ANNUAL REPORT 2018-19

KSCSTE - KERALA FOREST RESEARCH INSTITUTE

KFRI ANNUAL REPORT 2018-19

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

Cover Image :
"Anamudi and kurinji"
Photo Credit: Sandeep Das, Forest Ecology Department

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C O N T E N T S

Director's Desk...

There has been a paradigm shift in forest management from production/ commercial forestry to protection and conservation. This continues to be the mainstay of global forestry outlook. Forest management needs a strong research base that is contemporary and innovative. Global drivers, such as, climate change, ecosystem services, biodiversity conservation, invasive species, global markets, stakeholders, among others have all influenced forestry research in far reaching dimensions. Additionally, technological advancements in biotechnology and information technology, including artificial intelligence, emerging disciplines and development of interface with humanity has also hugely influenced forestry research. With increasing demands for social needs and environmental services, there is a need for reorientation in research priorities to enable informed decision making by researchers and policymakers. The Kerala Forest Research Institute by means of basic, applied and multi-disciplinary research is constantly endeavouring to develop strategies for effective and sustainable utilization of natural resources for societal benefits.

During 2018-19, KFRI engaged in 50 scientific research projects on different aspects of forestry and allied areas, 8 extension projects, 15 training programmes, 14 extension and outreach programmes. Financial support for these projects has been obtained from KFRI Plan Grants as well as from different international, national and state agencies. The external funding sources include : The United Nations Development Programme, The Mohamed Bin Zayed Species Conservation Fund, Abu Dhabi, The Dept. of Science and Technology-Govt. of India, The National Agroforestry and Bamboo Mission-Govt. of India, The Ministry of Agriculture, Govt. of India, The National Science and Technology Entrepreneurship Development Board (NSTEDB) of the Department of Science and Technology-i-STED -Govt.of India, The National Medicinal Plants Board, Ministry of AYUSH-Govt. of India, The Department of Biotechnology-Govt. of India, The Department of Space-Govt. of India, The Science and Engineering Research Board (SERB)-Dept. of Science and Technology-Govt. of India, The Kerala State Council for Science Technology and Environment, The Kerala Forest Development Fund, The Kerala Biotechnology Commission, The Kerala State Biodiversity Board, and The Kerala State Disaster Management Authority.

KFRI is now a member of the Association of Forestry Research Institutions (APAFRI) with rights to vote in its General Assembly. KFRI has disseminated 19 research reports, published 20 chapters in books, 41 papers in proceedings and 39 research papers in peer reviewed reputed national and international journals. In addition, five students have been awarded Doctoral degree and 83 students have completed academic attachment and internship programmes during this year. KFRI has received Rs.1773 Lakhs financial support from the Kerala State Council for Science Technology and Environment, Govt. of Kerala, both as plan and non-plan grants. Financial support from external agencies was Rs.516 Lakhs.

These accomplishments have been possible due to the support and timely guidance of the Research Council and Management Committee and the determined work carried out by the scientists, administrative staff, technical staff, research scholars, project fellows and other supporting staff. The contributions from all are duly acknowledged.

Dr.Syam Viswanath

THE INSTITUTE

The Government of Kerala established the Kerala Forest Research Institute (KFRI) as an autonomous organization 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 & Development Centres. The Institute mandates to conduct research on all aspects of tropical forestry including wood science and technology, wildlife biology and socioeconomics. 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, socioeconomics, 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, clonal multiplication, physiology, wildlife biology, soil science, molecular biology, wood science and technology, biochemistry, forest pathology, entomology, silviculture, 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, there are nurseries, green houses, mist chambers and the Kerala Forest Seed Centre. The secretariats of TEAKNET (the International Teak Information Network) funded by the Food and Agriculture Organization of United Nations, the Bamboo

Technical Support Group of the National Bamboo Mission, Government of India and the Regional Cum Felicitation Centre (RCFC) of National Medicinal Plant Board (NMPB), Department of AYUSH, Govt. of India are housed in the main campus of KFRI as also the Tree Health Helpline. The monitoring facilities are the established permanent plots and weather stations. Library, Central Instrumentation Unit, local area network (LAN), training facilities, stores, seminar and conference facilities, field work support (vehicles), staff accommodation, guesthouse and research scholars' hostel are the centralized facilities of KFRI. A seismic observatory operated and maintained by the National Centre for Earth Sciences (NCESS) is in KFRI main campus. The Institute has a Sub-centre at Nilambur in Malappuram District, a Field Research Centre at Velupadam in Thrissur District, and Field Stations at Munnar and Kottapara.

Sub-Centre, Nilambur

The Sub-Centre campus at Nilambur with facilities for laboratory work and field trials in a 43.36 hectares area is about 140 kms away from the main campus. A bambusetum with 21 species of bamboos and trial plots of several tree species are maintained at the Sub-Centre. The Sub-Centre also houses the famous Teak Museum, a Bio-Resources Nature Park, Medicinal Plant 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, 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.

