KFRI ANNUAL REPORT 2020-21

KSCSTE - Kerala Forest Research Institute
An Institution of Kerala State Council for Science, Technology and Environment
Peechi-680 653, Thrissur, Kerala

Cover Image : *Alsophila nilgirensis* (Holttum) R.M.Tryon, An endanged tree fern endemic to Western Ghats, captured from Anamudi Shola National Park

Photo credit : Dr.P.Sujanapal, Silviculture Department

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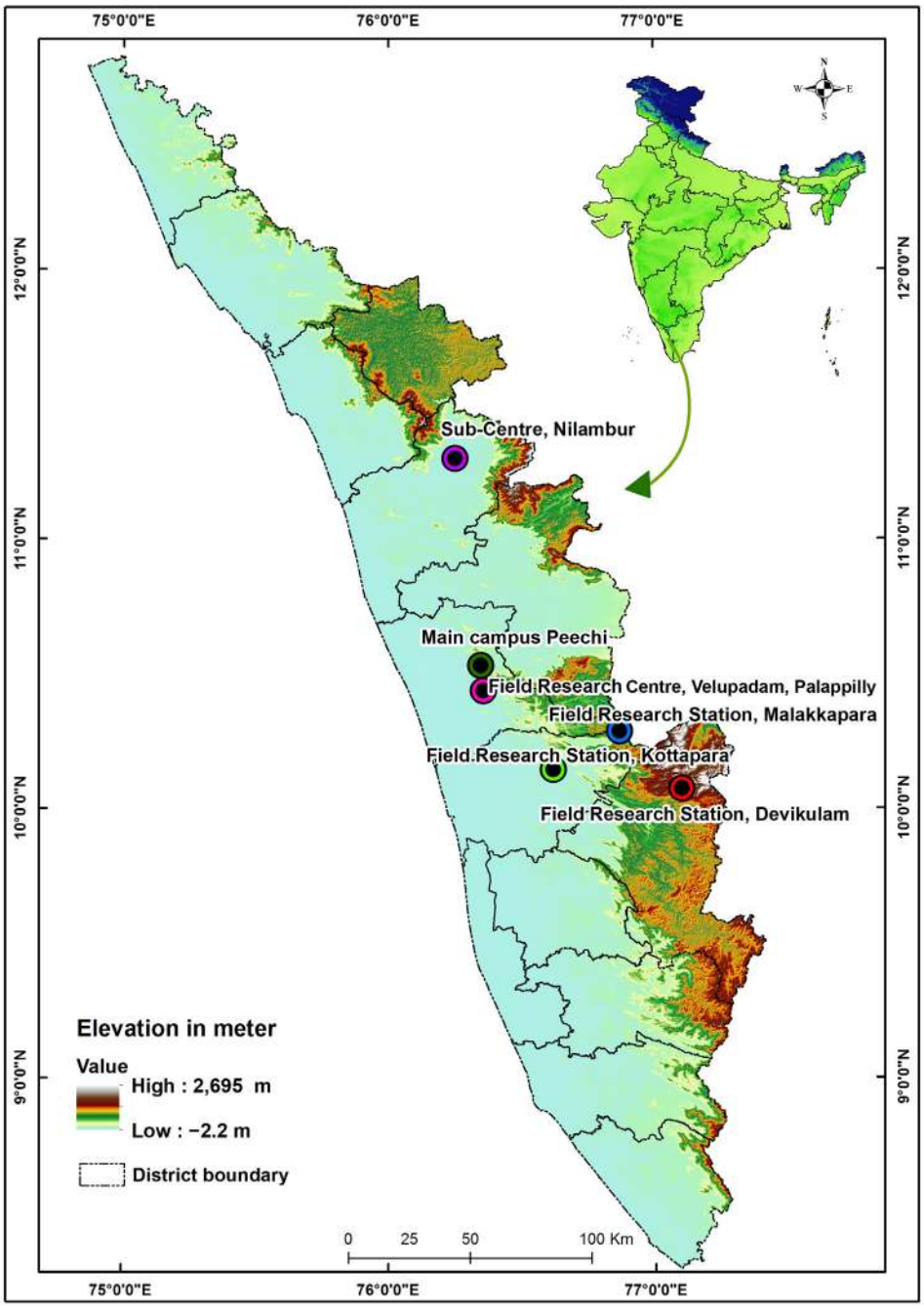
ANNUAL REPORT 2020-2021

C O N T E N T S

KFRI CAMPUSES



Director's Note...

The importance and significance of forests cannot be taken lightly given the fact that mankind depends on these primary resources for survival. UN General Assembly proclaims 2020 as year to recognize and protect plant health focusing to increase awareness among the public and policy makers of the importance of healthy plants and the necessity to protect them in order to achieve the Sustainable Development Goals. The importance of plant health is to enhance food security, protect the environment and biodiversity, and boost economic development. However, addressing impact of plant pests and diseases on the economy at large, in terms of crop damage, food scarcity, cost escalation and income reduction for sustainable livelihoods is a matter of concern. The United Nations has emphasized that sustaining plant health protects the environment, forests and biodiversity from plant pests, addresses the effects of climate change, and supports efforts to end hunger, malnutrition and poverty. An estimated 420 million ha of forests that sustain the health of the global economy has been lost worldwide through deforestation since 1990, but the rate of forest loss has declined substantially. In the most recent five-year period (2015–2020), the annual rate of deforestation was estimated at 10 million ha, down from 12 million ha in 2010–2015 (UN). Forests face many disturbances that can adversely affect their health and vitality

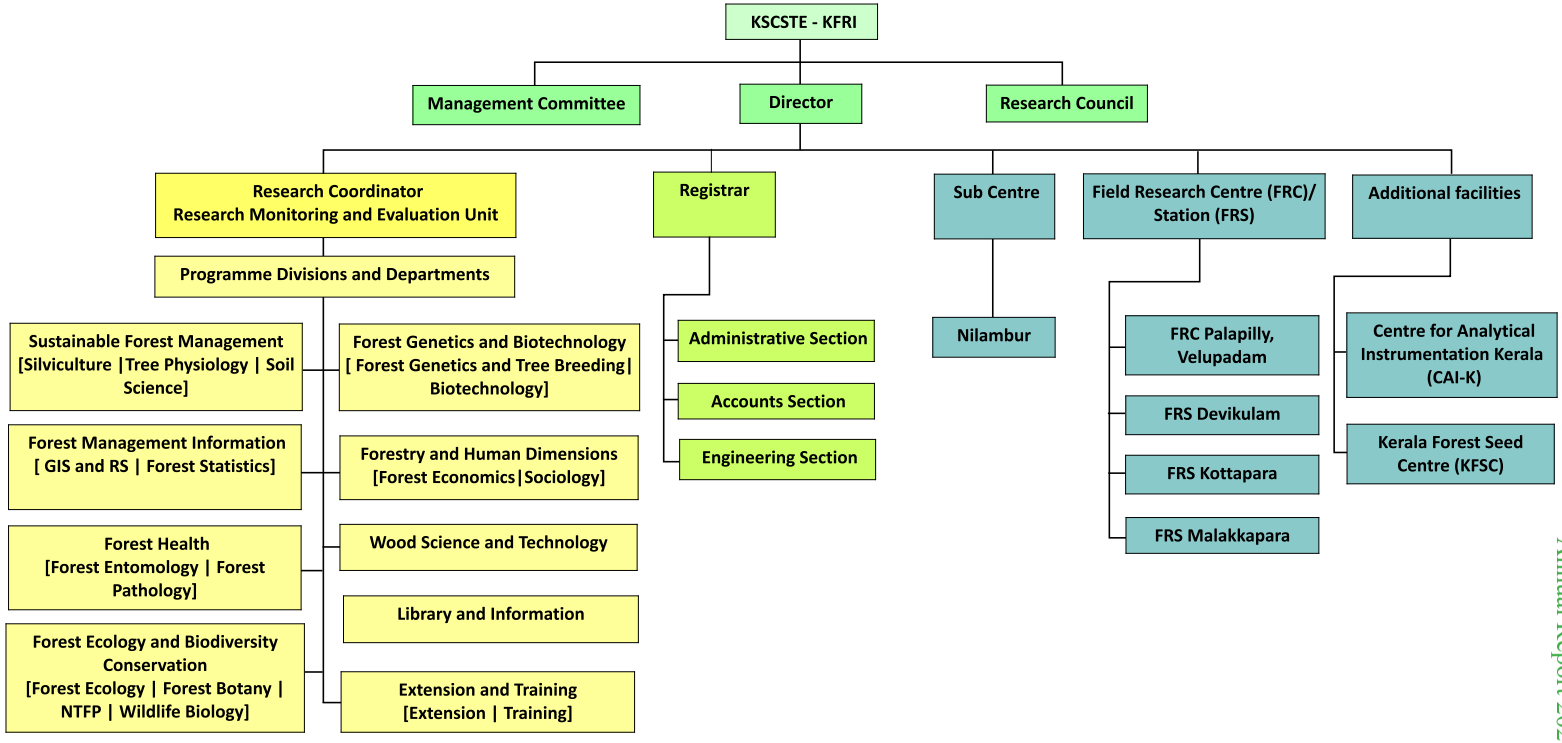
KFRI supports and continues focused research on plant pests and diseases, developing strategies for *in situ* as well as *ex situ* conservation of rare, endangered and threatened (RET) species besides monitoring of the impacts of climate change and vegetation process in the natural forests and human modified landscape and ecological studies on post restoration success of threatened plant species.

During 2020-21, the Institute had 120 ongoing projects (Research/Extension/Consultancy) looking at different aspects of forestry, covering global and local relevance. Our sponsors included the Food and Agricultural Organization (FAO), United Nations Development Programme (UNDP), ICLEI South Asia, United States Agency for International Development (USAID), Zayed Species Conservation Fund, Abu Dhabi, 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 Board (NMPB and 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 organisations and the KFRI Plan Grants. The Institute received Rs. 1361.71 Lakhs as grants from Kerala State Council for Science Technology and Environment, Government of Kerala of which Rs. 521.71 lakhs is under Plan Grants and the rest under Non-Plan. Financial support sanctioned by external agencies amounts to Rs. 2263.89 Lakhs. Funds from Plan Grants were utilized for research, extension projects and for infrastructure development.

I place on record the valuable guidance and unstinted support received from Research Council, Management Committee, Kerala State Council for Science Technology and Environment and the unrelenting co-operation and support from the scientists, staff and students of KFRI.

Dr.Syam Viswanath
Director

ORGANOGRAM


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

THE INSTITUTE

Kerala Forest Research Institute (KFRI) was established by the Government of Kerala as an autonomous Institute in 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 and Insect 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 of United Nations, the Bamboo Technical Support Group (BTSG) of the National Bamboo Mission, Government 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, fieldwork 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, Field Research Centre at Velupadam in Thrissur District, and Field Research Stations at Munnar, Kottapara, and Malakkappara.

Sub - Centre, Nilambur

Located in the fringes of the Nilgiri Biosphere Reserve at Nilambur, the KFRI Sub - Centre campus spread over 43.36 hectares area, is about 140 kms away from the main campus, Peechi. The Sub - Centre has Microbiology and Molecular Biology laboratories and field trials. The Sub Centre is one of the important green Institutions in Malappuram District with rich floral and faunal diversities on the banks of Karimpuzha, a tributary of Chaliyar River. 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 represent species, subspecies and natural varieties while the remaining 191 taxa represent cultivars and hybrids. A range of landscapes from carefully tended to naturalized areas can be seen within the campus. A bambusetum with 35 species of bamboos are maintained at the Sub - Centre. The Sub - Centre also houses the famous Teak Museum, Bio - resources Nature Park, Medicinal garden, Herbal garden and a model Butterfly garden.

Field Research Centre, 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: Located at Malakkappara 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 the

projects and scientific staff in field-oriented research activities, mainly to accommodate research personnel attached to the Institute in long - term monitoring programme. The permanent plots of the Institute in this area includs a 10 hectares plot in tropical wet evergreen forests of Karadishola, Sholayar in the Vazhachal Forest Division.

Devikulam: The FRS is located at Devikulam range of Munnar Forest Division in Idukki district. The Station has nurseries for the production of Eucalyptus clones for research projects of the Institute. 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. Presently, 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.

Kottappara: 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 Programme Divisions and Departments. Clusters of three or four Departments form a Programme Division. 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 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 manag-

ing 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 Institutes, 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 Animals 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. The study of physiological and biochemical aspects of recalcitrant seeds, developing protocols for clonal and seed propagation of Threatened trees/NTFPs/lesser known wild fruit trees, climate change impact on endemic and threatened trees, documentation of woody plants endemic to Kerala are the key domains of the Tree Physiology Department.

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

The notable contributions of the Silviculture Department are in the plantation sector, especially in teak and bamboos in Kerala. Coping with the current scenario, developments and requirements in world forestry sector, the programmes of the Department are multidisciplinary and multi-institutional in nature. Current pro-

grammes 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, among others. 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 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 providing wide range of services to various Government Departments and the general public. The Department also maintains live collections of orchids and ferns.

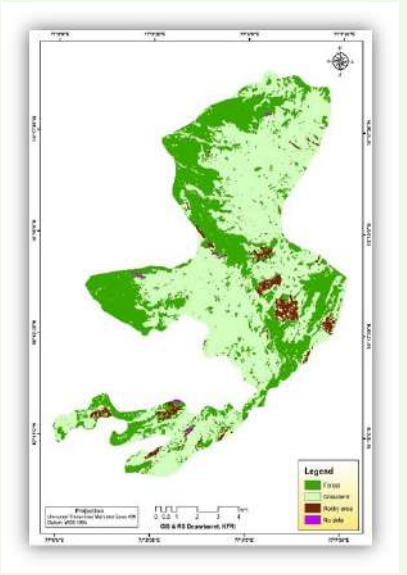
Forest Genetics and Biotechnology

The Programme Division includes Forest Genetics and Tree Breeding as well as Biotechnology Departments 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 micropropagation, field testing of superior clones, DNA fingerprinting, 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 Division also provides DNA evidences to trace the identity of seized timber logs to the suspected stumps in forests and undertakes consultancy services for various State Forest Departments.

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 of selected tree species, plus tree selection, establishment of seed orchard and clonal hedge garden, population genetic structure, adaptive genetics and transcriptomics for sustainable conservation and management of cane, teak and sandal genetic resources, conservation genetics of selected RET species in the Western Ghats as well as DNA barcoding for biosystematics, certification of bamboos, authentication of non-wood forest products (NWFPs) and timber forensics.

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, and manages a comprehensive database that supports the decision-making process. The Division has been actively engaged in various research activities including stand modeling, biodiversity mapping, ecosystem analysis, resource mapping, and population analysis. Currently, the core activities focus on different aspects of climate change research including the physical basis, mitigation and adaptation. The Division also works on the greenhouse gas inventorying, carbon stocks assessments, and carbon sequestration estimations. The Division uses high spatial, spectral and temporal remote sensing data for characterizing the compositional and functional attributes of forests and trees outside the forest. The Division partners with various national and international organizations, and provides 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 Forest Botany Department include, documentation and inventorisation of biodiversity of diverse forest types and protected areas, evaluation of below ground biodiversity, molecular taxonomy, biosystematics and conservation of RET species of flora. Impact of flood on floral elements and soil biota in Pamba, Periyar, Bharathapuzha and Chalakkudy Rivers in Kerala was one of the major projects executed by the Department after the 2018 flood scenario.

Forest Ecology Department works on long-term monitoring of forest ecosystems in Kerala through permanent sam-

ple plots, biodiversity characterization at community level in India using Earth Observation Data, eco-physiology, plant functional traits of forest trees and climate change responses of tropical trees.

The Wildlife Biology Department attempts various aspects on inventorisation of fauna, endangered animals, man-wildlife interaction, conservation activities of critically endangered Cyad, *Cycas annaikalensis* and wildlife census. Developing long term monitoring tools and strategies for mitigating human-wildlife conflicts in Kerala is one of the major activities of the Department. A wildlife museum with an exhaustive collection of species is attached to the Wildlife Department.

The NWFP Department works on phytochemical analysis of NWFPs and other medicinal plants, isolation, characterization and bioactivity studies of various biomolecules from medicinal plants of the Western Ghats, among others. Major projects of the Department include, studies on the pesticide usage pattern on the ecosystem of Munnar landscape, nutritional analysis of edible bamboos and bioactivity guided fractionation and mechanistic elucidation of biomolecules from *Cocculus laurifolius* DC. of southern Western Ghats.

