M. Amruth	…	Member
Dr. KF. George	…	Member
Mr. KM. Shiju	…	Member
Smt. Ricy Eliner Varkey	…	Convener

8. KERALA FOREST SEED CENTRE ADVISORY COMMITTEE

(Vide (Proceedings G53/KFRI/79 dated 11 Feb 2004 -Modified here)

Director, KFRI	…	Chairperson
PCCF (WP & Research), KFD	…	Member

CCF (Central Circle), KFD	…	Member
SRO (North), KFD	…	Member
SRO (South), KFD	…	Member
Dr. V. Anitha, Research Co-ordinator	…	Member
Dr. GE. Mallikarjuna Swamy	…	Member
Dr. VB. Sreekumar	…	Member
Dr. P. Sujanapal	…	Convener

9. NILAMBUR SUB CENTRE ADVISORY COMMITTEE

Director	…	Chairperson
Registrar	…	Co-Chairman
Research Co-ordinator	…	Member
Dr. VB. Sreekumar	…	Member
Dy. Registrar (Accounts)	…	Member
Dy. Registrar (Admin)	…	Member
Dr. KV. MohammedKunhi	…	Member
Dr. P. Sujanapal	…	Member
Dr. GE. MallikarjunaSwamy, Sub-Centre In-charge	…	Convener

10. CAMPUS/GARDEN DEVELOPMENT COMMITTEE

Dr. PA. Jose	…	Chairperson
Dr. VB. Sreekumar	…	Member
Dr. P. Sujanapal	…	Member
Smt. Anuja Prasannan	…	Member
Smt. MK. Raji, Engineering Division	…	Convener

11. JOURNAL OF BAMBOO AND RATTAN -EDITORIAL COMMITTEE

Director	…	Chief-Editor

Dr. S. Sandeep	…	Executive Editor
Dr. R. Jayaraj	…	Editor
Dr. V. Anitha	…	Editor
Dr. AV. Raghu	…	Editor
Dr. Suma Arun Dev	…	Editor
Dr. VB. Sreekumar	…	Editor & Convener

12. ANNUAL REPORT COMMITTEE

Dr. R. Jayaraj	…	Chairperson
Research Coordinator	…	Member
Dy. Registrar (Admin)	…	Member
Dy. Registrar (Accounts)	…	Member
Dr. KA. Sreejith	…	Member
Dr. S. Sandeep	…	Member
Dr. Suma Arun Dev	…	Convener

13. EVERGREEN NEWSLETTER COMMITTEE

Dr. AV. Raghu	…	Chief Editor
Dr. M. Amruth	…	Associate Editor
Dr. P. Sujanapal	…	Associate Editor
Dr. P. Balakrishnan	…	Associate Editor

14. STORES IAUCTION AND DISPOSAL COMMITTEE

Dr. VB. Sreekumar	…	Chairperson
Dr. R. Jayaraj	…	Member
Mr. K. Kamalakaran	…	Member
Smt. Anuja Prasannan	…	Member
Smt. MK. Raji	…	Member

Smt. Ricy Eliner Varkey	…	Member
Mr. PI. Shareef	…	Member
Smt. A. Aneesamole	…	Member
Stores-in-Charge	…	Convener

15. SPORTS COMMITTEE

Mr. PI. Shareef	…	Chairperson
Mr. K. Kamalakaran	…	Member
Smt. Anupa Vasu	…	Member
Smt. K. Keerthi	…	Member
Mr. VC. Jinesh	…	Convener

16. COMMITTEE FOR TRANSFORMATION OF OFFICIAL LANGUAGE TO MALAYALAM

Registrar	…	Chairperson
Dr. KV. Mohammed Kunhi	…	Member
Dy. Registrar (Admin)	…	Member
Smt. PS. Manju	…	Member
Smt. C.K. Sindhumol	…	Member
Smt. Shirly Issac	…	Convener

17. EXHIBITION ADVISORY COMMITTEE

Dr. S. Sandeep	…	Chairperson
Dr. AV. Raghu	…	Member
Dr. M. Amruth	…	Member
Mr. VC. Jinesh	…	Member
Dr. KV. Mohammed Kunhi	…	Convener