Organization

Research in KFRI is undertaken in 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 each Department within the Division is managed by a Head. Divisions having laboratory and other facilities is under a Scientist-in-Charge (Facilities). The Research Coordinator, who heads the Research Monitoring and Evaluation Unit, oversees the implementation of programmes, facilitates and monitors research activities in the Institute. The Research Council is the vital body responsible for overseeing and guiding the formulation and implementation of various research programmes in KFRI. It comprises of eminent scientists in the field of forestry research in the country. It also monitors the quality and content of research undertaken by the Institute and provides guidance for improvement.

The rules and regulations of the KSCSTE guide the functioning of the Institute. The control, administration and management of the Institute are vested with the Management Committee chaired by the Director who as the Head of the Institute is also responsible for the day-to-day ad-

ministration and implementation of programmes. Besides, basic and applied research, 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 assists the Director in managing the day-to-day functioning of the Institute. An Internal Auditor scrutinizes financial and expenditure matters of the Institute. The total staff strength of the Institute is 85, which include 23 scientists, 55 administrative staff and 7 technical staff. In addition, 125 project personnels 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, Dehradun, Cochin University of Science and Technology, 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. An Academic Coordinator heads the academic programme of the Institute.

Right to Information

The RTI is an Act to provide for setting out 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 key research areas of the Division are: improved nursery and silvicultural practices, seed technology, sustainable forest management and production of better clones and quality planting stock of plantation species. In addition, studies have also been undertaken on 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 environmental physiology, especially water use, photosynthesis and microclimate. Division also undertakes weather parameters monitoring.

Some of the current activities of the Division include assessment of medicinal plant resources, conservation and management of red listed trees, climate change impact studies on endemic and threatened plants, medicinal plants resource enhancement, eco-physiology of recalcitrant tree seeds, developing nanocomposites from weed compost, bamboo waste processing, pedogenic influences on vegetation in mangrove ecosystems of Kerala, and chemistry and transformation of clay minerals under continuous teak rotation of Kerala Western Ghats. A soil museum dedicated to forest soils is attached to the Soil Science Department.

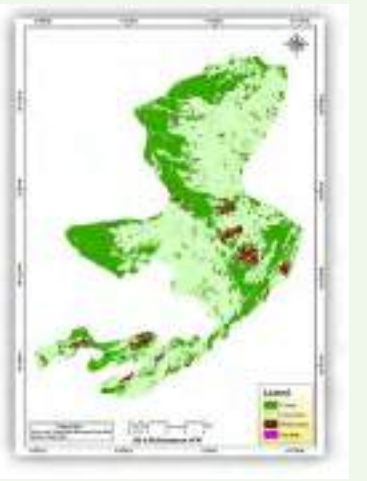
Forest Genetics and Biotechnology

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 & dipterocarps and development of institutional capability for DNA barcoding of life forms, among others. DNA barcoding facility caters to the DNA barcoding requirements of various academicians and researchers in the field and undertakes consultancy services for various State Forest Departments and other agencies.

The current research activities of the Division include development of clonal propagation protocols through micro and macro propagation for important forest tree species and medicinal plants, population demography, genetic structure, adaptive genetics and transcriptomics for sustainable conservation and management of teak and sandal genetic resources, conservation genetics of selected RET species in the Western Ghats as well as DNA barcoding for biosystematics, authentication of Ayurvedic raw drugs 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 manage 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 forest and trees outside the forest. The Division partners with various national and international organizations, and provides training on Remote Sensing, GPS and GIS.



Forest Ecology and Biodiversity Conservation

Programme Division comprises of Forest Ecology, Botany, Wildlife 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, traditional knowledge system analysis and biodiversity-informatics. Documentation and inventorisation of biodiversity of diverse forest types and protected areas, evaluation of below ground biodiversity, taxonomic studies and conservation of RET species of flora are some of the research areas of the Division. In addition, Wildlife Department attempts various aspects on inventorisation of fauna, endangered animals, man-wildlife interaction and wildlife census. A wildlife museum with an exhaustive collection of species is attached to the Wildlife Department. Phytochemical analysis of medicinal plants, nursery and plantation technology of selected indigenous timber species, ethno-biological studies and cultivation of medicinal plants and other NWFPs, such as, bamboos and rattans, are other activities of the Division. The NWFP Department also works on isolation, characterization and bioactivity studies of molecules from medicinal plants of the Western Ghats. Some of the current activities of the Division include, long-term monitoring of forest ecosystems in Kerala through permanent sample plots and of *Strobilanthes kunthianus* in Eravikulam National Park, biodiversity characterization at community level in India using Earth Observation Data, impact of flood on floral elements and soil biota in selected Rivers of Kerala, resolving species complexes using molecular systematics, long-term monitoring of forest ecosystem dynamics of permanent plots in tropical wet evergreen forest of Kerala, studies on the pesticide usage pattern on the ecosystem of munnar landscape and bioactivity guided fractionation and mechanistic elucidation of biomolecules from *Cocculus laurifolius* DC. of southern Western Ghats.