Wood Science and Technology

The Programme Division focuses on research related to wood properties and utilization, wood structure, timber processing technology for increased durability, value addition, pulping characteristics of reed bamboos, among others. Division has facilities for Universal Testing Machine (UTM), image analyzer and NIR spectroscope. The Division undertook many studies on wood structure, properties, quality assessment of teak, eucalypts and preservative treatments for species like rubber wood and coconut wood. The Division also focuses on wood quality variation of natural teak provenances and the impact of climate change on growth dynamics of tropical species like teak. Under the latter, the Division procured and established the latest State of the Art, Tree-Ring measuring station. The major extension activities of the Division include, wood identification of tropical/temperate and exotic timbers for public sectors and judicial purposes. The well-curated Xylarium serves this purpose to the scientific community. In addition, anatomical studies, utilization and value addition of products on bamboos and canes have been undertaken. Activities include, evaluation of *Ochlandra* germplasm, mass propagation and field trials of elites for selection of low lignin plant material with desirable pulping properties and facilitating the establishment of bamboo and cane enterprises through training and technology transfer.

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

The Programme Division has Forest Entomology and Forest Pathology Departments. The thrust areas of the Forest Entomology Department in KFRI include monitoring of forest insect diversity, control of termites in plantations, wood damaging insects and teak defoliators, traditional methods of post-harvest protection of bamboo from insect borers, among others. The mass production technology of the biopesticide, *Hyblaea puera* Nucleo Polyhedrosis Virus (HpNPV) has been standardized, and the application technology has been transferred to stakeholders. Research programmes in the Department of Forest Entomology include (a) Evaluation of the present and potential insect pest problems relevant to forestry in Kerala, (b) Development of suitable methods or procedures to reduce the economic loss caused by the pests, (c) Study of the soil biology with special reference to the insect biota and (d) Biological control of the insect pests. In addition to this problem-solving research, some fundamental studies on the taxonomy, biology and ecology of insects are undertaken to increase our understanding of the interaction between insects and trees and the role of insects in the forest. Research highlights of the Entomology

Department includes: management of biological invasion in Kerala, control and management of teak borer pest, *Cossus cadambe*, *ex-situ* conservation of lac insect genetic resources, standardization of methods for control of termites in eucalypt plantations, identification and control of insect borers of stored commercial wood, study on loss of wood increment in teak due to insect defoliator, *Hyblaea puera*, management strategy for *Hyblaea puera* in teak using a potential of natural enemy *Hyblaea puera* Nucleo Polyhedrosis Virus (HpNPV). Investigations are made on the seasonal incidence and control of pests of *Ailanthus*, *Albizia* and *Gmelina*, incidence of pests in natural forests and develop methods to manage insect pest populations, popularization of the concept of butterfly gardens and provide technical advice to various agencies for the establishment of butterfly parks. The Department maintains a representative collection of identified insects and is equipped to provide identification service to other research organizations on the Lepidopteran fauna.

The Department of Forest Pathology has been working on morpho-molecular characterization and *ex-situ* conservation of phytopathogenic fungi causing various

fungal diseases in forestry plants as well as commercially important medicinal plants in different ecosystems of Kerala part of the Western Ghats. Additionally, the Department focuses on plant growth promoting microbes for high quality bamboo planting production and detection of *Ganoderma* disease in plantations and Agro-ecosystems of Kerala. The Department is also exploring possibilities to manage plant diseases using eco-friendly, cost effective approaches like bio-fertilizers and biocontrol agents. During this period, the Department established a well-equipped Molecular Pathology Laboratory with support of DBT, Govt. of India. Furthermore, the Department has been actively engaged in Food and Agricultural Organization (FAO) sponsored project for the study of invasive pathogens in Nepal.

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 transfer of technology and conducts training programmes in different aspects of tropical forestry like 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 conducting training programmes including lecture halls, trainees' hostel and vehicles for field trips. The Division also liaisons and coordinates technical support to the various stakeholders and Departments, researchers, student community and general public and showcases the Institute in various National and State level exhibitions. During the period, KFRI organized 7 training programmes.

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. KFRI library with a core collection of more than 18,000 books and 2000 back volumes of journals on forestry and allied subjects caters to the information requirements of scientists and research scholars of the Institute and others who are interested. Online access to many of the core journals in forestry and allied subjects is made available which include both national and international journals. Online access to EBSCO database of Environment Complete is possible, which contains more than 2.4 million records from more than 2,200 national and international titles going back to 1888 as well as more than 190 monographs. The library collections 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 and databases in CDs and DVDs.

Online catalogue of book and back volume collections of the library developed by 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 and

other documents published by KFRI scientists, which is possible to access through the Intranet library portal developed for the purpose. Digital resources of the library include KFRI Information Bulletins, Ph.D. theses, Annual Reports and all the published issues of the Evergreen - KFRI Newsletter. 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 by 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 two websites maintained by Library are:

Indian Forestry Abstracts (IFA): Indian Forestry Abstracts (IFA) is a new venture of KFRI library to present a comprehensive bibliography of current forestry literature published in India, along with an abstract for each citation. No such abstracting service exists for Indian forestry literature. The purpose of IFA is to ensure that Indian publications get their due attention from the national and international academic community.

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 collecting, proper documentation and dissemination of bamboo information for the easy access of users. Gathered information of published documents and information on bamboo species, researchers and artisans is consolidated and repackaged and brought to the public in different forms. 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.

Support Sections

The research activities in KFRI are well supported by its Administration, Accounts and Engineering sections. The Administrative section looks after the day-to-day administrative activities of the Institute. Administrative section headed by Registrar, helps Director in the 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. 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.

GLOBAL NETWORKS

TEAKNET (International Teak Information Network)

TEAKNET, an International Network established by FAO addresses the issues of the global teak sector including institutions and individuals interested in teak. TEAKNET is basically manned by an International Steering Committee and its Secretariat is hosted by the Kerala Forest Research Institute (KFRI), Peechi, India, since 2008. TEAKNET activities include releases of quarterly TEAKNET Bulletin, involve in teak related research projects in the sustainable management of natural and planted teak forests in the tropics, answering queries regarding various aspects of teak cultivation and management at global level, routine website updation with the recent reports and current market trends of teakwood products and enrollment of new members to TEAKNET. Events/activities organized by TEAKNET during 2020 - 21 are given below.

1. Developed Teak Bibliography up to 2020
2. Developed Pilot Decision Support Tool for Teak Timber Price
3. Published TEAKNET Newsletters
4. Prepared Policy briefs based on the technical sessions of the World Teak Conference 2021
5. Organized TEAKNET Webinars

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/

MEMBERSHIPS

Asia-Pacific Association of Forestry Research Institutions (APAFRI)

The Asia-Pacific Association of Forestry Research Institutions (APAFRI) is an independent non-profit body, which aims to enhance research and technology development capabilities in support of conservation and management of forest resources in the Asia-Pacific region. APAFRI is the Asia-Pacific chapter of International Union of Forest Research Organizations(IUFRO). Director, KFRI is a member of the executive committee (2021-2024) of APAFRI

REGIONAL CENTRES

Bamboo Technical Support Group (South Zone), National Agroforestry and Bamboo Mission, Ministry of Agriculture, Govt. of India

The Bamboo Technical Support Group (BTSG) South Zone is hosted at KFRI supported by the National Bamboo Mission (NBM) of the Ministry of Agriculture and Farmers Welfare, Govt. of India (GOI). KFRI BTSG team supports various aspects of bamboos by 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 suitability of species for different regions and land types, among others. BTSG KFRI has been involved in training of field functionaries of the various southern States for the past several years.

The following facilities were established through the financial support from NBM, GOI. (1) KFRI Big Bamboo Nursery has improved facilities such as green house, mist chamber, composting units and is capable of mass production of commercially important bamboo seedlings. It serves as a model training unit for trainees, farmers and provides technical guidance to establish bamboo nurseries. The seedlings available in the nursery is duly certified for its quality. During





the reporting period, more than 2 lakhs multiplied seedlings were supplied for river bank stabilization programmes, planting in land slide areas, for boundary plantations, among others. (2) Bamboo biochar production and composting units installed at the Field Research Station (FRS), Velupadam, process bamboo wastes from primary processing units, pelletizer, shredder and chipper. (3) Bamboo shoots processing facility harvests and processes bamboo shoots, evaluates nutrients, removes anti-nutrients, and also carries out post-harvest processing of useful edible bamboo species. (4) Bamboo bazaar at FRS, Velupadam, develops market strategy and marketing of bamboo products produced by different clusters. This will act as a facility to showcase products at conventional and non-conventional spaces across the state and through various websites. KFRI is in the process of becoming a certification authority of planting materials through DNA barcoding and establishing a germplasm of commercially important species through National Bamboo Mission funding for selection of superior genotypes.

Regional Cum Facilitation Centre – Southern Region (RCFC-SR), National Medicinal Plants Board (NMPB), Ministry of AYUSH, Government of India

The NMPB is the apex body, under the Ministry of AYUSH, for promotion of the medicinal plants in the country. NMPB has established six Regional Cum Facilitation Centres (RCFCs) in the country to function and serve as one-stop shop with five objectives: (i) provide techni-

cal inputs to stakeholders for enhancing their managerial and technical skills, (ii) develop agro-technology of medicinal plants, (iii) facilitate production and distribution of Quality Planting Materials (QPMs), (iv) assist various organizations in formulation of project proposals in the priority areas identified by NMPB, and (v) attend to field assessment/evaluation of NMPB projects and other works assigned by NMPB from time to time. RCFC-SR, housed at KFRI, Peechi, is the first of the six Regional cum Facilitation Centres established by NMPB in 2018. RCFC (SR) covers five southern states (Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, Telangana), and the three Union Territories (Puducherry, Lakshadweep, Andaman and Nicobar Islands). During this period, RCFC (SR) has conducted four physical trainings and an online training programme in Karnataka and Kerala. A total of 144 farmers were given training in medicinal plants farming and exposed to the activities of NMPB and RCFC-SR. One web seminar was organized on 'Herbal Garden' during this period. Nine agencies were identified in the five southern States for production of 785750 Quality Planting Materials (QPMs) of 24 medicinal plants and promote cultivation through farmer clusters in their areas. Four NMPB projects were monitored in Kerala and Telangana and the monitoring and evaluation reports were submitted to NMPB. Collection of market prices was carried out for 85 items from the southern region and its trend analysis was graphically presented. Assistance was also extended to 14 stakeholders to establish linkages. Raw drug requirement of 4 industries were also gathered for the purpose of putting the farmers in touch with them for marketing of their produce. During this period, the Centre organized 7 meetings and participated in 11 meetings. In all, 75 extension works and expert services were taken up apart from providing inputs to NMPB.

FACILTIES

Arboretum

KFRI Arboretum established in the Peechi campus in 2003 is an area of about 5 hectares currently has 3355 accessions belonging to 192 species under 50 families and 130 genera, with more than 50 taxa endemic to southern Peninsular India. Arboretum is maintained with grid maps which have location details markings of each of the live collections. Among the 192 taxa in the arboretum, there are 3 gymnosperms and 189 angiosperms. A collection of wild nutmegs, key components of 'Myristica swamps' characterized by evergreen, water-tolerant trees which is considered as the most primitive of the flowering plants or 'living fossils' are special attraction of KFRI Arboretum. *Myristica fatua* (Kotthapanu) *Myristica beddomei* (Pathiripoovu), *Myristica malabarica* (Ponnampayin), *Gymnacranthera farquhariana* (Undappayin) are few among them. The rare woody climbers like *Coscinium fenestratum* is also introduced. It is also recognized internationally by Index Seminum with ID No. 1518 and enlisted in the National Network of Botanical Gardens in India.

Bambusetum

The KFRI Bambusetum at FRC, Velupadam, in Thrissur District of Kerala (10° 26' 07.95" N; 76° 21' 32.92" E) was established during 1985-88 for the *ex situ* conservation of Indian bamboo species and to create awareness and promote the cultivation of bamboo and its products. Moreover, it acts as a living laboratory

which can be effectively utilized for taxonomical, molecular, silvicultural, ecological and synecological studies apart from its educative and aesthetic values. The bambusetum also serves as a genetic resource for future crop improvement programmes for forest managers and farmers. Offsets, rhizomes and seedlings from different parts of the country (Andhra Pradesh, Arunachal Pradesh, Assam, Himachal Pradesh, Karnataka, Kerala, Meghalaya, Mizoram, Orissa, Tripura and West Bengal) were used as planting materials for establishing the bambusetum. It has different types of bamboos like climber bamboos (*Dinochloa andamanica*), monopodial or runner bamboos (*Melocanna baccifera*) and clump form bamboos (*Bambusa bambos*). Fourteen genera with 56 species were the established bamboo species till 2016: *Bambusa* (20 spp.), *Cephalostachyum* (2 spp.), *Dendrocalamus* (9 spp.), *Dinochloa* (2 spp.), *Gigantochloa* (6 spp.), *Guadua angustifolia*, *Melocanna baccifera*, *Ochlandra* (6 spp.), *Oxytenanthera abyssinica*, *Phyllostachys sulphurea*, *Pseudoxytenanthera* (3 spp.), *Schizostachyum dullooa*, *Sinoarundinaria edulis* and *Thyrsostachys* (2 spp.). In 2020-21, the new accessions of *Bambusa cacharensis* (Assam) and *Dendrocalamus hamiltonii* (Aruncachal Pradesh) were added to the collection. Currently, the bambusetum with 71 species of bamboos, is one of the biggest in the country.

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. Conservation of such vast biological resources for the future, while continuing to utilize them to meet the present needs, is really a challenging task. In this context, apart from reduction of habitat loss and *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 - KFRI 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, Palms and rattan Garden, hydrophytes Garden, Butterfly Garden and Taxonomic Garden. By having a rich plant diversity assembled in above mentioned theme areas, this 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 indicates that the visitors have acknowledged the educational and recreational values of the Bioresources Nature Park.

Butterfly Garden

Butterfly garden developed by KFRI in half a hectare area is an important achievement in the field of nature education and also an effort for *in-situ* con-

servation of butterflies. It involves recreation of lost habitats of butterflies through careful landscaping and host plant introduction. KFRI has set up three parks- 1) in the KFRI main campus at Peechi, 2) in the KFRI Sub-Centre at Nilambur and 3) at Thenmala in the Ecotourism area. It is a main attraction for school and college students from all over Kerala. Some of the butterflies that can generally be seen in the garden include Red pierrot *(Talicada nyseus),* Southern Birdwing *(Troides minos),* Common Rose *(Pachliopta aristolochiae),* Malabar Rose *(Pachliopta pandiyana),* Glassy Tiger *(Parantica aglea),* Blue Tiger *(Tirumala limniace),* Dark Blue Tiger *(Tirumala septentrionis),* Chocolate Pansy *(Junonia iphita),* common crow *(Euploea core)* etc. The garden includes more than 60 varieties of plants which comprise larval host plants such as *Citrus, Albizia*, *Cassia*, *Cinnamomum*, *Aristolochia* and nectar plants like *Ixora, Lantana, Mussaenda, Marigold, Zinnia* and *Clerodendrum*. To understand the relationship between temperature and humidity and its influence upon the behavior of butterflies in garden, thermo hygrometers are placed at different sites. Butterfly gardens have be-

come very popular in recent years. Based on requests from appropriate authorities, butterfly gardens were established in schools, colleges, research centers, Government offices and public firms.

Centre for Analytical Instrumentation – Kerala (CAI-K)

The Centre for Analytical Instrumentation was created with a vision to have an assemblage of sophisticated analytical instruments in a centralized facility which will help better management with qualified and dedicated scientific personnel, continuous monitoring, regulated power supply and ambient conditions, among others and provides services to a wide spectrum of stakeholders. The Centre was actively involved in the envisioned objectives during the year such as (a) Create an assemblage of high-end sophisticated instruments for the use of researchers, academicians and other interest groups and (b) Conduct training programmes on analytical instrumentation. A good number of samples for routine analysis were received during the period. During the year (April 2020 - March 2021), three major instruments were added to the facility including High performance thin layer liquid chromatography

(HPTLC), M/s. Camag, Switzerland; High performance liquid chromatography (HPLC), M/s. Shimadzu Corporation, Japan and X- Ray Diffractometer (XRD), M/s. Rigaku Corporation, Japan. Though there were hindrances due to Covid-19 pandemic, routine analysis of internal and external samples was carried out in the facility. A total number of 1420 samples were analyzed during the peri-

od. In addition, two training programmes i.e., an internship training programme in analytical instrumentation from January to March 2021 and a hands-on training programme in water quality monitoring from 15 – 26 March 2021, were carried out. A total income of Rs. 07.15 lakhs was generated during the period.

Central Nursery

The Central Nursery of KFRI is developed to supply Quality Planting Materials (QPM) of forestry species under different categories. It has a collection of about 220 species of high demand under timber yielding, fruit bearing and medicinal categories of plants. The nursery is also engaged in handling a number of rare and threatened species from the Western Ghats, related to various research programmes conducted by the Institute. The nursery ensures the timely availability of planting material to the farmers, general public and other departments. Besides the above species and aspects, the nursery is engaged in handling a number of rare and threatened species from the Western Ghats, related with various research programmes conducted by the Institute. Standardization of nursery techniques of various species

in collaboration with KFRI Seed Centre, is one of the major responsibilities of Central nursery. The data generated in the nursery is used in various ongoing research programs and is useful in future research programmes of the Institute. It also provides employment opportunities and income generation especially for the women. During the financial year, more than 3.5 lakhs Quality Planting Materials of 185 native species were developed

and distributed. In addition, nursery techniques for 20 commercially important species were standardized.