18. SEMINAR COMMITTEE

Dr. KA. Sreejith	…	Chairperson
Dr. AV. Raghu	…	Member
Dr. V. Anitha	…	Member
Dr. M. Amruth	…	Member
Dr. P. Balakrishnan	…	Convener

19. IGH CAFETERIA ADVISORY COMMITTEE

Dr. AV. Raghu	…	Chairperson
Mr. KP. Manoj	…	Member
Smt. Sabitha Balakrishnan	…	Member
Mr. KM. Shiju	…	Member
Mr. PI. Shareef - Guest House in charge	…	Convener

20. BUILDING COMMITTEE

Dr. PA. Jose	…	Chairperson
Smt. MK. Raji	…	Member
Mr. PI. Shareef	…	Member
Dy. Registrar (Accounts)	…	Member
Registrar	…	Convener

21. VEHICLE ADVISORY COMMITTEE

Dr. P. Sujanapal	…	Chairperson
Dr. KA. Sreejith	…	Member
Dy. Registrar (Admn)	…	Member
Mr. KM Shiju	…	Member
Vehicle - in Charge (Mr.V.S. Krishnanunni)	…	Convener

22. ENDOWMENT COMMITTEE

Director	…	Chairperson
Dr. TV. Sajeev	…	Member
Dr. VB. Sreekumar	…	Member
Dr. P. Sujanapal	…	Member
Dr. Suma Arun Dev	…	Member
Dr. PA. Jose	…	Convener

23. KFRI QUARTERS ALLOTMENT COMMITTEE

Registrar	…	Chairperson
Dy. Registrar (Admin)	…	Member
Dr. S. Sandeep	…	Member
Smt. MK. Raji	…	Member
Mr. PI. Shareef	…	Convener

24. RESEARCH SCHOLAR'S HOSTEL ADVISORY COMMITTEE

Registrar	…	Chairperson
Mr. PI. Shareef	…	Member
Smt. MK. Raji	…	Member
Smt. P. Anupa Vasu, Asst. Warden, Ladies Hostel	…	Member
Dr. Suma Arun Dev, Warden, Ladies Hostel	…	Member
Dr. P. Balakrishnan, Warden, Men's Hostel	…	Convener

25. GRIEVANCE REDRESSAL COMMITTEE

Director	…	Chairperson & Convener
Registrar	…	Member
Dr. T.K. Kunjamu, Professor, KAU	…	Member
Smt. Sabitha Balakrishnan, Asst. Registrar (Admin)	…	Member

Smt. MK. Raji	…	Member

26. INTERNAL COMPLAINTS COMMITTEE (ICC) -COMMITTEE TO PREVENT SEXUAL HARASSMENT ON WOMEN AT WORKPLACE

Dr. Suma Arun Dev	…	Chairperson
Registrar	…	Member
Smt. Maymol Joseph	…	Member
Smt. K. Keerthy	…	Member
Dr. Uma Maheswari, Rtd. Addl. Director of Health Services, Govt. of Kerala	..	Member
Smt. Sabitha Balaksrishnan	…	Convener

27. PROGRAMMER'S COMMITTEE

Registrar	…	Chairperson
Smt. P. Anupa Vasu	…	Member
Shri. KM. Shiju	…	Member
Smt. Ricy Eliner Varkey	…	Co-Convener
Shri. K. Kamalakaran	…	Convener

28. NURSERY MANAGEMENT COMMITTEE

Director	…	Chairperson
Registrar	…	Member
Dr. PA. Jose	…	Member
Dr. P. Sujanapal	…	Member
Dr. AV. Raghu	…	Member
Dr. VB. Sreekumar	…	Convener