Wood Science and Technology

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. Studies undertaken also include genetic conservation of natural teak resources of India with emphasis 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. The Division was also involved in the consultancy services for the Archaeology Department, Government of Kerala in the renovation of Punalur Suspension bridge with regard to selection and quality assessment of Thambagam wood (*Hopea parviflora*) laid on the bridge. 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 mangement in protected areas, NTFPs management, environmental, and social impact assessments, economics of invasive alien sepcies, 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, create awareness amongst all relevant stakeholders about advances in forestry research.

Forest Health

Programme Division has Forest Entomology and Forest Pathology Departments. The thrust areas of research are different aspects of insects, microbes and weeds in the forest ecosystem. Authentic collections of microbes and insects of Kerala forests and of microbial pathogens of forest insects are maintained in the Division. One of the focal point is development of eco-friendly biological technologies for management of pests, diseases and weeds in forest plantations. In addition, management of nursery and plantation diseases, diversity of plant pathogenic fungi in different forest ecosystems, Vesicular-Arbuscular and ectomycorrhizal fungal diversity and biological control of invasive alien species are the thrust areas of research in Pathology Department. The Entomology Department is involved in monitoring of forest insect diversity, control of termites in plantations, wood damaging insects and teak defoliator, and traditional methods of post-harvest protection of bamboo from insect borers. 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. The concept of butterfly garden has been popularized and technical advice is being provided to various agencies for the establishment of butterfly parks. Some of the current activities of the Division include, studies on plant growth promoting rhizosphere and rhizoplane fungi of grasses and their ability to control important fungal diseases of forest nurseries, morpho-molecular characterization and ex-situ conservation of phytopathogenic fungi of Aralam Wildlife Sanctuary, Kerala, evaluation of antifungal efficiency and management of the invasive Alien Giant African Snail (*Achatina fulica*) in Kerala.

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.

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 17,000 books and 10,000 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 committed to forestry. Online access to many of the core journals in forestry and allied subjects is made available which include both national and international journals. Additionally, it has access to CAB's bibliographic database which covers the major subjects like agriculture, environment, and forestry, among others and archives from 1939. CAB Abstracts now comes with CABI full text and provides access to more than 220,000 journal articles, conference papers and reports. Online access to complete EBSCO database of Environment is possible, which contains more than 2.4 million records from 2,200 national and international titles dating 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, IUFRO and databases in CDs and DVDs.

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. A total of 40 foreign journals and 35 Indian journals are subscribed during the period. Also a total of 86 books and 45 back volumes of journals have been added to the collection. The two websites, Indian Forestry Abstracts (IFA) and Bamboo Information Centre – India (BIC – India) are maintained by the library. Upgradation of library portal, an information system for forests of Kerala and compilation of Indian Forestry Abstracts (IFA) – Phase III are the current ongoing projects.

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 transporation requirements for project implementation, trainings and other logistics are taken care by administrative section. KFRI has a fleet of vehicles including buses, 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.

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 headquarters is located at the Kerala Forest Research Institute, Peechi, India since 2008. The Network aims to transform the global teak sector from its current suboptimal state to that of a dynamic entity for the benefit of all stakeholders of the sector and to address the issues of the global teak sector. Regular TEAKNET activities include, website updation, release of quarterly online TEAKNET Bulletin, enrollment of new Teaknet Members and clearing doubts regarding various aspects of teak at a global level. TEAKNET and IUFRO Teakwood Working Party (Div 5.06.02) with the support of FAO the United Nations Regional Office for Asia Pacific (FAO RAP), Bangkok, successfully organized a Partner Event on Teak "Mainstreaming High Quality Timber Production from Planted Teak Forests and Efforts for conservation of Teak Genetic resources" on the occasion of FAO's 4th International Congress on Planted Forests 2018, Beijing. The half-day high level speakers from Inter-governmental organisations, researchers and forestry professionals from universities and academia, private teak investment companies and non-governmental organisations from Asia Pacific, Latin America, Africa and European countries. TEAKNET is a Project Partner in the ITTO – Teak Mekong project "Enhancing the conservation and sustainable management of teak forests and legal and sustainable wood supply chains in the Greater Mekong Sub-region" executed by ITTO, Japan and funded by the Govt. of Germany for a period of 3 years, which was initiated in March 2019.