Herbarium

The herbarium at KFRI, established in 1982, is recognized by the International Association of Plant Taxonomists, and is known by the acronym KFRI by Index Herbarium (Taxon 37:503.1988). The herbarium has over 18000 specimens demonstrating more than 2140 species from 203 families and is one of the major reference herbarium of forest plants. It has extensive specimen collection of flowering plants of Kerala, especially medicinal plants and a pan Indian collection of rattans, palms and bamboos of India including Andaman and Nicobar Islands. 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 (171 spp.), Orchidaceae (151 spp.), Arecaceae (109 spp.), Fabaceae (81 spp.), Euphorbiaceae (96 spp.) and Rubiaceae (90 spp.). The herbarium is also represented with more than 90 species of pteridophytes. For instant access of 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/. The website provides basic and advanced search capabilities. Default search can be conducted in all fields of the herbarium database, while advanced search allows searches in specific fields.

Kerala Forest Seed Centre (KFSC)

Kerala Forest Seed Centre (KFSC) established under World Bank assisted Kerala Forestry Project in 2003 as a collaborative programme of KFRI and Kerala Forest & Wildlife Department (KFD). It is located in the main campus of the Institute (10.52668° N; 76.35095° E). It is under direct administrative control of the Director, KFRI. Functioning of the Centre is monitored by an Advisory Committee comprising officials from both the establishments. KFSC is led by a Senior Scientist of KFRI having professional experience in the field of Seed Technology. A Range Forest Officer and a Section Forest Officer on working arrangement is deputed from KFD to the KFSC. The Centre caters the requirement of certified seeds of forestry species to the KFD, other Government Departments, NGOs and farmers in and outside the State. Main objective is to collect seeds from superior trees/stands, process, grade, store and cater to the requirements of stakeholders. It's service is being extensively utilized by research institutions, students, entrepreneurs and farmers. Teak seeds from Seed Production Areas (SPAs) in Kerala are brought to KFSC during March–April. The seeds are subjected for grading, and routine tests like rapid viability test and germination test as per ISTA rules. Depending on the storage physiology, healthy and viable seeds are stored at optimum storage conditions in plastic bins/gunny bags/plastic bags. The seeds in stock are being tested at frequent intervals for viability. In addition to supply of seeds, the facility is utilized for re-

search in Seed Science and Technology on tropical forestry species of the Western Ghats and provides training to forestry professionals, researchers, students and others interested in seeds. During 2020-21, about 5.5 tons of 80 forestry species including Teak (3 tons), other miscellaneous species (2.5 tons) like Mahogany, Sandal, Asokam, Malaveppu, Kanjiram, etc. have been collected and supplied to the stakeholders through KFSC

Medicinal Plants Garden

The Medicinal plant garden at Peechi campus spreads in 0.6 hectares, consisting of 380 species of medicinal plants including of herbs, shrubs, climbers and trees. It is maintained as a reference collection of authentic medicinal plants of Kerala forests. The collection in the garden is enriched by bringing new plants from wild or through exchange with other Botanic gardens. In 2020-21, 65 plant accessions of 58 species were made through various plant collections, of which 16 are new introductions to the garden. For labelling the plants, descriptions for 30 species were prepared and 60 metal boards were displayed both for field and potted plants. As part of QR code preparation of plants, 133 species along with videos were prepared. In addition, 28 species covering 300 medicinal plants were raised for distribution.

Orchidarium and Fernery

The Orchidarium and Fernery are meant to provide artificial habitats for orchids and ferns and help in the *ex situ* conservation, multiplication, besides providing materials for study purposes. Orchids

and ferns are peculiar group of plants with wide range of economic and conservation importance. Orchidaceae, one of the largest families of flowering plants, consists of about 700 genera and 30,000 species and with untold number of hybrids. Though about 265 species have been recorded from Kerala, some species are known only by their type collections and few are presumed to be extinct. Among the orchids of Kerala, thirteen species are used medicinally. At present, the Orchidarium/Fernery of KFRI have 240 species including Rare, Threatened, Terrestrial, Epiphytic species of Orchids and Ferns, also maintaining some rare ornamental orchids and Ferns. During 2020-21, five endangered species of orchids and ferns were added to the Orchidarium.

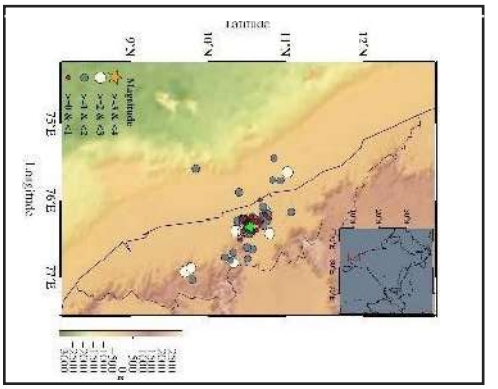
Palmetum

Palmetum is a live collection of indigenous and exotic palms. KFRI Palmetum was established in the year 2000 and the collection includes 158 species of palms under 57 genera. Of these, 75 are indigenous palms and 83 are exotic species with 8 species critically endangered, 9 endangered, 8 vulnerable and 23

near threatened categories as per IUCN standards. The exotic species includes those which are commonly found in Indian parks, gardens and along avenues. The species like *Pinanga manii, P. dicksonii, Bentinckia condapanna, Bentinckia nicobarica, Rhopaloblaste augusta, Calamus andamanicus, C. brandisii, C. vattayila, Wallichia disticha, W. nana, Korthalsia laciniosa, Korthalsia rogersii, Licuala spinosa* as well as mangrove species like *Phoenix paludosa* and *Nypa fruticans* are also present in the collection. Palmetum serves as a facility for educating the public about taxonomy, economical importance and conservation of palm resources.

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 location of earthquakes 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 here 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 informa-

tion on these changes facilitates improved land management decisions that maintain soil productivity and therefore preserve forest sustainability and long-term ecosystem health. The main attraction is a collection of soil monoliths featuring the soils in different types of forests *viz*. shola, evergreen, semi-evergreen, moist and dry deciduous, bamboo, grasslands, teak plantations, degraded forests and agroforestry systems in Kerala. A monolith is essentially a profile representing the soil typical 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. 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 regu-

latory 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 reminiscences 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 in the Museum explain the numerous facets of teak research that KFRI has undertaken and offer a glimpse of the multifarious uses teak timber has been put to in the State. The artifacts include traditional household objects like the granary, swing cot, cloth-chest etc. To regale visitors, details are provided of some of 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

Tree health helpline attends to all queries related to tree planting and management such as site selection, species site matching, planting, thinning, soil testing, fertilization, pest, disease and weed management, multi-species interactions, landscape level forestation programmes, tree/wood sample identification, preservative treatments and economic valuation. The queries related to pests and diseases were mostly concerned with the pests of *Tectona grandis*, *Swietenia mahagoni*, *Artocarpus heterophyllus, Santalum album, Mimusops elangi, Mangifera indica, Ficus religosa, Dalbergia sessoides* among the trees and garden plants. Fertilizer application for teak was mostly reported in the tree health helpline. Some of the cases were regarding the enquiry of health status of the trees and selection of appropriate sites for planting trees.

Wildlife Museum

The wildlife museum has a comprehensive collection of well-preserved specimens belonging to various taxa from different locations across the Western Ghats, a collection from different projects undertaken by KFRI since 1978. It has variety of preserved specimens including many mammals, invertebrates,

amphibians, fishes, birds and reptiles. More than 1000 specimens were collected as study materials, for awareness creation and reference materials for research students. Majority of the collection are identified and labeled. The collection has 76 amphibians including rare and endangered living fossil, *Nasikabatrachus sahyadrensis*, 95 reptiles including rare coral snakes, kraits and many more reptiles, 49 mammals include rare little Indian porpoise, flying squirrel, spiny dormouse and 8 aves. Other than vertebrates, there are a number of preserved invertebrate species including molluscs, *Meretrix* species and spiders from various regions of the State. The specimen collection at the museum is used for graduate and undergraduate training, species identification workshops and educational programs by State and local agencies. The major objective is to support and encourage morphology based taxonomy research and education which will establish KFRI as a key reference facility in Kerala addressing environmental issues, such as, wildlife conservation, endangered species recovery, native fish decline, landscape ecology, systematics and biodiversity studies.

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 programmes. KFRI xylarium was established in the year 1979, and has a collection of 587 specimens, 133 samples representing 68 genera and 114 species from Kerala/India and the

rest are from 13 foreign countries. It has been indexed in Kew Royal Botanic Garden, UK in its Index Xylarium 4 - a directory of Institutional Wood Collections from around the world. The dimension of the KFRI xylarium sample is: 10 x 6 x 1 cm for small specimens and 16 x 10 x 2 cm for large specimens following international standard. The xylarium database has detailed records, covering, family name of the tree from which the wood was collected, species name, original wood specimen number, date of collection, collector(s) name, herbarium number of the voucher specimen, country, altitude, latitude, longitude, habit, habitat, and note on collection or accession. For each wood specimen, there will be a corresponding voucher herbarium specimen deposited in the KFRI Herbarium with the same accession number. KFRI offers a few Indian species for mutual exchange of xylarium samples.

RESEARCH AND EXTENSION

Completed Research Projects

KFRI Research Report No. 564

Development of biomarkers as a predictive tool for organophosphate toxicity in terrestrial ecosystem

(Jayaraj R, Suma Arun Dev)

Terrestrial ecosystem is the major agro-ecosystem in India and is predominately controlled by human activities for maximizing the food production. There are heavy inputs of chemicals including fertilizers and pesticides applied to this system for optimal agricultural production and organophospate (OP) chemicals occupy a predominant position. Many studies have clearly indicated that terrestrial organisms are severely affected by pesticide exposures. The present study tried to identify biomarkers for organophosphate toxicity, investigating the oxidative stress pathway utilizing *Eisenia fetida* as a model organism. Earthworms provide key soil functions that favour many positive ecosystem services and occupy 80 per cent of the invertebrate biomass in the terrestrial system. The present study evaluated the response of *E. fetida* against eight organophosphate pesticides; acephate, chlorpyriphos, dichlorvos, dimethoate, malathion, monocrotophos, quinalphos and triazophos. *E. fetida* showed avoidance to the pesticide contaminated soils in varying degrees. The transcript analysis of five major genes involved in the oxidative stress pathway – glutathione peroxidase (GPx), glutathione-s-transferase (GST), superoxide dismutase (SOD), catalase (CAT) and HSP-70 - showed upregulation in a dose depended manner indicating their involvement in the OP toxicity. The evaluation of the connected biochemical events, increased lipid peroxidation, depletion of reduced glutathione and total protein confirmed the involvement of oxidative stress pathway. The results are in tandem with the inhibition of classical OP biomarker acetylcholine esterase. The study identified that the evaluation of major macromolecules of oxidative stress pathway reduced glutathione along with the enzymes GPx, GST, CAT and SOD - could function as biomarkers of organophosphate toxicity in terrestrial organisms.

KFRI Research Report No. 565

BTSG-NBM-Project Coordination

(Muralidharan EM)

The Annual Action Plan (AAP) of the Bamboo Technical Support Group (BTSG-KFRI) activities approved by NBM included training of various stakeholders, information dissemination through setting up of a new website for Bamboo Information Center (BIC -India), development of a framework for certification of bamboo planting materials and nurseries, preparation of manuals & guidelines for bamboo nurseries and plantations, and upgradation of the Bamboo Primary Processing Centre (BPPC). Other components *viz*. monitoring of productivity in bamboo plantations, interaction workshop for State Mission Directors, undertaking of model plantations, livelihood assessment and database development for supporting certification of planting materials were not undertaken since the amount received as grants

were not sufficient for all activities. Certification of bamboo products and multiple-use bamboo plantations which were proposed activities, were not approved by NBM for the year. Each of the approved activities under the AAP were given separate KFRI Research Project numbers and at the end of the project period KFRI Research Reports have been produced separately.

The activities undertaken in the component on coordination of the BTSG included liaison with the NBM headquarter and interaction with the officials. Other than meetings called for in New Delhi, frequent interactions took place when queries from Lok Sabha or from other agencies were received and answered or in the form of advice to the DDG (NBM) regarding policy issues. Support was also given in the form of review of NBM projects and project reports submitted by various agencies. Frequent interaction occurred with the Kerala State Bamboo Mission and the Kerala State Bamboo Corporation in the form of technical advice on cultivation of bamboo and other aspects and as a member of various committees. Interaction with different stakeholders in the bamboo sector occurred routinely. Frequent queries were received through phone calls, emails and social media from bamboo farmers and artisans. Most common queries were on selection of appropriate species for planting and the scope of commercial cultivation. Field visits were undertaken to the sites in some of the instances to understand the site conditions and feasibility of implementing the suggestions.

KFRI Research Report No. 566

Establishment of a soil museum at KFRI

(Sujatha MP)

The objective of this study was to establish a Soil Museum by displaying monoliths from different forest ecosystems of the Western Ghat region of Kerala. For this, 15 soil monoliths were excavated from the soil profiles dug at 15 different forest ecosystems, such as, teak plantations of 1st, 2nd and 3rd rotations, natural bamboo, moist deciduous forest, reed bamboo, shola forest, grass land, dry deciduous forest, scrub jungle, degraded forest, semi-evergreen forest, teak plantation of 2nd rotation on lateritic soil, agro-forestry and evergreen forest, and processed as per the standard procedure. The soil profiles were studied for various morphological properties, and horizon-wise samples collected were

subjected to physico-chemical analysis. Results of the study revealed wide variation in the morphological as well as physical and chemical characteristics of the soils as influenced by the variation in vegetation, elevation, topography and climatic factors. Among the ecosystems, shola forest was very unique in its soil characteristics with its higher stock of organic carbon (631.2 Mg C ha^{-1}) even up to 1.5 m depth, and higher content of exchangeable Aluminium (Al). But the same pattern with respect to carbon stock and Al was not seen in grasslands, which was adjacent to shola forest. All the soils were fairly rich in organic carbon and associated nutrients, even though some definite variations could be observed in the vegetation between windward and rain shadow area. Soils of teak plantations at Nilambur were unique with its alluvial origin while those in midland were lateritic in nature. The disturbance to natural forests showed a strong impact on weathering and laterization processes. The monoliths excavated clearly depict the variation in the soils of windward and rain shadow areas as well as the influence of each vegetation in protecting and conserving the soil below it, which ultimately dictate the hydrology and carbon sequestration and stability of the systems.

KFRI Research Report No. 567

Quality improvement of organic manures for reducing soil health hazards (Sujatha MP)

The present study was undertaken with the aim of arriving at a good quality organic manure for the production of healthy food and timber by sustaining the health of soil. The main objectives of the study were to evaluate the quality of organic manures available in the market and, to popularize the use of high-quality manures especially with the help of rural women. The study was conducted by collecting a total of 21 samples of composts, produced and marketed at various places in Thrissur and Palakkad Districts. Evaluation at the site of sample collection revealed that all the samples differed in their mode of preparation and feed stock materials used. Nutrient assay indicated that composts made out of coir pith had low pH (4.8) followed by castor bone complex (pH 5.7). All other composts were with pH > 6. C/N ratio of most of the samples were below 10 indicating a relatively higher content of N than C, which automatically leads

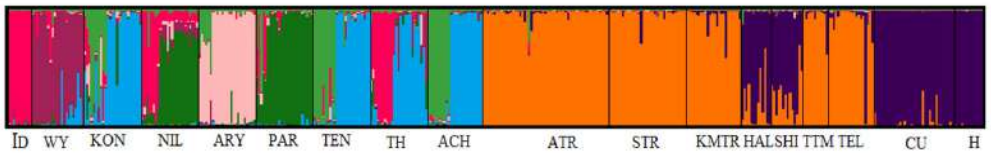
to faster mineralization process, on application to soil. Most of the samples under study were with more N and P than the prescribed limit. But the composts made out of paper, mushroom, market, Oushadhi and sugarcane wastes, etc. did not meet the prescribed limit of K. Composts from paper, market, mushroom and kitchen wastes, etc. were also poor in Ca and Mg, while all of them were a good reserve of micronutrients. Toxic levels of heavy metals, such as, Cd, Pb and Cr were noted in some composts warranting an assay of heavy metals prior to their application in soil. Among the 21 samples analyzed, the urban waste composts from Laloor and Palakkad were found contaminated with *E. coli*, *Salmonella* and other pathogenic fungi. The pesticide analysis revealed non-detectable level of commonly used pesticides in all the samples. The quality indices of organic manures tested in this study varied from 2.92 to 4.28, the lowest value in vermin agri-waste compost from Vettukkad and highest in weed compost produced using jeevamrutham. Lower values (<4.0) in most of the manures except weed compost indicated that they were laden with one or more toxic heavy metals.