STAFF LIST

Name		Designation
1. Dr. Syam Viswanath	…	Director (On deputation)
2. Dr. T.V. Sajeev	…	Chief Scientist, Registrar (i/c) & Deputy Registrar (i/c) (Finance)
3. Dr. V. Anitha	…	Senior Principal Scientist & Research Co-ordinator
4. Dr. K.V. Mohammed Kunhi	…	Principal Scientist
5. Dr. P.A. Jose.	…	Principal Scientist
6. Dr. Suma Arun Dev	…	Principal Scientist
7. Dr. K.F. George	…	Principal Scientist
8. Dr. A.V. Raghu	…	Principal Scientist
9. Dr. P. Sujanapal	…	Principal Scientist
10. Dr. V.B. Sreekumar	…	Principal Scientist
11. Dr. S. Sandeep	…	Principal Scientist
12. Dr. R. Jayaraj	…	Principal Scientist
13. Dr. K.A. Sreejith	…	Principal Scientist
14. Dr. Shambu Kumar	…	Senior Scientist
15. Dr. T. K. Hrideek	…	Senior Scientist (On deputation to SMPB)
16. Dr. G.E. Mallikarjuna Swamy	…	Senior Scientist
17. Dr. M. Amruth	…	Senior Scientist
18. Dr. P. Balakrishnan	…	Scientist
19. Dr. Wable Pawan Shyamrao	…	Scientist
20. Dr. Donald James	…	Jr. Scientist/ Scientist B
21. Dr. Deepu Sivadas	…	Jr. Scientist/ Scientist B
22. Dr. S. Mahadevakumar	…	Jr. Scientist/ Scientist B (Relieved on 26/10/2022 to join Botanical Survey of India)
23. Dr. Jithu U Krishnan	…	Jr. Scientist/ Scientist B

24. Mr. V. R. Arun	…	Jr. Scientist/ Scientist B
25. Dr. Siljo Joseph	…	Jr. Scientist/ Scientist B
26. Dr. Shweta B Kukreti	…	Jr. Scientist/ Scientist B
27. Dr C. K. Adarsh	…	Jr. Scientist/ Scientist B
28. Dr. Madiga Bheemalingappa	…	Jr. Scientist/ Scientist B
29. Dr. R. Suganthasakthivel	…	Jr. Scientist/ Scientist B
30. Dr. Ayate Dipika Purushottam	…	Jr. Scientist/ Scientist B
31. Dr. Badole Srikanth Purushottam	…	Jr. Scientist/ Scientist B
32. Ms. S. Soorya	…	Jr. Scientist/ Scientist B
33. Dr. R. Murali	…	Jr. Scientist/ Scientist B

Administrative staff

1. Smt. Sabitha Balakrishnan	…	Assistant Registrar & Deputy Registrar (i/c) (Admin)
2. Smt. Shirly Issac	…	Section Officer Gr. II
3. Sri. K. Kamalakaran	…	Section Officer Gr.II
4. Sri. Krishnanunni V.S.	…	Section Officer
5. Smt. Sindhumol C.K.	…	Assistant Gr. II
6. Smt. Anupa Vasu P.	…	Assistant Gr. II
7. Smt. Anuja Prasannan	…	Assistant Gr. II
8. Smt. Keerthy K.	…	Assistant Gr. II
9. Smt. Maymol Joseph	…	Assistant Gr. II
10. Sri. Sudheesh P.S.	…	Assistant (Stay order)
11. Smt. Manju P.S.	…	Assistant
12. Smt. Aneesamole A	…	Assistant
13. Sri. Shiju K.M.	…	Assistant
14. Smt. Grace Andrews	…	PA to Director Gr.II (Retired on 31-07-2022)