Composting of mixed weeds with various treatments *viz*., cow dung, urea, microbial consortium and jeevamrutham revealed that application of microbial consortium and jeevamrutham could reduce the composting period from 120 days (without inoculum) to 70-75 days, while the reduction was only up to 100 days with cow dung. Microbial assay of different types of inocula revealed relatively higher number of bacteria, fungi and actinomycetes in jeevamrutham. Based on the temperature attained and the turnings carried out, the interval of turning was standardized as alternate days up to 10 days, three days interval for the next 15 days and five days interval for the next 25 days. Results also pointed out that the practice of application of urea during composting can be eliminated by the use of jeevamrutham. The organic manure thus produced is popularised in the name of KFRI Sampoorna jaivavalam, ie., an organic manure with all essential nutrients, diversified microorganisms and various phytochemicals. The technology thus developed was popularized through training and awareness programmes to various sections of the society.

KFRI Research Report No. 568

Documentation of population demography and genetic structure of teak for developing sustainable conservation strategies and resource management (Suma Arun Dev, Pillai PKC)

Population genomics determines the evolutionary potential of a species by decoding the genetic structure and diversity of populations from diverse geo-ecological gradients. Teak, a tropical timber tree species distributed in diverse environmental and geographical conditions, is more responsive to local adaptation. The study investigates the extent of genetic variation and local adaptive potential of teak natural populations in India using genome-wide SSR markers, thereby identifying the role of isolation by dis-



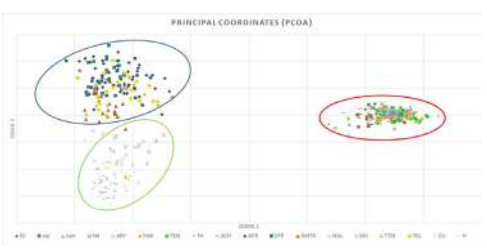
tance and isolation by environment in shaping the genetic structure. Bottleneck effect along with genetic drift and local adaptation have played a crucial role in designing the population genetic structure which separated the population into three genecological zones namely, Kerala, Tamil Nadu-Karnataka and Karnataka-central India (Gujrat and Madhya Pradesh). We have examined the genetic variability, genetic structure, allelic richness, private and unique adaptive alleles. Significant association of genetic structure to environmental factors like temperature and precipitation has revealed using linked neutral loci (locus TFGTB285 and IFGTB479b). Genetic variability of teak populations in India was also determined by geographical factors and specifically longitude (95.92 %) showed greater correlation than latitude (21.2 %). The populations/genotypes with higher private or adaptive unique alleles could be targeted for sustainable management, conservation and genetic improvement of teak genetic resources in the country. Niche modelling identified central Indian populations to be more vulnerable to climate change and probable shift in the distribution pattern of the species in the ensuing years.

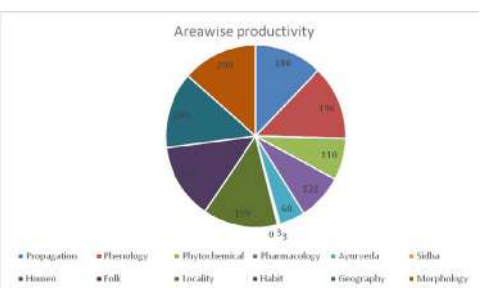
Research Report Number No. 569

Information system on selected medicinal plants of Kerala

(George KF)

An information system is developed with two hundred research oriented medicinal plants. It contains plant details, traditional system of medicine, pharmacology, conservation, botany and bibliography. Forty-two rare, old and precious books on medicinal plants were digitized and made available in KFRI library portal and can be searched by author, title and subjects. Twenty KFRI Research Reports and fourteen KFRI scientific papers on





medicinal plants were also digitized. A significant advantage of digitizing older documents is to make them accessible and searchable for future use. Once a document has been properly digitized, it becomes immortal and can remain accessible for a long time even after the original has ceased to exist. The same resources can be used simultaneously by a number of users and accessed from anywhere at any time. The option of digital access further aids in preservation of originals through reduced need for physical handling.

KFRI Research Report No. 570

Long-term monitoring of forest ecosystem dynamics: Phase l: Establishment of 10 ha. permanent plot in tropical wet evergreen forest of Kerala

(Sreejith KA, Sreekumar VB)

A permanent plot of 10 ha (500×250 m^2) was established for long-term ecological research and data collection on diversity and dynamics of forest ecosystem in a tropical evergreen forest at Karadichola, Sholayar Range, Vazhachal Forest Division, Kerala in Southern Western Ghats. Complete inventory of woody individuals ≥1 cm dbh was done and each individual was permanently tagged with sequentially numbered aluminium tags. In all, 25390 individuals belonging to 44 families, 81 genera and 106 species were tagged. Out of the 106 species, 38 species' are endemic to the Western Ghats and 20 are listed in IUCN categories. Among the trees, *Palaquium ellipticum* scored high in terms of Importance Value Index (IVI) followed by *Cullenia exarillata* and *Vateria indica*. In the shrubs, *Psychotria nudiflora* had the highest IVI, followed by *Dendrocnide sinuata* and *Psychotria anamalayana*. Girth class distribution showed normal distribution indicating a relatively static undisturbed forest patch of trees. Structure, function and dynamics of the forest patch shall be studied on a long-term basis as the results would be useful in the context of climate change.

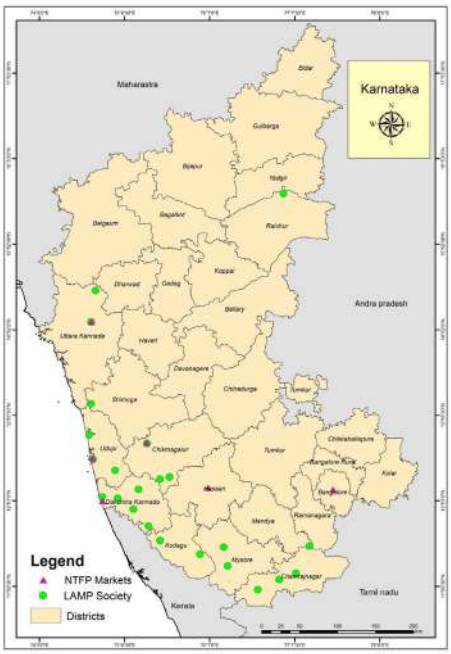
KFRI Research Report No. 571

The medicinal plants market in south India: economic value and tribal rights

(Anitha V, Sujanapal P)

The study of the medicinal plants market in south India, covering Karnataka, Kerala, and Tamil Nadu, is an exploration of the synergistic opportunities for livelihoods and industry linked with the medicinal plants in lieu of its ever-growing demand. The market in south India is demand driven, wherein, many products that cater to subsistence needs are now being replaced by those with high economic value. The structure and functioning of the medicinal plant sector highlight a formal and informal system. The study identified 25 major firms based on their market share in the south India with Tamil Nadu constituting 37 per cent followed by Karnataka (36 %) and Kerala (27 %). The trend values of the price components of sales and collection of the medicinal plants in the formal sector highlight that the administered price mechanism is influenced by market price movements.

The informal sector/local market plays a crucial role in the medicinal plants trade in south India that cater to a larger social base. The medicinal plants supply value chain depicts multi stakeholder groups that operates with little vertical integration and almost no horizontal collaboration. There exists an inverse relationship between length of supply chain and returns. The price spread and percentage share of Collection Price of plant species highlights that the percentage share



of collection to Retail Price is the least in the price spread of medicinal plants trade. This endorses the vulnerability of the primary stakeholders. Consequently, a high proportion of production, trade and consumption takes place in the informal sector. The key marketing and management institutions in south India created as part of different policy initiation of State and central government illustrate institutional overlaps, a key causative for the growth of the informal sector. Using the specific case of selected wild harvested medicinal plants, the study highlights a growing informal sector, market failure and institutional overlaps as the key issues facing the medicinal plants sector.

Total monetary value of selected plants species *Sida rhombifolia*, *Desmodium gangeticum* and *Pseudarthria viscida* traded in Kerala is Rs. 87.92 Cr. Spe-

cies-wise value is estimated as Rs. 62.84 Cr., Rs.14.01 Cr. and Rs.11.07 Cr. respectively. With a shift towards domestication of medicinal plants, many farmers are engaged in cultivation of medicinal plants in south India. Tamil Nadu is leading in terms of area, production, and productivity of medicinal plants followed by Karnataka. Kerala is yet to depict visible outcomes in the cultivation of medicinal plants. Further chronicled and discussed is the Forest Rights Acts 2006 and its implications. The study proposes improved mechanisms towards management of medicinal plants and economic outcomes focusing on social development of the primary stakeholders that is pivotal to conservation and development of medicinal plants and benefit sharing with local communities in a public policy framework. The study discusses the challenges in a south Indian perspective and recommends interventions for sectoral progress.

KFRI Research Report No. 572

Authentication of major commercially traded raw drugs in the ayurvedic systems of medicine in India

(Suma Arun Dev, Jayaraj R, Sujanapal P, Anitha V)

Huge demand for medicinal plants in India has exerted a heavy strain on the existing natural resources, leading to depletion of highly traded ayurvedic plants. Alongside, adulteration of expensive raw drugs with inferior taxa compromised the quality and safety of herbal products. Therefore, it is imperative to bring forth universally acceptable standard tools to authenticate ayurvedic raw drugs. In this regard, the study addresses the development of an integrated approach involving DNA barcode and High Performance Thin Layer Chromatography (HPTLC) fingerprinting to authenticate selected commercially traded ayurvedic raw drugs *(viz. Saraca asoca* (Roxb.) *de Wilde, Terminalia arjuna* (Roxb. ex DC.) Wight & Arn*., Sida alnifolia* L*., Desmodium gangeticum* (L.) DC. and *Cosciniu fenestratum* (Gaertn.) Colebr.) from its adulterants. CBOL recommended DNA barcode gene regions *viz*. nuclear ribosomal–Internal Transcribed Spacer (nrDNA-*ITS*), maturase K (*matK*), ribulose-1,5-bisphosphate carboxylase/ oxygenase large subunit (*rbcL*) and *psbA-trnH* spacer regions along with HPTLC profiling were experimented for the purpose. Even though, DNA barcode region, *ITS* showed promising results along with other barcode gene regions in *D. gangeticum*, *T. arjuna*, *S. asoca* and *psbA-trnH* barcode in *C. fenestratum*, *S. alnifolia*, high number of indels along with huge interspecific variation limited their utility for authentication. Consequently, *rbcL* and *matK* barcode sequence database which was discriminant enough to identify adulterants were selected to validate the traded raw drugs. HPTLC analysis depicted quality profiles that distinguished original raw drugs from adulterants, though showed profile variations among accessions of species. Further, an integrated analytical approach employing Maximum Likelihood phylogenetic tree and Waikato Environment for Knowledge Analysis (WEKA) were employed to prove efficacy of DNA

barcode method. The automated species identification technique, WEKA provided a large platform for rapid and precise authentication analysis of raw drug samples. Along with the recommended organoleptic and analytical methods, an integrated approach involving a DNA barcode tool along with HPTLC fingerprinting can strengthen the existing practice of quality checking and authentication of ayurvedic raw drugs by any of the certification agencies.

KFRI Research Report No. 573

Appraisal of Forest Rights Act 2006-Implementation among the Particularly Vulnerable Tribal Groups in Kerala

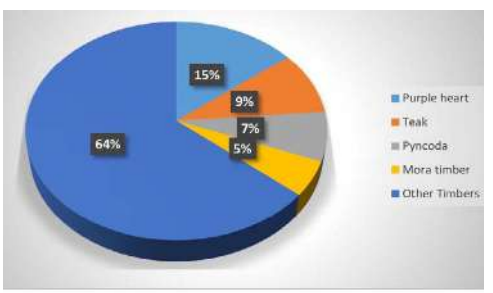
(Anitha V, Sankar S, Amruth M)

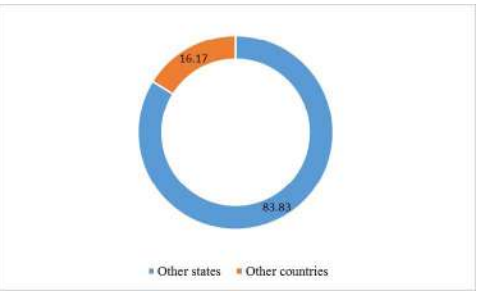
The study explores the policy implementation strategy, in the context of Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Rights on Forest) Act, 2006 among the Particularly Vulnerable Tribal Groups in Kerala. This investigates the major points on implementation status, the major deterrents, the challenges and opportunities entailed with respect to target group. Primary data was also collected through focus group discussions that involved meeting with officials of various implementing agencies and discussions with the primary stakeholder. Secondary data from different sources ranging from different departmental bodies to ministerial data provided the needed comparative frame. Quantitative analysis using simple descriptive statistics was used for data analysis and interpretation. The study identified its potential structural strengths and weaknesses. The differences across cases is attributable to differential vulnerabilities, the nature of community life - sedentary versus nomadic living closer to forest fringe versus living in the forest, among others. But to a larger extent it has got to do with qualitative variations in implementation strategy. The implementations in many cases have been qualitatively poor. Rather than creating total awareness among the key implementing officials and primary stakeholders on the details of the law and the various provisions under it through extensive trainings, primacy was given to ensuring

faster implementation of the law. This led to prevention in understanding and tackling the complex nature of the law, as well as circumvention of complex feedback on benefits and impacts on resources. The study highlights that the key to a successful implementation is the target group being a socially developed and well informed. These policies have the potential to be useful, provided there is clarity on the provisions. This requires active participation of key stakeholders that is possible only through awareness generation and a system that encourages feedback and improvements.

KFRI Research Report No. 574
Wood balance study in Kerala 2014-15
(Anitha V, Sandeep S)

This study estimates the demand and supply of timber wood in Kerala for the year 2014-15. The demand for timber during 2014-15 in Kerala was estimated to be 10.98 million m^3 of round wood equivalent. The households sector accounted for 14.1 per cent and industries sector 77.55 per cent of the total demand. Export accounted for 8.35 per cent of the total timber wood demand. Export of packing cases was in the order





of 7,52,000 m^3 round wood equivalent during 2014-15 and rubber wood alone contributed 3,38,175 m^3 round wood equivalent to this export. During 2014-15, home gardens and estates (including rubber estates) catered to > 95 per cent of the timber wood demand in the State. The study revealed a comfortable situation in the matter of timber wood availability in Kerala, mainly due to the large volume of rubber wood production which is used by the packing cases, plywood and even furniture industries. Of the total timber wood demand, a major portion is used for furniture, fixtures and construction (66.9 % of the total demand), where the preference of the timber species is as jack wood > teak wood > anjily. The dependency of wood-based industries on the state forest was minimal. During 2014-15 period, 2,66,044 m^3 of round wood equivalent was imported to the State either from neighbouring states or other countries. Import of timber into Kerala has been growing and the trend is expected to continue in the future. The estimates of the demand and supply of timber wood in Kerala during 2014-15 highlights a scenario where supply meets the current timber wood demand. A total of 9256 wood based industrial units have

been provided with license/NOC by the Empowered Committee – Kerala Forest Department. At present, these units handle 10.79 million m^3 of round wood equivalent per annum whereas the total demand is for 10.98 million m^3 of round wood equivalent per annum, leaving a gap of 0.190 million m^3 of round wood equivalent per annum between demand and installed sawmill capacity. This gap is filled by unregistered units working with the permission of local bodies alone. The present number of licensed units meet the current timber wood demand in the state. A physical verification of the sawmills should be taken up at periodic intervals to ensure that the licensed units are functional and wherever cases of non-functional units exist, the numbers may be met by issuing new licenses or permitting technological upgradation of the existing ones in the respective categories.

SPECIES NEW TO SCIENCE

1. *Rungia remadeviae* [Jithin KV, Sanil MS, Jose PA* Tree Physiology Department of Sustainable Forest Management Division, Binoy NM, Gin A (2020)]

Rungia remadeviae (Acanthaceae), a new species of Acanthaceae described from Idukki, Kerala, Western Ghats, India. The new species differs from *Rungia apiculata* in their glabrous stem, long slender lax inflorescence, conspicuous bract, length of calyx and corolla, glabrous fruit etc. and from *Rungia linifolia* in their terete glabrous stem, petiolate leaf, shape of lamina, architecture of inflorescence, shape of fruit and seed.

2. *Cercosporella bundelkhandae* comb. nov. [Singh R, Verma SK, Yadav S, Kumar S* Department of Forest Pathology, Forest Health Division (2020)]

The new combination *Cercosporella bundelkhandae* (≡ *Pseudocercosporella bundelkhandae*) is proposed, based on critical morphological re-examination of the holotype specimen and fresh topotypic material and comparison with closely related species of cercosporoid hyphomycetes. The species was originally collected on living leaves of *Tinospora sinensis* from Jhansi, Utttar Pradesh, India

3. Five new species of frog genus *Raorchestes* [Garg S, Suyesh R, Das S *PhD Scholar, Wildlife Department, Forest Ecology & Biodiversity Conservation Division,, Bee MA, Biju SD (2021)]

The genus *Raorchestes* is a large radiation of Old World tree frogs for which the Western Ghats in Peninsular India is the major center for origin and diversification. Five new species of the genus were formally described *viz. Raorchestes drutaahu* sp. nov., *Raorchestes kakkayamensis* sp. nov., *Raorchestes keirasabinae* sp. nov., *Raorchestes sanjappai* sp. nov., and *Raorchestes vellikkannan* sp. nov, all from the State of Kerala in southern Western Ghats.

ONGOING RESEARCH PROJECTS

INTERNATIONAL

1. Building capacities to improve and sustain forest health to enhance the resilience of forests and livelihoods of forest-dependent communities in Nepal (Sajeev TV, Sandeep S, Sujanapal P, Shambhu Kumar) - Food and Agriculture Organization (FAO), United Nations

2. Study on the impact of invasive plant species on ecology of GEF-Munnar landscape project area (Sajeev TV) -United Nations Development Programme (UNDP)

3. Study on diversity and current status of fish and fisheries in GEF-Munnar landscape project area (Sreekumar VB, Sajeev TV) - United Nations Development Programme (UNDP)

4. 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) - United Nations Development Programme (UNDP)

5. Developing a report with photographic documentation on species in the home gardens of Kochi (Sajeev TV, Sujanapal P, Raghu AV) - ICLEI South Asia

6. Demonstration model for utilizing the potential of bamboo and other bioengineering measures for landslide risk reduction and mitigation stabilization under IHRML project (Sandeep S, Sreekumar VB) - United Nations Development Programme (UNDP)

7. Development of tool for timber traceability from private land (Sandeep S, Anitha V, Sreekumar VB, Suma Arun Dev) - United States Agency for International Development (USAID)

8. Conservation of critically endangered Cyad, *Cycas annaikalensis* in India (Balakrishnan P), Zayed Species Conservation Fund, Abu Dhabi

NATIONAL

1. Biodiversity characterization at community level in India using Earth observation data (Sreejith KA) – Dept. of Biotechnology, Govt. of India.

2. Management of destructive invasive alien species in the high range mountain landscape of Munnar in the Western Ghats of Kerala (Sajeev TV, Hrideek TK) – Dept. of Science and Technology (DST), Govt. of India.

3. Population dynamics of selected endemic and threatened trees in the Protected Areas of Kerala: Temporal analysis in the contest of climate change (Jose PA, Sreejith KA) - Dept. of Biotechnology, Govt. of India.

4. Morpho-molecular characterization and *ex-situ* conservation of phytopathogenic fungi of Aralam Wildlife Sanctuary, Kerala and evaluation of antifungal efficiency of five selected medicinal plants leaf extracts against isolated most phytopathogenic fungi (Shambhu Kumar, Mallikarjunaswamy GE) - Dept. of Biotechnology, 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 (Mallikarjunaswamy GE) – Ministry of Environment, Forest and Climate Change (MoEF & CC), 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 the Western Ghats, Kerala (Jose PA) - National Medicinal Plant Board, Ministry of AYUSH, Govt. of India.

7. Genomewide and geospatial approaches for enhancing the adaptive potential of threatened rattan resources in India (Suma Arun Dev, Sreekumar VB) - Dept. of Biotechnology, Govt. of India.

8. Biological management of pest and diseases of selected commercially important medicinal plants (Mallikarjunaswamy GE) – National Medicinal Plant Board, Regional cum Facilitation Centre (RCFC) Ministry of AYUSH, Govt. of India.

9. Assessment of adaptive genetic diversity in teak and sandalwood to guide conservation and genetic improvement efforts (Suma Arun Dev, Jayaraj R) - Dept. of Biotechnology, Govt. of India.

10. Annual Action Plan-BTSG- Coordination (Sreekumar VB, Anitha V) - National Bamboo Mission (NBM) of the Ministry of Agriculture and Farmers Welfare, Govt. of India

11. BTSG-Big Bamboo Nursery (Raveendran VP, Sujanapal P) - National Bamboo Mission (NBM) of the Ministry of Agriculture and Farmers Welfare, Govt. of India

12. Management of bamboo waste in primary processing unit (Sujatha MP, Mohammed Kunhi KV) - National Bamboo Mission (NBM) of the Ministry of Agriculture and Farmers Welfare, Govt. of India

13. Bamboo shoot processing facility (Jayaraj R, Muralidharan EM) - National Bamboo Mission (NBM) of the Ministry of Agriculture and Farmers Welfare, Govt. of India

14. Establishment of bamboo bazaar (Raghu AV, Mohammed Kunhi KV) - National Bamboo Mission (NBM) of the Ministry of Agriculture and Farmers Welfare, Govt. of India.

15. Training of farmers/artisans/field functionaries (Muralidharan EM, Raveendran VP, Raghu AV) - National Bamboo Mission (NBM) of the Ministry of Agriculture and Farmers Welfare, Govt. of India.

16. Organizing workshops and seminars (Anitha V, Sreekumar VB) - National Bamboo Mission (NBM) of the Ministry of Agriculture and Farmers Welfare, Govt. of India.

17. Identification of genetically superior bamboo species (Muralidharan EM, Sreekumar VB, Suma Arun Dev) - National Bamboo Mission (NBM) of the Ministry of Agriculture and Farmers Welfare, Govt. of India.

18. Strengthening of tissue culture lab (Muralidharan EM) - National Bamboo Mission (NBM) of the Ministry of Agriculture and Farmers Welfare, Govt. of India

19. DNA barcoding of bamboos - Phase 2 (Suma Arun Dev, Sreekumar VB, Muralidharan EM) - National Bamboo Mission (NBM) of the Ministry of Agriculture and Farmers Welfare, Govt. of India.

20. Plant growth promoting and biocontrol microbes for high quality bamboo planting stock production (Mallikarjunaswamy GE, Muralidharan EM, Shambhu Kumar) - National Bamboo Mission (NBM) of the Ministry of Agriculture and Farmers Welfare, Govt. of India.

21. Germplasm collection of *Litsea* and *Persea* (Jiggat) species (Muralidharan EM, Sreekumar VB, Sujanapal P, Jose PA) - National Bamboo Mission (NBM) of the Ministry of Agriculture and Farmers Welfare, Govt. of India.

22. Evaluation of alternative species for Jiggat production, characterization of accessions for growth, adaptability and gum production (Sreekumar VB, Muralidharan EM, Jayaraj R, Anitha V) - National Bamboo Mission (NBM) of the Ministry of Agriculture and Farmers Welfare, Govt. of India.

23. Characterization and quality assessment of bark/gum of alternative species for Jiggat production (Jayaraj R, Sreekumar VB, Muralidharan EM) - National Bamboo Mission (NBM) of the Ministry of Agriculture and Farmers Welfare, Govt. of India.

24. Plantation technology for Jiggat species (Muralidharan EM, Jose PA, Sujanapal P) - National Bamboo Mission (NBM) of the Ministry of Agriculture and Farmers Welfare, Govt. of India.

25. Standardization of sustainable harvesting methods for Jiggat species (Jose PA, Sujanapal P, Sreekumar VB) - National Bamboo Mission (NBM) of the Ministry of Agriculture and Farmers Welfare, Govt. of India.

26. Bird hazard to aircrafts in Thiruvananthapuram Airport (Sreekumar VB, Sajeev TV) - Airport Authority of India, Govt. of India.

27. Molecular systematics, geospatial modelling and conservation of the genus *Terminalia* L. in India (Sreekumar VB, Suma Arun Dev, Sreejith KA) - Science and Engineering Research Board (SERB) –Dept. of Science and Technology (DST), Govt. of India.

28. Studies on diversity, distribution and morphomolecular taxonomy of foliicolous hyphomycetous fungi of Peechi - Vazhani Wildlife Sanctuary Kerala (Shambhu Kumar) - Science and Engineering Research Board (SERB) –Dept. of Science and Technology (DST), Govt. of India.

29. Conservation, improvement, management and promotion of Sandalwood (*Santalum album* Linn.) cultivation in India (Suma Arun Dev) - All India Coordinated Research Project-3 CAMPA-ICFRE, Govt. of India.

30. Quantification of the bird hazard to aircraft in the Naval Air Station (INS Garuda), Kochi to develop mitigation strategies (Balakrishnan P, Jayson EA) - INS Garuda (Indian Navy), Govt. of India.

31. Patterns of tree-cavity occurrence and use by vertebrates in tropical forests of the Western Ghats: a community web approach and its implications in forest management (Balakrishnan P) – Ministry of Environment Forest and Climate Change (MoEF & CC), Govt. of India.

32. Demographic survey and restoration of two endangered variants of 'Daruharidra', *Berberis tinctoria* Lesch. and *Coscinium fenestratum* (Gaertn.) Colebr. in the Western Ghats (Sujanapal P, Sreekumar VB) - National Medicinal Plants Board (NMPB), Ministry of AYUSH, Govt. of India.

33. Developing Bamboo Agroforestry Models (Sreekumar VB, Raghu AV) - National Bamboo Mission (NBM) of the Ministry of Agriculture and Farmers Welfare, Govt. of India.

34. Establishment of Herbal Garden as a peri-urban green space at Nilambur, Malappuram District, Kerala (Sujanapal P) - National Medicinal Plants Board (NMPB), Ministry of AYUSH, Govt. of India.

35. Establishment of a Medicinal Plant Seed Centre cum Seed Museum at Kerala Forest Research Institute, Peechi, Thrissur, Kerala (Sujanapal P, Shilpa V Kumar IFS, - National Medicinal Plants Board (NMPB), New Delhi, Govt. of India.

36. Tropical ecosystem vulnerability to the changing climate: An Eco-physiological study from Forests of Southern Western Ghats (Sreejith KA and Sreekumar VB)- Science and Engineering

CONSULTANCY PROJECTS

1. Preparation of compensatory mangrove afforestation and conservation plan related to the widening and improvement of NH 17 from Ramanattukara to Edappally in Kerala (Sujanapal P), National Highway Authority of India, Govt. of India.

2. Preparation of compensatory mangrove afforestation and conservation plan related to the widening and improvement of NH 17 (NH 66) from Vengalam to Edapally (Package II-NHDP Phase III in The State of Kerala) (Sujanapal P), National Highway Authority of India, Govt. of India.

3. Preparation of compensatory mangrove afforestation and conservation plan related to the widening and improvement of NH 17 from Kannur to Thalapady (Karnataka Kerala border) in Kerala (Sujanapal P) - National Highways Authority of India (NHAI)

STATE

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 (Hrideek TK, Muralidharan EM, Raghu AV) - Kerala Forest Development Fund (KFDF), Govt. of Kerala.

2. Economic valuation of ecosystem services in the moist deciduous forests of Kerala (Anitha V, Sreejith KA, Sandeep S, Sreekumar VB) - Kerala Forest Development Fund (KFDF), Govt. of Kerala.

3. Development of management protocols for already established invasive alien species in the protected and other forests of Kerala (Hrideek TK, Raghu AV, Mallikarjunaswamy GE, Sujanapal P) - Kerala Forest Development Fund (KFDF), Govt. of Kerala.

4. Evaluation of selected clones of teak through multisite testing to identify site specific clones for large scale plantation (Hrideek TK) - Kerala Forest Development Fund (KFDF), Govt. of Kerala.

5. Preparation of detailed project report for wildlife friendly Palakkad District (Balakrishnan P, Sajeev TV, Sujanapal P, Raghu AV, Sreekumar VB) - District Panchayat, Palakkad

6. Developing a conservatory of palms and bamboos in the proposed Zoological Park at Puthur, Thrissur (Sreekumar VB, Raveendran VP, Sujanapal P, Sreejith KA), Zoological Park and Wildlife Centre, Thrissur..

7. Reassessing insect assemblage after three decades to decipher climate change induced impact in southern Western Ghats (Sajeev TV) - Department of Environment and Climate Change (DOECC), Govt. of Kerala

8. Medicinal Plants - on call Help Centre and Farm Library (Raghu AV) - State Medicinal Plants Board, Govt. of Kerala (SMPB).

9. Production of organic manure from weeds and organic wastes (Sujatha MP) – Kerala Forest Development Fund (KFDF), Govt. of Kerala.

10. Establishment of a model nursery of medicinal plants at KFRI Field Research Station, Devikulam, Munnar (Sujatha MP, Hrideek TK) - State Medicinal Plants Board, Govt. of Kerala (SMPB).

11. Chemistry and transformation of clay minerals under continuous teak rotations of Kerala Western Ghats (Sandeep S, Sujatha MP) - Kerala State Council for Science Technology and Environment (KSCSTE), Govt. of Kerala.

KFRI PLAN GRANTS

1. Sophisticated analytical instrumentation facility (Jayaraj R, Sandeep S) – Kerala State Council for Science Technology and Environment (KSCSTE), Govt. of Kerala & KFRI Plan Grants.

2. Standardization of vegetative propagation techniques of selected bamboo species and its field performance evaluation in different agroclimatic regions of Kerala Phase -1 (Syam Viswanath -Project Coordinator, Hrideek TK, Raghu AV, Sreekumar VB, Jijeesh CM)

3. Genetic Improvement of Teak- Phase II: locating plus trees, establishment of clonal multiplication area and clonal evaluation trials (Hrideek TK)

4. National Children's Science Congress (NCSC) Assessing goals' impacts after 25 years in Kerala (Raghu AV)

5. Identification of gender specific SNPs in *Coscinium fenestratum* through comparative transcriptomics (Suma Arun Dev, Sujanapal P)

6. 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 (Balakrishnan P, Sajeev TV)

7. Establishment and maintenance of the Centre for Citizen Science and Biodiversity Informatics (Balakrishnan P)

8. Kannadipaya (special bamboo weaved mat product) - studies on physio-chemical and microstructure properties of special bamboos used in weaving by tribal communities of Idukki District, Kerala (Raghu AV, Sreekumar VB)

9. Ecological studies on post restoration success of threatened plants *in situ* (Jose PA, Sujanapal P, Sreekumar VB)

10. Development of protocol for rapid detection of *Ganoderma* disease in plantations and agroecosystems of Kerala (Mallikarjunaswamy GE, Jayaraj R)

11. Assessing landslide vulnerability of forest systems in Kerala and developing restoration protocols (Sandeep S, Sujatha MP, Sreejith KA, Sujanapal P)

12. Development of nanocomposite organic manure from weed compost (Sujatha MP, Sandeep S, Mallikarjunaswamy GE)

13. Study on plant functional traits of selected tree species of Kerala (Sreejith KA, Sreekumar VB)

14. Diversity and dynamics of a tropical forest ecosystem in southern Western Ghats in the context of changing climate (Sreejith KA, Sajeev TV, Sreekumar VB, Sandeep S, Jose PA, Hrideek TK, Mallikarjunawamy GE, Balakrishnan P, Shambhu Kumar)

15. Scaling up of protocol for *in vitro* tuberization for production of quality planting material of two tuber yielding medicinal plants and promotion of organic homestead farming as an income generation opportunity for rural women in Kerala (Phase-1) (Raghu AV, Muhammed Kunhi KV, Anitha V, Amruth M, Sandeep S, Hrideek TK)

16. Developing long term monitoring tools and strategies for mitigating human-wildlife conflicts in Kerala (Phase I) (Balakrishnan P, Sajeev TV)

17. Compilation of Indian Forestry Abstracts (IFA) Phase III (George KF)

18. Evaluation of clonal teak plantations with particular reference to growth and wood properties (Hrideek TK)

19. Establishment of Nodal Centre of alien invasive species research and management (Sajeev TV)

20. Restoration and reassessment of selected IUCN listed endangered trees in the Western Ghats (Jose PA, Sujanapal P, Sreekumar VB)

21. Historical review of ecological and development trajectory of various sectors in Anamalais and high ranges of the southern Western Ghats (Amruth M)

22. Studies on the effect of elicitors and precursor feeding on *in vitro* production of secondary metabolites and plant growth in *Oroxylum indicum* (Raghu AV, Muralidharan EM, Hrideek TK)

ESTABLISHMENT PROJECTS

1. Maintaining Permanent Plots – Phase II (Sreejith KA)

2. Maintenance and enrichment of Microbial Culture Collection (Mallikarjunaswamy GE)

3. Maintenance of Museums in KFRI Peechi Campus (Sandeep S)

4. Maintenance of live collections in KFRI Peechi Campus (Jose PA)

5. Maintenance of live collections at FRC Velupadam (Sreekumar VB)
6. Tree Health Help Line (Sajeev TV)
7. Strengthening and enriching Institute Central Nursery (Sujanapal P)
8. Commercial Nursery - –FRC, Velupadam (Raghu AV)
9. LAN, Internet and Website (Balakrishnan P)
10. Research Monitoring and Evaluation Unit (Research Coordinator)
11. Digital archiving of administration records and multimedia services for public relations (Registrar)
12. Strengthening and capacity building in administration and research (Registrar)
13. Mathrubhasha-facilitating/strengthening the application of Mathrubhasha (Malayalam) in office use (Registrar)
14. Monitoring of teak experimental plots, clonal Multiplication area (CMA) and production of superior clonal plants (Raghu AV)
15. Maintenance of Forest Seed Processing Unit (Sujanapal P)
16. Strengthening and enriching Institute Central Nursery (Sujanapal P)
17. Enriching live collections of wild orchids & ferns (Sujanapal P)
18. Bamboo Processing Centre (Raghu AV)
19. Maintenance of Research Nursery for bamboos (Raveendran VP)
20. Maintenance and enrichment of Bio-Resources Nature Park (Mallikarjunaswamy GE)
21. Maintenance of Field Research Station, Devikulam (Sreejith KA)
22. Maintenance of Field Research Station, Kottapara, Ernakulam (Raghu AV)
23. Soil health restoration programmes through participatory approach (Sandeep S)
24. Campus Garden Development (Jose PA)
25. Research Management (Registrar)

26. Updation of KFRI Library Portal (George KF)

27. Field Research Centre (FRC), Velupadam - Eco Tourism and Conservation Awareness Programmes (Raghu AV)

28. Academic Coordination Cell (Anitha V)

29. Maintenance of Malakkappara Field Station (Sreejith KA)

30. Maintenance of Wildlife Museum (Balakrishnan P)

31. Maintenance of Plant Tissue Culture Facility (Suma Arun Dev)

32. Strengthening and enriching Institute Central Nursery (Sujanapal P)

EXTENSION PROJECTS

1. International Teak Information Network – TEAKNET (Sandeep S) – Food and Agriculture Organization(FAO) of United Nations

2. Regional-cum-facilitation Centre for sustainable development of medical plants (Southern Region) (Sujanapal P, Chandrashekara UM) - National Medicinal Plant Board (NMPB), Ministry of AYUSH, Govt. of India.