15. Sri. K.P. Manoj	…	Office superintendent
16. Sri. P. Rajeesh	…	Clerical Assistant Gr.II (Nilambur)
17. Sri. T.M. Abdul Vahab	…	Word Processing Assistant Gr. V
18. Sri. P.K. Rajendran	…	Driver Gr. II (Retired on 31-08-2022)
19. Sri. C.H. Herald Wilson	…	Driver Gr.II
20. Smt. A.M. Lalitha	…	Office Attendant Gr. V (Retired on 30-04-2022)
21. Sri. V.K .Mohandas	…	Office Attendant Gr. IV
22. Sri. E.P. Ulahannan	…	Office Attendant Gr. IV
23. Smt. K. Aparna	…	Office Attendant Gr.III
24. Sri. Abdul Jaleel K	…	Office Attendant Gr.II
25. Smt. Ashamole S.	…	Office Attendant Gr.II
26. Smt. Sujatha C.	…	Office Attendant Gr.II
27. Sri. Hamsa E	…	Office Attendant Gr.II
28. Sri. T.P. Valsan	…	Office Attendant Gr.II
29. Smt. Deepa P.	…	Office Attendant Gr.III (Nilambur)
30. Sri K.K. Mohammed	…	Helper Gr. IV (Nilambur)
31. Sri. A.V. Chamy	…	Helper Gr.II (Retired on 31-08-2022)
32. Sri. T.S .Prakash	…	Helper Gr.II (Retired on 31-05-2022)
33. Sri. M.S. SanthoshKumar	…	Helper Gr.II
34. Sri. T.O. Simon	…	Helper Gr.II
35. Sri. M.K. Suresh	…	Helper Gr.II
36. Sri. N. Rajan	…	Helper Gr.II (Nilambur)
37. Sri. C.P. Ummer	…	Helper Gr.II (Nilambur)
38. Smt. P.S. Kadeeja	…	Helper Gr.II (Palappilly)
39. Sri. K.A. Thankachan	…	Helper Gr.II (Kottappara)

40. Sri. C.B. Sajy	…	Helper Gr.II
41. Sri. P.V. SanthoshKumar	…	Helper Gr.II
42. Sri. K. Rajan	…	Nursery Man Gr.III
43. Sri. N.K. Rajan	…	Nursery Man Gr.III (Palappilly)

Technical Staff

1. Sri. P.I .Shereef	…	Technical Officer Gr.III
2. Smt. Raji M.K.	…	Technical Officer Gr.III
3. Smt. Ricy Eliner Varkey	…	Technical Officer Gr.II
4. Sri .Jinesh V.C.	…	Technical Officer Gr.II (Palappilly)
5. Sri. M.R. Anilkumar	…	Technical Assistant Gr. IV
6. Sri. O.P Ranjith	…	Technical Assistant Gr.II

Total	**81**

KSCSTE - KERALA FOREST RESEARCH INSTITUTE, PEECHI - 680 653
(A unit of Kerala State Council for Science, Technology & Environment. Govt. of Kerala)
INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st MARCH, 2023

in (₹)

Expenditure	Sch No.	Year ended 31 March 2023	Year ended 31 March 2022	Income	Sch No.	Year ended 31 March 2022	Year ended 31 March 2021
Infrastructure Strengthening (Non Plan)	14	28,040,173	22,376,918	Grant from Government of Kerala	11	155,821,044	114,990,644
Salaries and Allowances (Non Plan)	15	83,099,674	53,187,055	Other Receipts	12	10,521,925	15,012,945
Depreciation	7	28,546,101	28,068,483	Depreciation transferred to Capital Reserve	7	28,546,101	28,068,483
Other Project Expenses		55,004,218	55,290,879	Income from other Project	13	55,004,218	55,290,879
Project Expenses under Plan scheme		55,203,122	54,439,615				
TOTAL		**249,893,287**	**213,362,951**	**TOTAL**		**249,893,287**	**213,362,951**

KSCSTE - KERALA FOREST RESEARCH INSTITUTE PEECHI, THRISSUR - 680653
(A unit of Kerala State Council for Science, Technology & Environment. Govt. of Kerala)
BALANCE SHEET AS ON 31 MARCH 2023

in (₹)

Liabilities	Sch No.	As at 31 March 2023	As at 31 March 2022	Assets	Sch No	As at 31 March 2023	As at 31 March 2022
Reserves and Surplus	2	235,037,815	233,707,596	Plant property & equipment	7	206,119,521	204,789,302
Current Liabilities & Provisions				**Current Assets, Loans and Advances**			
Creditors for Expenses	3	7,764,534	6,590,288	Cash & Bank balance	8	232,324,380	266,864,658
Other Liabilities	4	10,125,061	12,756,399	Loans and Advances	9	24,170,022	17,441,029
Provisions	5	66,697,603	75,300,000	Other Current Assets	10	4,275,882	4,335,289
Unspent Balance of Grant-in-Aid(Net)	6	147,264,793	165,075,996				
TOTAL		**466,889,806**	**493,430,278**	**TOTAL**		**466,889,806**	**493,430,278**


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