3. Forestry extension and conservation education programmes (Raghu AV, Mohammad Kunhi KV, Raveendran VP) - Plan Grants

4. Establishment of KFRI-KILA Bambusetum (Raghu AV, Sreekumar VB) – Plan grants

5. Preparation of a handbook on woody plants endemic to Kerala (Jose PA, Sreekumar VB, Sujanapal P) – Plan Grants

6. Implementation of Harithakeralam programme at KFRI (Sreekumar VB) - Plan Grants

PUBLICATIONS

Books

1. Hrideek TK, Muraleekrishnan K, Suby, Amruth M (2020) Major Invasive Plants of Kerala, KSCSTE-Kerala Forest Research Institute. P96. ISBN 81-85041-92-x.

2. Manjunath S, Chiranjeevi P, Dantus KJ, Sumod M, Rekha G, Devbrath Andia J, Fensi Alex (2020). A Guide on Prioritized Medicinal Plants from Southern Region of India. (Eds. Sasidharan N, Sujanapal P, Chandrasekhara UM, Chacko CN). Regional cum Facilitation Centre (Southern Region), National Medicinal Plants Board, Kerala Forest Research Institute, Peechi. Thrissur (ISBN No. 81-85041-89-X)

3. Sandeep S, Jayaraj R (2020) Handbook on Soil Quality Analysis and Pollution Monitoring, Centre for Analytical Instrumentation – Kerala, KSCSTE - Kerala Forest Research Institute, Peechi.

4. Viswanath S, Sandeep S, Sreekumar VB, Vishnu R (2020) Manual for Bioresoration of River banks in Kerala, KSCSTE-Kerala Forest Research Institute, Peechi. ISBN: 81-85041-97-0.

5. Viswanath S, Sreekumar VB, Sruthi S (2020) *Bambusa balcooa* Roxb: A multi-utility Bamboo for Domestication, KSCSTE-Kerala Forest Research Institute, Peechi. ISBN:81-85041-98-9.

6. Viswanath S, Mohanan KV, Radhakrishnan VV, Hrideek T K, Raghu AV, Amruth M (2020) Prospects in Plant Biology, Kerala Forest Research Institute and Gregor Mendel Foundation, Calicut University, Kerala, India. P 210. ISBN: 978-81-942768-2-1.

Chapters in Books

1. George KF (2020) Massive Open Online Courses (MOOCs) and Library and Information Science education. In: Academic Inclusion of Librarians in Digital Era (Eds. Franics AT et al.), pp. 95-102, Astral International Pvt. Ltd, New Delhi.

2. Hrideek TK, Suby, Amruth M (2020) Unique metabolites from alien invasive plants. In: Plant Metabolites: Methods, Applications and Prospects. (Eds. Swapna S, Shiburaj S, Sabu A). pp. 141-165, Springer Publishers.

3. Rao HCY, Parthasarathy R, Mondal S, Sundararaj R, Kumar S (2020) Exploring the molecular signatures of host-pathogen interactions in plant diseases: conflict and cooperation (Chapter-4). In: Food Security and Plant Disease Management (Eds. Kumar A, Droby S), Wood head Publishing, Elsevier [ISBN 9780128218433].

4. Vijayan R, Raghu AV (2020) Methods for enhanced production of metabolites under *in vitro* conditions plant metabolites: In: Methods, Applications and Prospects (Eds. Sukumaran et al.), Springer Nature Singapore Pte Ltd., pp. 111-140. https://doi.org/10.1007/978-981-15-5136-9

5. Yadav S, Mishara AP, Kumar S, Negi A, Asha, Maurya VK (2020) Herbal wound healing agents. (Chapter-13). In: Preparation of Phytopharmaceuticals for the Management of Disorders (Ist Edition): The Development of Nutraceuticals and Traditional Medicine. Part 1 (Therapeutic Potentials of Phytopharmaceuticals), (Eds. Egbuna C, Mishra AP, Goyal M), Academic Press, Elsevier [ISBN 9780128202845]

Research Papers in Journals

1. Anaz KM, Sasidharan N, Remakanthan A, Dilsha MV (2021) ITS 2 and RNA secondary structure-based analysis reveals a clear picture on phylogeny of south Indian *Salacia* spp. Computational biology and chemistry 91: 107438. https://doi.org/10.1016/j.compbiolchem.2021.107438.

2. Bhasker D, Easa PS, Rowell CHF (2020) *Mopla guttata* (Acrididae: Catantopinae) rediscovered in the Western Ghats, Kerala, India. Journal of Orthoptera Research 29 (1): 17-23.

3. Chandrashekar S, Amit K, Rodigues V, Viswanath S, Shukla AK, Sundaresan V (2020) Morphogenetic divergence and population structure in Indian *Santalum album* L. Trees 34: 1113-1129.

4. Dantas KJ (2020), *Hopea sasidharanii* (Dipterocarpaceae)—a new species from southern Western Ghats, India. Phytotaxa 429(2): 167-172.

5. Das S, Rajkumar KP, Sreejith KA, Royaltata M, Easa PS (2020) New locality records and call description of the resplendent shrub frog, *Raorchestes resplendens* (Amphibia: Anura: Rhacophoridae) from the Western Ghats, India Journal of Threatened Taxa 12(11): 16502–16509.

6. Das S, Easa PS, Divakar N, Thomas A Tapley B (2021) Predators of the purple frog *Nasikabatrachus sahyadrensis* Biju and Bossuyt, 2003. Herpetology Notes 14: 247-249.

7. Garg S, Suyesh R, Das S, Bee MA, Biju SD (2021) An integrative approach to infer systematic relationships and define species groups in the shrub frog genus

Raorchestes, with description of five new species from the Western Ghats, India. PeerJ 9: e10791. https://doi.org/10.7717/peerj.10791.

8. Harishma KM, Sandeep S, Sreekumar VB (2020) Biomass and carbon stocks in mangrove ecosystems of Kerala, southwest coast of India. Ecological Process 9: 31, https://doi.org/10.1186/s13717-020-00227-8.

9. Hassan MAE, Santhoshkumar AV, Hrideek TK, Jijeesh CM, Joseph H (2021) Variability in drought response among the plus tree accessions of *Tectona grandis* (Linn f.) from the provenances of Kerala, South India. Acta Physiologiae Plantarum. 43: 47 (https://doi.org/10.1007/s11738-021-03215-3).

10. Hime PM, Lemmon AR, Lemmon ECM, Prendini E, Brown JM, Thomson RC, Kratovil JD, Noonan BP, Pyron RA, Peloso PLV, Kortyna ML, Keogh JS, Donnellan SC, Mueller RL, Raxworthy CJ, Kunte K, Ron S, Das S, Gaitonde N, Green DM, Labisko J, Che J, Weisrock DW (2021) Phylogenomics reveals ancient gene tree discordance in the Amphibian Tree of Life. (Systematic Biology 70 (1): 49–66. https://doi.org/10.1093/sysbio/syaa034.

11. Hrideek TK, Jijeesh CM, Suby (2021) Adventitious root induction in *Cinnamomum heyneanum* and *C. riparium*: the endemic tree species of the Western Ghats. Proc. Natl. Acad. Sci., India, Sect. B Biol. Sci. (9). https://doi.org/10.1007/s40011-020-01222-x.

12. Jimtha CJ, Kumar S, Mallikarjunaswamy GE (2020) Probiotic prospects of PGPR for green and sustainable agriculture. Archives of Phytopathology and Plant Protection 53, doi: 10.1080/03235408.2020.1805901.

13. Jithin KV, Sanil MS, Jose PA, Binoy NM, Gin A (2020) *Rungia remadeviae* (Acanthaceae), a new species from the Western Ghats of Kerala, India. International Journal of Advanced Research 8 (08): 664-667. doi: 10.21474/ IJAR01/11540. ISSN 2320-5407.

14. Jose R, Vincent EJ, Subin K, Jose PA, Pandurangan AG (2020) New population records and ecology of *Humboldtia bourdillonii* (Leguminosae: Caesalpinioideae) – a critically endangered tree of southern Western Ghats, Kerala. Nelumbo 62(1): 40-45.

15. Joshi S, Jose BK, Gullan P, Sajeev TV, Anoop EV (2020) A new species of mealybug (Hemiptera: Coccomorpha: Pseudococcidae) from *Tectona grandis* L.f. (Lamiaceae) in southern India. Zootaxa 4718 (3): 391–400.

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tosporic micromycete, *Corynespora Gussow* (Corynesporascaeae): an updated checklist with current status. Studies in Fungi 6 (1): 1-63.

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28. Rajeev AR, Sahu N, Arvind K, Deori M, Grace T, Dev SA, Yadav VP, Ghosh I (2021) Exploring prevalence of potential pathogens and fecal indicators in geographically distinct river systems through comparative metagenomics. Environmental Pollution 282 (Article No.117003). https://doi.org/10.1016/j.envpol.2021.117003.

29. Raveendran U, Ganga KA, Viswanath S, Sreekumar VB, Jayaraj R (2020) Nutritional evaluation of different bamboo species in Kerala as a sustainable food source. Journal of Non-Timber Forest Products 27(1): 22-26.

30. Salim PM, Mathew J, Hrideek TK (2020) *Sonerila sulpheyi* (Melastomataceae, Sonerileae): a new species from the Southern Western Ghats, India. Phytotaxa 435 (1): 076–080. https://doi.org/10.11646/phytotaxa.435.1.10.

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32. Sijimol K, Dev SA, Sreekumar VB (2020) DNA barcoding supports existence of morphospecies complex in endemic bamboo genus *Ochlandra* Thwaites of the Western Ghats. India. J Genet 99: 68. https://doi.org/10.1007/s12041-020-01227-5.

33. Singh R, Verma SK, Yadav S, Bhojak P, Kumar S (2020) Morphology and phylogeny of *Pseudocercospora hamiltoniani* - a new species similar to Sirosporium from Uttarakhand, India. Phytotaxa 458 (4): 281–293.

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44. Vijayan K, Suganthasakthivel R, Sajeev TV, Soorae PS, Naggs F, Wade CM (2020) Genetic variation in the giant african snail, *Lissachatina fulica* (Bowdich, 1822) in its invasive ranges of Asia and West Africa. Biological Journal of the Linnean Society 131(4): 973–985.

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2. Paul A, Suprima MS, Sudheesh PS, Jayaraj R (2020) Evaluation of anti-insect properties of *Cocculus laurifolius* DC. against two lepidopteran pests. In: Proceedings of the 32nd Kerala Science Congress, 25th-27thJanuary 2020, Yuvakshetra Institute of Management Studies, Mundur, Palakkad.

3. Anu NA, Jose PA, Sanil MS, Binoy NM (2020) Ecological studies of *Vatica chinensis* L., a critically endangered dipterocarps of sacred groves of Kerala. In: Proceedings of 32nd Kerala Science Congress 25th-27th January 2020, Palakkad. p. 104.

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9. Jose PA, Sujanapal P, Sreekumar VB, Subin K, Ancy V (2021) A study on woody plants endemic to Kerala: taxonomy, distribution and population ecological information for conservation and management. In: Proceedings of 33rd Kerala Science Congress (Online), KSCSTE, Thiruvananthapuram.

10. Kanagaraj R, Jose PA (2021) Standardization of sustainable harvesting methods of Jiggat species. At 33rd Kerala Science Congress (Online). KSCSTE, Thiruvananthapuram.

11. Patel B, Hrideek TK, Balakrishnan P (2021) Tree-microhabitats in tropical forests of the southern Western Ghats. In: Proceedings of the International Conference on 'New Horizons in Plant Sciences', Department of Botany, University of Kerala, Thiruvananthapuram.

12. Rasmi CK, Jose PA (2021) Preliminary seed studies of *Baccaurea courtallensis* (Wight) Mull. Arg. – A wild edible fruit tree endemic to the Western Ghats, India. In: Proceedings of International Conference on 'New Horizons in Plant Science (Online)', organized by Dept. of Botany, University of Kerala, Kariavattom, Thiruvananthapuram.

13. Sanil MS, Jose PA, Ranjith CV, Binoy NM (2020) Restoring wild nutmegs for conservation and management: a case study from Kerala. In: International Symposium on 'Plant Taxonomy and Ethnobotany', 13th-14th February, Botanical Survey of India, Kolkata, p.135.

14. Subin K, Jose PA (2020) Identifying reproductive constraints in two endemic and endangered *Hydnocarpus* species of the Western Ghats, Kerala. In: International Symposium on Plant Taxonomy and Ethnobotany. Botanical Survey of India, Kolkata

15. Raveendran U, Ganga K A, Viswanath S, Sreekumar VB, Jayaraj R (2020) Nutritional and anti-nutritional properties of bamboo shoots from Kerala part of the Western Ghats. In: Proceedings of the 32nd Kerala Science Congress, 25-27 January 2020, Yuvakshetra Institute of Management Studies, Mundur, Palakkad.

16. Vijayan KR, Raghu AV (2020) Methods for enhanced production of metabolites under *in vitro* conditions, In: Plant Metabolites: Methods, Applications and Prospects (Sukumaran et al. Eds), Springer Nature, Singapore Pte Ltd., pp. 111-140.

Training Manuals

1. Jayaraj R, Sandeep S (2021) Training programme in Analytical Instrumentation (Training Handbook) January 2021, Centre for Analytical Instrumentation Kerala (CAI-K), KSCSTE - Kerala Forest Research Institute.

2. Anitha V, Raveendran VP (Eds) (2020) Valuation of Ecosystem Services and Green GDP – Course Handbook. Green Skill Development Programme Certificate Course on Valuation of Ecosystem services, February 2020, KSCSTE - Kerala

Handbook

1. Jose PA, Sujanapal P, Sreekumar VB (2020) Handbook on woody plants endemic to Kerala. KFRI Handbook. Kerala Forest Research Institute, Peechi. pp.64.

2. Jose PA, Sujanapal P, Sreekumar VB (2020) Keralathinte thadheseeya vruksha-ganangal. KFRI Handbook. Kerala Forest Research Institute, Peechi. pp.64.

Popular articles

1. Arunraj PT, Jose PA, Kanagaraj R (2020) Preliminary seed biological studies of *Cinnamomum verum* Presl. and *Sapindus trifoliatus* L.- two high demanding NTFP trees of the Western Ghats, Kerala. In: Proceedings of UGC-SAP National Seminar on new vistas in Botany, Goa University, p. 41.

2. Balakrishnan P, Bindu TN (2020) Impact of forest fragmentation on wildlife, Aranyam, September (Malayalam), Kerala Forest Department Publication.

3. Raghu AV (2020) Bamboo propagation and cultivation, Aranyam, Oct-Nov Issue (Malayalam), Kerala Forest Department Publication.

4. Dev SA, Balakrishnan S, Yasodha R (2020) Teak genetic research towards climate change mitigation. Teaknet Bulletin 13 (3): 2-5.

5. Hema ES, Viswanath S, Sumod M, Dantas KJ, Sujanapal P (2020) Chandanam labhythayum: vipani niyamangalum. Aranyam October Issue (Malayalam), Kerala Forest Department Publication.

6. Jose PA (2021) Vanapunasthapanam sasyasamrakshanathilude. Aranyam, March Issue (Malayalam), Kerala Forest Department Publication.

7. Muraleekrishnan K, Hrideek TK (2020) Krishiyidagalile adhinavesha sasyagal. Keralakarshakan. 33-36 (Malayalam), Farm Information Bureau Publication.

Forest Research Institute, Ministry of Environment, Forest and Climate Change (MOEF & CC), Government of India.

8. Sandeep S (2020) Manushyante carbon padamudrakal. Sasthrakeralam. 52(1-2): 25-27.

9. Sreekumar VB, Viswanath S (2020) 'Bamboo' a crop. Kerala Karshakan. February pp. 48-50, Farm Information Bureau Publication.

10. Sreekumar VB, Viswanath S, Raghu AV (2020) Bamboo Diversity of Kerala, Aranyam, October-November Issue, Kerala Forest Department Publication.

11. Sreekumar VB, Viswanath S, Raghu AV (2020) Bamboos of Kerala. Aranyam October- November (Malayalam), Kerala Forest Department Publication.

12. Sujanapal P, Dantas KJ, Sumod M (2020) Sughasushupthiyil mrithopasasyangal Aranyam. April (Malayalam), Kerala Forest Department Publication.

13. Sujanapal P, Sandwana KS, Sumod M (2020) Oushadhasasyngalum theerapradesangalude pangum pradhanyavum (Malayalam).

14. Sumod M, Sujanapal P, Roy MM, Dantas KJ (2020) Oushadhasasyngalum samrakshana pradhanyavum (Malayalam).

15. Viswanath S, Sreekumar VB (2020) Sandal plantations, scope and possibilities. Aranyam. Oct-Nov. issue (Malayalam), Kerala Forest Department Publication.

EXTENSION AND OUTREACH

ENDOWMENT AWARDS

The Endowment Memorial Award instituted in the memory of KFRI's first Director, Dr. C. Chandrasekharan, an expert in tropical forestry, carries a purse of Rs. 40,000/-, a gold medal and citation. The 10th Dr. C. Chandarasekharan Endowment award of the year 2019 was jointly awarded to Mr. Dhaneesh Bhaskar and Mr. Sreehari Raman held on 11th September 2020 coinciding with death anniversary of Dr. Chandrasekharan. The memorial lecture titled 'Transitions in Forest governance and Management' was delivered by Shri. Pramod G. Krishnan IFS, CCF (WP & R), Kerala Forests and Wild-life Department, Thiruvananthapuram.

Mr. Dhaneesh is a Ph.D. Scholar registered with the University of Calicut, attached to Wild life Biology Department, Kerala Forest Research Institute, Peechi, pursuing studies on 'Diversity and fire induced behavioural dynamics of short- horned grass-hoppers (Insecta: Orthoptera: Caelifera) in Eravikulam National Park and Parambikulam Tiger Reserve, Western Ghats'.

Mr. Sreehari is a Ph.D. Scholar at the Chinese Academy of Sciences, Yunan, China working on the topic 'Understanding the probable impact of climate change on bat-communities in southern Western Ghats, India'.

Training Programmes

1. One-week compulsory training course for IFS officers on 'Conservation and development of medicinal plants and benefit sharing with local communities, 09th-13th November 2020, Ministry of Environment, Forest and Climate Change (MOEF & CC), Government of India (Raveendran VP, Raghu AV, Mohammed Kunhi KV, Amruth M).

2. GSDP- Certificate Course on 'Valuation of ecosystem services and green GDP', Ministry of Environment, Forest and Climate Change (MOEF & CC), Government of India. 11 participants completed the programme (Anitha V, Raveendran VP).

3. One day training programme on 'Bamboo Day Celebration' 18.09.2020, Department of Science & Technology (DST), Govt. of India. 30 Participants completed the programme (Mohammed Kunhi KV, Raveendran VP, Sajeev TV).

4. One week compulsory training course for IFS officers on 'Conservation and development of medicinal plants and benefit sharing with local communities', from 09.11.2020 to 13.11.2020, Ministry of Environment, Forest and Climate Change, (MoEF & CC) Govt. of India. 15 participants completed the programme (Raghu AV, Amruth M, Raveendran VP, Mohammed Kunhi KV).

5. Three-day training programme on 'Skill development' organized jointly by Kadalundi – Vallikkunnu community reserve, Kerala Forest & Wildlife Department & KFRI (DST) I-STED project at Kadalundi- Vallikkunnu community reserve office, Kadalundi, 16.11.2020 to 18.11.2020, 21 participants completed the programme (Mohammed Kunhi KV).

6. Three-day training programme on 'Skill development' organized jointly by Kadalundi – Vallikkunnu community reserve, Kerala Forest & Wildlife Department & KFRI (DST) I-STED project at Kadalundi - Vallikkunnu community reserve office, Kadalundi, 28.12.2020 to 30.12.2020, 23 participants completed the programme (Mohammed Kunhi KV)

7. Two week training programme on 'Skill development' organized jointly by KFRI & JSS, Malappuram at Edimuzhikkal, Chelambra, calicut, 20.02.2021 to 06.03.2021, Department of Science & Technology (DST), Govt. of India & Ministry of Skill Development & Entrepreneurship, 20 participants completed the programme (Mohammed Kunhi KV)

8. GSDP – Certificate Course on pollution – Monitoring soil pollution. Ministry of Environment, Forest and Climate Change, (MoEF & CC) Govt. of India (Jayaraj R, Sandeep S)

9. Training Programme in Analytical Instrumentation, January – March 2021 (Jayaraj R, Sandeep S)

Outreach Programme

1. As per the request from KFD, Chalakudy Division, a training was given to the tribal people of Chalakudy in Bamboo Craft making during 30th to 31th October 2020.

Online Exhibitions

1. Online Exhibition on "BAMBOO FEST VIRTUAL EXHIBITION" was organized from Feb 16th - 20th, 2021.

2. Online Exhibition on "VAIGA VIRTUAL EXHIBITION" was organized from Feb 10th -13th, 2021.

ACADEMIC PROGRAMMES

Doctoral Degree awarded

1. Neethu RS (2020). Regional differences in phenotypic and phytochemical profiles of selected medicinal plants in Kerala.

   Degree of Doctor of Philosophy in Forestry (Forest Botany), FRI-Deemed to be University, 08.12.2020, Supervising Guide –Dr. TV. Sajeev.

2. Dhaneesh Bhaskar (2020). Diversity and fire induced behavioural dynamics of short-horned grasshoppers (Insecta: Orthoptera: Caelifera) in Eravikulam National Park and Parambikulam Tiger Reserve, Western Ghats.

   Degree of Doctor of Philosophy in Zoology under the Faculty of Science, University of Calicut, 08.03.2021, Supervising Guide –Dr. PS. Easa.

3. Riju P (2020). Assessment of human-wildlife conflict and mitigation measures in Malappuram District, Kerala, India.

   Degree of Doctor of Philosophy in Zoology under the Faculty of Science, University of Calicut, 09.03.2021, Supervising Guide –Dr. EA. Jayson.

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)

2. Geochemistry of carbon storage under continuous teak rotation in southern Western Ghats. (Panchami Jaya)

3. Integrative taxonomic studies on skippers (Lepidoptera: Hesperidae) of southern Western Ghats (Athulya C)

Cochin University of Science and Technology

1. Foraging ecology of selected birds in the kole wetlands of Thrissur, Kerala, India (Greeshma P)

2. Chemistry of mangrove soils in Kerala (Renuka R)

3. Pedogenesis and geochemical transformations in forest ecosystems of the Western Ghats of Kerala (Vishnu PS), KSCSTE Fellowship

4. Assessment of ecosystem services from Parambikulam Tiger Reserve (Divya Soman), KSCSTE Fellowship

5. Carbon dynamics in mangrove systems of Kerala (Harishma KM)

6. Molecular fingerprints and geo-chemical interaction of organo-nano composite from forest floor humic acid in the Western Ghats, Kerala (Ninu Jose M)

7. Seasonal influence on phenology of woody species in a tropical wet evergreen forest of southern Western Ghats, India (Thasini VM), KSCSTE Fellowship

8. Molecular diagnostic markers for authentication and early sexing of *Coscinium fenestratum* (Gaertn.) Colebr (Remya Unnikrishnan)

9. Molecular characterization and adaptive genetic diversity linked to wood property traits for sustainable management of teak genetic resources (Swathi Balakrishnan)

10. Bioactivity and mechanistic studies of certain botanical extracts for their potential application as biopesticides (Alina Paul), KSCSTE Fellowship

11. Soil carbon pool and its dynamics in the systems of Kerala Western Ghats (Binsiya TK), KSCSTE Fellowship

12. Invasive alien plants in tourist locations of Kerala: pathways, spread and impact (Karthika M Nair)

13. Exploring the antioxidant activity of humic substances in composts and development of nanocomposites for environmental and health benefits (Faniya Toby)

14. Temporal analysis of distribution and morphometry of Coleoptera in Kerala part of the Western Ghats (Thushar Naduvalloor)

15. Faunal interactions of invasive alien plants: case studies on *Lantana camara* L.,

Mimosa diplotricha Sauvalle, and *Mikania micrantha* Kunthin Kerala (Premdas S)

16. Chemistry and geochemical interactions of organo-clay nano composites developed on humic acid microstructures (Navya M)

University of Calicut

1. Ecology and behaviour of amphibians of Eravikulam National Park, with special reference to bush frogs (Sandeep Das)

2. Herpetofaunal diversity in swamp (Vayal) ecosystems in Periyar Tiger Reserve, Western Ghats (Rajkumar KP)

3. Micropropagation of selected species of *Embelia Burm*. f., characterization and *in vitro* production of secondary metabolites (Rini Vijayan)

4. Biocontrol potential of rhizosphere and rhizoplane fungi of grasses against certain fungal diseases of forest nursery seedlings (Bharath Nair)

5. Systematics and phylogeny of dipterocarps in the Western Ghats, India (Sanil MS)

6. Studies on plus tree selection, variability and seed biology of *Terminalia paniculata* Roth (Combretaceae) in Kerala part of peninsular India (Sanal C. Viswanath)

7. Studies on variability, phenology and management methods of the alien invasive tree, *Senna spectabilis* (D.C.) Irwin & Barneby in Kerala, India (Muraleekrishnan K)

8. Conservation biology of *Atuna indica* (bedd.) Kosterm. and *Hydnocarpus longipedunculatus* Robi et al., two endemic tree species of the Western Ghats of Kerala (Subin K)

9. Study on the impact of allelochemicals of *Senna spectabilis* (DC.) Irwin and Barneby invasion in Wayanad, Kerala (Suby)

10. Ecophysiology of mangroves in Kerala: an enquiry through plant functional traits (Abdulla Naseef)

11. Plant-frugivore interaction and seed dispersal syndromes in Shola forests of the Western Ghats, India (Nimisha ES), Dept. of Science and Technology (DST) - INSPIRE, Govt. of India Fellowship

12. 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 CS)

13. Ecophysiological and biochemical studies on seed viability loss in *Dysoxylum malabaricum* Bedd. and *Persea macrantha* (Nees.) Kosterm. - two threatened tree species of the Western Ghats, Kerala (Vidya R)

14. A study on population dynamics of two threatened *Myristica* species of the Western Ghats, Kerala in the context of climate change (Anuraj K)

15. Studies on plus tree selection, genetic variability and wood properties of the endemic tree species *Artocarpus hirsutus* Lamk. (Moraceae) in Kerala (Sinny Francis)

16. Studies on variability, growth performance and wood properties of selected clones and plus trees of teak (*Tectona grandis* L.f.) in Kerala (Preetha B)

17. Morphological and molecular taxonomy of skippers (Lepidoptera: Hesperiidae) in Kerala (Rakhi KR)

18. 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 the Western Ghats, Kerala (Rasmi CK)

19. Ecology of Troidini butterflies (Lepidoptera; Papilionidae) in Kerala (Anju MS)

20. Investigation on application of nanobionics on accumulation of biomass and biosynthesis of compounds in *Holostemma adakodien* K. schum *in vitro* (Sangeeth Chandran)

Masters attachment programmes

Total number of 39 attachments covering Biochemistry, Biotechnology, Botany, Chemistry, Environmental Science, Environmental Science and Management, Forestry, Life Science, Microbiology, and Zoology were completed during the reporting period. The Academic programme also had 5 Internships covering B-Arch, Biotechnology, Botany, Climate Change and Adaptation, Environmental Science, Microbiology, and Social Science.

KERALA FOREST RESEARCH INSTITUTE, PEECHI, THRISSUR

(A unit of Kerala State Council for Science, Technology & Environment, Govt. of Kerala)

INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 MARCH 2021

EXPENDITURE	Sch No.	As at 31 March 2021	As at 31 March 2020	INCOME	Sch No.	As at 31 March 2021	As at 31 March 2020
		₹	₹			₹	₹
Infrastructure Strengthening Non Plan	IX	1,72,63,712	1,99,72,875	Grand from Government of Kerala	VI	10,03,03,534	12,24,68,287
Salaries and Allowances (Non Plan)	X	7,23,42,250	8,60,52,933	Other Receipts	VII	1,73,76,091	1,24,79,832
Depreciation	IV	2,70,70,159	2,68,98,102	Depreciation transferred to Capital Reserve		2,70,70,159	2,68,98,102
Other Project Expenses		6,00,79,722	5,38,62,731	Income from other Projects	VIII	6,00,79,722	5,38,62,731
Project Expenses under Plan Scheme		2,80,73,663	2,89,22,311				
TOTAL		**20,48,29,506**	**21,57,08,952**	**TOTAL**		**20,48,29,506**	**21,57,08,952**

KERALA FOREST RESEARCH INSTITUTE, PEECHI, THRISSUR

(A unit of Kerala State Council for Science, Technology & Environment. Govt. of Kerala)

BALANCE SHEET AS ON 31 MARCH 2021

LIABILITIES	Sch No.	As at 31 March 2021	As at 31 March 2020	ASSETS	Sch No.	As at 31 March 2021	As at 31 March 2020
Reserves and Surplus	I	23,62,13,529	22,39,44,925	**Property, plant & Equipment**	IV	20,72,95,301	19,50,26,697
Current Liabilities & Provisions				**Current Assets, Loan and Advances**			
Creditors for Expenses	II (a)	75,47,960	63,85,815	Cash with Banks	V (a)	27,35,74,157	26,26,00,480
Creditors for fixed assets	II (b)	1,83,38,100	11,68,224	Cash in Hand	V (b)	1,11,258	80,714
Other Liabilities	II (c)	1,28,38,088	1,31,55,806	Loans and Advances	V (c)	1,28,41,350	1,13,45,807
Provisions	II (d)	10,32,21,050	11,38,75,157				
Unspent Balance of grand, in-Aid (Net)	III	11,56,63,339	11,05,23,770				
TOTAL		**49,38,22,066**	**46,90,53,697**	**TOTAL**		**49,38,22,066**	**46,90,53,697**

INSTITUTIONAL COMMITTEES

RESEARCH COUNCIL

Chairman

Dr. BR. Ramesh
Researcher,
Institut Francais de Pondicherry,
French Institute of Pondicherry,
UMIFRE 21, CNRS-MAEE.

Members

Dr. Mohit Gera IFS
Director,
Institute of Forest Genetics and Tree Breeding,
Indian Council of Forestry Research and
Education, P.B.No. 1061,
R.S. Puram P.O., Coimbatore – 641 002.

Dr. CTS. Nair
Former Chief Economist of Forestry Department,
Food & Agricultural Organization, United Nations, Rome
Former Executive Vice President - KSCSTE
Former Director, KFRI.

Prof. Dr. N. Parthasarathy
Professor & Dean,
School of Life Sciences, Pondicherry
University, Puducherry – 605 014.

Prof. Dr. Raman Sukumar
Professor,
Centre for Ecological Sciences,
Indian Institute of Science,
Bangalore – 560 012.

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

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

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

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

Chairman

Dr. N. Krishnakumar IFS
(Rtd.) and Former Head of Forest Force
Tamil Nadu Forest Dept.
G/03/01, TAISHA (AIS quarters)
Natesan Nagar West, 3rd Main Road
Virugambakkam, Chennai 600 092.

Members

Dr. C. Kunhikannan
Director,
Institute of Forest Genetics &
Tree Breeding,
Indian Council of Forestry
Research & Education,
PB No.1061, RS Puram P O,
Coimbatore – 641 002.

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

Shri. PK. 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. RV. Varma
Former Chief Scientist KSCSTE - KFRI
Former Chairman, Kerala State
Biodiversity Board,
Lakshmipuram, Royal Avenue,
Thrissur – 680 020.

Dr. AJT. 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. Samson Mathew
Director,
KSCSTE - National Transportation Planing & Research Centre - NATPAC

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

Dr. MP. Sujatha
Senior Principal Scientist,
KSCSTE - KFRI

Additional Secretary
Science &Technology Department,
Govt. of Kerala

Shri. B.Biju
Registrar,
KSCSTE - KFRI
Convener (Member)

CONSULTATIVE GROUP FOR FORESTRY RESEARCH MANAGEMENT (PROGRAMME ADVISORY GROUP)

1.	The Principal Chief Conservator of Forests & Head of Forest Force	…	Chairman
2.	The Additional PCCF (D&P) & Disciplinary Authority	…	Member
3.	The Additional PCCF (FMIS)	…	Member
4.	The Additional PCCF (Development)	…	Member
5.	The Additional PCCF (WP&R)	…	Member
6.	The Additional PCCF (E&TW)	…	Member
7.	The Additional PCCF (Administration)	…	Member
8.	The Additional PCCF(Southern Region)	…	
9.	The Additional PCCF (Protection)	…	Member
10.	The Additional PCCF (Vigilance)	…	Member
11.	The Additional PCCF (Northern Region)	…	Member
12.	The Additional PCCF (BDC)	…	Member
13.	The Additional PCCF (IHRD)	…	Member
14.	The Additional PCCF (SA&NO)	…	Member
15.	The Principal Chief Conservator of Forests Wildlife & Chief Wildlife Warden	…	Member
16.	The Principal Chief Conservator of Forests (Social Forestry)	…	Member
17.	The Principal Chief Conservator of Forests (Vigilance)	…	Member
18.	The Principal Chief Conservator of Forests (Dev. & PFM)	…	Member
19.	The Chief Conservator of Forests (Protection)	…	Member
20.	The Chief Conservator of Forests (FMIS)	…	Member
21.	The Chief Conservator of Forests (HRD)	…	Member
22.	The Chief Conservator of Forests (Administration)	…	Member
23.	The Chief Conservator of Forests (Vigilance)	…	Member
24.	The Chief Conservator of Forests (Social Forestry)	…	Member
25.	The Regional Chief Conservator of Forests (North)	…	Member
26.	The Regional Chief Conservator of Forests (South)	…	Member
27.	The Conservator of Forests (Biodiversity)	…	Member
28.	The Deputy Conservator of Forests (Research) North	…	Member

29.	The Deputy Conservator of Forests (Research) South	…	Member
30.	The Managing Director, Kerala Forest Development Corporation	…	Member
31.	The Associate Dean, Forestry Faculty, Kerala Agricultural University	…	Member
32.	The Director, Jawaharlal Nehru Tropical Botanic Garden & Research Institute, Palode	…	Member
33.	The Director, Institute of Forest Genetics & Tree Breeding, Coimbatore	…	Member
34.	The Managing Director, Oushadhi, Thrissur	…	Member
35.	The Director, Center for Earth Science Studies, Thiruvananthapuram	…	Member
36.	The Director, Center for Water Resources Development and Management	…	Member
37.	The Director, Rajiv Gandhi Center for Biotechnology, Thiruvananthapuram	…	Member
38.	The Managing Director, Oushadhi, Thrissur	…	Member
39.	The Director, Medicinal Plant Research Center, Arya Vaidya Sala, Kottakkal	…	Member
40.	The Managing Director, Hindustan Newsprint Ltd., Kottayam	…	Member
41.	The Managing Director, Kerala State Wood Industries Ltd., Nilambur	…	Member
42.	The Managing Director, Kerala State Bamboo Corporation Ltd.	…	Member
43.	The Director, Salim Ali Center for Ornithology and Natural History, Coimbatore	…	Member
44.	Director, Kerala Forest Research Institute, Peechi	…	Member
45.	Joint Director (Science & Technology Promotion), KSCSTE, TVPM	…	Member
46.	Research Coordinator, KFRI, Peechi	…	Invitees
47.	All Scientists of KFRI	…	Invitees
48.	Programme Coordinator, Training & Extension Division, KFRI	…	Convener

1. INTERNAL RESEARCH GROUP

Director	:	Chairman
Dr. S. Sandeep	:	Convener
Dr. Suma Arun Dev	:	Assoc. Convener
All Scientific staffs	:	Members

2. FINANCE COMMITTEE

Director	:	Chairman
Research Coordinator	:	Member
Two elected members from IRG	:	Member
Dy. Registrar (Accounts)	:	Member
Registrar	:	Convener

3. PURCHASE COMMITTEE

Dr. MP. Sujatha	:	Chairperson
Dr. R. Jayaraj	:	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. KA. Sreejith	:	Member
Dr. R. Jayaraj	:	Member
Dr. Suma Arun Dev	:	Convener
Respective Research Guides	:	Invitees

5. EQUIPMENT/INFRASTRUCTURE DEVELOPMENT COMMITTEE

Dr. S. Sandeep	:	Chairman
Dr. Suma Arun Dev	:	Member
Dr. VB. Sreekumar	:	Member
Dr. TK. Hrideek	:	Member
Mr. PI. Shareef.	:	Member
Section Officer (Purchase)	:	Convener

6. LIBRARY ADVISORY COMMITTEE

Librarian	:	Chairman
Dr. VB. Sreekumar	:	Member

Dr. TK. Hrideek	:	Member
Dr. Shambu Kumar	:	Member
Dr. KA. Sreejith	:	Convener

7. WEBSITE & SOFTWARE HARDWARE COMMITTEE (LAN)

Dr. TK. Hrideek	:	Chairman
Dr. M. Amruth	:	Member
Dr. P. Balakrishnan	:	Member
Dr. KF. George	:	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	:	Chairman
PCCF (WP &Research), KFD	:	Member
CCF (Central Circle), KFD	:	Member
SRO (North), KFD	:	Member
SRO (South), KFD	:	Member
Dr. TV. Sajeev, Research Coordinator	:	Member
Mr. VP. Raveendran	:	Member
Dr. VB. Sreekumar	:	Member
Dr. P. Sujanapal	:	Convener

9. NILAMBUR SUB-CENTRE ADVISORY COMMITTEE

Director	:	Chairman
Registrar	:	Co-Chairman
Research Coordinator	:	Member
Dr. KV. Mohammed Kunhi	:	Member
Dr. VB. Sreekumar	:	Member
Dy. Registrar (Accounts)	:	Member
Dy. Registrar (Admin)	:	Member
Dr. P. Sujanapal	:	Member
Dr. GE. Mallikarjuna Swamy, Sub-Centre In-charge	:	Convener

10. CAMPUS/GARDEN DEVELOPMENT COMMITTEE

Dr. PA. Jose	:	Chairman
Dr. EM. Muralidharan	:	Member

Dr. MP. Sujatha	:	Member
Smt. MK. Raji, Engineering Division	:	Member
Dr. P. Sujanapal	:	Member

11. JOURNAL OF BAMBOO AND RATTAN - EDITORIAL COMMITTEE

Director	:	Chief Editor
Dr. S. Sandeep	:	Executive Editor
Dr. TV. Sajeev	:	Editor
Dr. V. Anitha	:	Editor
Dr. AV. Raghu	:	Editor
Dr. Suma Arun Dev	:	Editor
Dr. VB. Sreekumar	:	Editor & Convener

12. ANNUAL REPORT COMMITTEE

Dr. V. Anitha	:	Chairperson
Dy. Registrar (Admin)	:	Member
Dy. Registrar (Accounts)	:	Member
Dr. KA. Sreejith	:	Member
Dr. R. Jayaraj	:	Member
Dr. P. Balakrishnan	:	Member
Dr. Suma Arun Dev	:	Convener

13. EVERGREEN NEWSLETTER COMMITTEE

Dr. AV. Raghu	:	Chief Editor
Dr. M. Amruth	:	Associate Editor
Dr. TK. Hrideek	:	Associate Editor
Dr. P. Balakrishnan	:	Associate Editor

14. STORES AUCTION AND DISPOSAL COMMITTEE

Dr. PA. Jose	:	Chairman
Dr. VB. Sreekumar	:	Member
Dr. R. Jayaraj	:	Member
Smt. Anuja Prasannan	:	Member
Smt. MK. Raji	:	Member
Smt. Ricy Eliner Varkey	:	Member
Mr. PI. Shareef	:	Member
Stores·in - Charge	:	Convener

15. SPORTS COMMITTEE

Mr. VP. Raveendran	:	Chairman
Dr. TK. Hrideek	:	Member
Dr. Shambu Kumar	:	Member
Mr. VC. Jinesh	:	Member
Smt. PS. Manju	:	Member
Smt. K. Keerthi	:	Member
Mr. PI. Shareef	:	Convener

16. COMMITTEE FOR TRANSFORMATION OF OFFICIAL LANGUAGE TO MALAYALAM

Registrar	:	Chairman
Dr. AV. Raghu	:	Member
Dy. Registrar (Admin)	:	Member
Mr. VS. Krishnanunni	:	Member
Smt. Maymol Joseph	:	Member
Smt. Shirly Issac	:	Convener

17. EXHIBITION ADVISORY COMMITTEE

Dr. TV. Sajeev	:	Chairman
Mr. VP. Raveendran	:	Member
Dr. AV. Raghu	:	Member
Dr. M. Amruth	:	Member
Dr. Mohammed Kunhi	:	Convener

18. SEMINAR COMMITTEE

Dr. TV. Sajeev	:	Chairman
Dr. TK. Hrideek	:	Member
Dr. P. Sujanapal	:	Member
Dr. Shambu Kumar	:	Member
Dr. Mohammed Kunhi	:	Convener

19. IGH CAFETERIA ADVISORY COMMITTEE

Dr. AV. Raghu	:	Chairman
Mr. VP. Raveendran	:	Member
Dr. KA. Sreejith	:	Member
Smt. Sabitha Balakrishnan	:	Member
Mr. PI. Shareef -Guest House-in-charge	:	Convener

20. BUILDING COMMITTEE

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

21. VEHICLE ADVISORY COMMITTEE

Dr. P. Sujanapal	:	Chairman
Dr. KA. Sreejith	:	Member
Dy. Registrar (Admn)	:	Member
Smt. CK. Sindhumol	:	Member
Vehicle-in Charge (Mr. Shiju)	:	Convener

22. ENDOWMENT COMMITTEE

Director	:	Chairman
Dr. EM. Muralidharan	:	Member
Dr. Mohammed Kunhi	:	Member
Dr. P. Sujanapal	:	Member
Dr. R. Jayaraj	:	Member
Dr. PA. Jose	:	Convener

23. KFRI QUARTERS ALLOTMENT COMMITTEE

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

24. RESEARCH SCHOLAR'S HOSTEL ADVISORY COMMITTEE

Registrar	Chairman
Dr. P. Balakrishnan, Warden, Men's Hostel	Member
Mr. PI. Shareef.	Member
Smt. MK. Raji	Member
Smt. Anupa Vasu, Asst. Warden, Ladies Hostel	Member
Dr. V. Anitha, Warden, Ladies Hostel	Convener

25. GRIEVANCE REDRESSAL COMMITTEE

Director	Chairman & Convener
Registrar	Member
Dr. TK. Kunjamu, Professor, KAU	Member
Smt. Geetha Parakkot, Dy. Registrar (Admin)	Member
Dr. V. Anitha	Member

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

Dr. V. Anitha	Chairperson
Registrar	Member
Smt. Geetha Parakkot, Dy. Registrar (Admin)	Member
Smt. CK. Sindhumol	Member
Dr. Uma Maheswari, Retd. Addl. Director of Health Services, Govt. of Kerala	Member
Dr. Suma Arun Dev	Convener

STAFF LIST

Sl No	Name	Designation
Scientific Staff		
1.	Dr. Syam Viswanath	Director (Chief Scientist-on deputation)
2.	Dr. UM. Chandrashekara	Senior Principal Scientist
3.	Dr. MP. Sujatha	Senior Principal Scientist
4.	Dr. EM. Muralidharan	Senior Principal Scientist
5.	Dr. TV. Sajeev	Senior Principal Scientist
6.	Dr. V. Anitha	Senior Principal Scientist
7.	Dr. KV. Mohammed Kunhi	Principal Scientist
8.	Dr. PA. Jose	Principal Scientist
9.	Shri. VP. Raveendran	Principal Scientist
10.	Dr. Suma Arun Dev	Senior Scientist
11.	Dr. Shambu Kumar	Senior Scientist
12.	Dr. KF. George	Senior Scientist
13.	Dr. AV. Raghu	Senior Scientist
14.	Dr. P. Sujanapal	Senior Scientist
15.	Dr. VB. Sreekumar	Senior Scientist
16.	Dr. S. Sandeep	Senior Scientist
17.	Dr. KA. Sreejith	Senior Scientist
18.	Dr. R. Jayaraj	Senior Scientist
19.	Dr. TK. Hrideek	Senior Scientist
20.	Dr. GE. Malikarjuna Swami	Senior Scientist
21.	Dr. M. Amruth	Scientist
22.	Dr. P. Balakrishnan	Scientist

Administrative staff

1	Shri. B. Biju	REGISTRAR
2	Sri. K. Satheesakumar	Dy. Registrar(Accts)
3	Smt. Geetha Parakkott	Dy. Registrar (Admin.)
4	Smt. Sabitha Balakrishnan	Assistant Registrar
5	Smt. Shirly Issac	Section Officer Gr. II
6	Sri. K. Kamalakaran	Section Officer Gr. II
7	Sri. VS. Krishnanunni	Section Officer
8	Smt. CK. Sindhumol	Assistant Gr. II
9	Smt. P. Anupa Vasu	Assistant Gr. II
10	Smt. Anuja Prasannan	Assistant Gr. II
11	Smt. K. Keerthy	Assistant Gr. II
12	Smt. Maymol Joseph	Assistant Gr. II
13	Sri. PS. Sudheesh	Assistant
14	Smt. PS. Manju	Assistant
15	Smt. A. Aneesamole	Assistant
16	Sri. KM. Shiju	Assistant
17	Smt. Grace Andrews	PA to Director Gr. II
18	Sri. KP. Manoj	Office superintendent
19	Sri. P. Rajeesh	Clerical Assistant Gr. II (Nilambur)
20	Sri. TM. Abdul Vahab	Word Processing Assistant Gr. IV
21	Sri. PK. Rajendran	Driver Gr. II
22	Sri. EO. Mathai	Driver Gr. II
23	Sri. CH. Herald Wilson	Driver Gr. II
24	Smt. AM. Lalitha	Office Attendant Gr. V
25	Sri. VK. Mohandas	Office Attendant Gr. IV
26	Sri. EP. Ulahannan	Office Attendant Gr. IV
27	Smt. K. Aparna	Office Attendant Gr.III (Nilambur)
28	Sri. K. Abdul Jaleel	Office Attendant Gr. II
29	Smt. S. Ashamole	Office Attendant Gr. II
30	Smt. C. Sujatha	Office Attendant Gr. II
31	Sri. E. Hamsa	Office Attendant Gr. II

32	Sri. TP. Valsan	Office Attendant Gr. II
33	Smt. P. Deepa	Office Attendant Gr. II (Nilambur)
34	Sri. K. Mohammed	Helper Gr. IV (Nilambur)
35	Sri. KK. Mohammed	Helper Gr. IV (Nilambur)
36	Sri. AV. Chamy	Helper Gr. II
37	Sri. TS. Prakash	Helper Gr. II
38	Sri. MS. SanthoshKumar	Helper Gr. II
39	Sri. TO. Simon	Helper Gr. II
40	Sri. MK. Suresh	Helper Gr.II
41	Sri. IO. Thomas	Helper Gr. II
42	Sri. N. Rajan	Helper Gr. II (Nilambur)
43	Sri. CP. Ummer	Helper Gr. II (Nilambur)
44	Smt. PS. Kadeeja	Helper Gr. II (Palappilly)
45	Sri. KA. Thankachan	Helper Gr. II (Kottappara)
46	Sri. CB. Sajy	Helper
47	Sri. PV. SanthoshKumar	Helper
48	Sri. K. Rajan	Nursery Man Gr. II
49	Smt. S. Padmavathy	Nursery Man Gr. II
50	Sri. NK. Rajan	Nursery Man Gr. II (Palappilly)
51	Sri. K. Rajan	Nursery Man Gr. II
52	Smt. S. Padmavathy	Nursery Man Gr. II
53	Sri. NK. Rajan	Nursery Man Gr. II (Palappilly)

Technical Staff

1	Sri. PI. Shereef	Technical Officer Gr. II
2	Smt. MK. Raji	Technical Officer Gr. II
3	Smt. Ricy Eliner Varkey	Technical Officer Gr. II
4	Sri. VC. Jinesh	Technical Officer (Palappilly)
5	Sri. MR. Anilkumar	Technical Assistant Gr. IV
6	Sri. OP. Ranjith	Technical Assistant (Binder) Gr. II