Participants of the TEAKNET Partner Event during 4th ICPF at Beijing

MEMBERSHIPS

Asia-Pacific Association of Forestry Research Institutions

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. In the APAFRI 8th General Assembly (28-30 November 2018), at Putrajaya, Malaysia, KFRI was readmitted into APAFRI after a gap of eight years. KFRI is now a member of the APAFRI with rights to vote in its General Assembly. Director, KFRI, has been elected as Executive Committee member for a period of three years. This will help in shaping policy decisions at international level and fostering international collaborations, organizing international training programmes and exposure to the scientist faculty at KFRI.

APAFRI

REGIONAL CENTRES

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

The Bamboo Technical Support Group (BTSG-KFRI South zone) consisting of a team of scientists from different disciplines, set up at KFRI and supported by the National Agroforestry and Bamboo Mission (NBM), Ministry of Agriculture and Farmer's Welfare, Government of India, since 2006, offers technical support for different stakeholders in the bamboo sector. Training programmes for field functionaries and farmers on propagation, cultivation and utilization of bamboo has been a major activity of the BTSG for several years. Other activities have been to conduct specific R&D, offer technical support on bamboo to the National Bamboo Mission and to farmers and artisans. KFRI has set up a bamboo nursery to provide quality-planting material of the important commercial bamboo species to farmers. A Bamboo Information Centre (www.bicindia.org) has been set up and is a valuable source of published literature on bamboo. The Bamboo Processing Centre at Velupadam, Thrissur, under the Bamboo Technical Support Group–KFRI was established with the support of the National Bamboo Mission. The Centre is currently working as Common Facility Centre for bamboo based entrepreneurs, giving them technical support in the various stages of bamboo processing from raw materials to end products. KFRI also provides Entrepreneurship Development Programmes for emerging Bamboo Entrepreneurs. The machines and facilities of the Bamboo Processing Centre are demonstrated to NGOs, research students, entrepreneurs and architects working on bamboo and allied fields. The products of the Centre were demonstrated and are exhibited in exhibitions and fests.

Regional cum Facilitation Centre – Southern Region, National Medicinal Plants Board, Ministry of AYUSH, Government of India

The National Medicinal Plants Board (NMPB) is the apex body, under the Ministry of AYUSH, for promotion of 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-fold objectives: (i) provide technical 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 organisations 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 (RCFC Southern Region), housed in KFRI Peechi, is the first of the six RCFC's 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, and Andaman & Nicobar Islands. In 2018-'19 RCFC (SR) : (1) conducted two Regional Workshops on

'Strengthening forward-backward linkages for sustained supply of quality medicinal plants to industry through profitable cultivation" in Mysore and Chennai with over one hundred stakeholders, including farmers, traders, industries and technical experts, (2) organized nine training programmes for plant identification and cultivation practices across Kerala and in Mysuru, (3) provided financial and technical support to eight short term QPM projects in Kerala, Karnataka, and Tamil Nadu for production of quality planting materials of about 25 species and distribution to farmer clusters for planting out, (4) provided financial assistance to seven short term research projects in Kerala, Karnataka, Telangana and Tamil Nadu on biological control of pests and diseases, intercropping, organic cultivation practices, semi-processing, and value addition, (5) field assessment of an NMPB supported Kerala SMPB project on 'Conservation and Resource Augmentation of Selected Sacred Groves of Kerala with Medicinal Plants', (6) participated in capacity building training programmes, and (7) documentation and dissemination of success stories of NMPB projects, wherein, a short video on the state-level herbal garden established in KFRI Sub-Centre, Nilambur

was acknowledged by NMPB as one of the 10 success stories in the country.

FACILTIES

Arboretum

Arboreta are special places for the cultivation and display of a wide variety of evergreen and moist deciduous trees. It is a living laboratory, which functions as an outreach, teaching, and research facility dedicated to preserving the beauty and ecological functions of our biodiversity hotspot. KFRI Arboretum established in the Peechi campus in 2003 in an area of about 5 hectares currently has 3200 accessions belonging to 178 species under 50 families and 128 genera, with more than 50 taxa endemic to southern Peninsular India. Arboretum is maintained with grid maps with markings of the location details of each of the live collection. Among the 178 taxa in the arboretum, there are two gymnosperms and 176 angiosperms. Among the angiosperms, 162 taxa are dicotyledons belonging to 118 genera and 47 families and monocotyledons are represented by 14 species of 3 genera and 2 families.

A collection of wild nutmegs, key components of '*Myristica* swamps', characterized by evergreen, water-tolerant trees considered as the most primitive of the flowering plants or 'living fossils' are special attraction in KFRI Arboretum. *Myristica fatua* (Kotthapanu) *Myristica beddomei* (Pathiripoovu), *Myristica malabarica* (Ponnampayin), *Gymnacranthera farquhariana* (Undappayin) are few among them. It is also recognized internationally by Index Seminum with ID No. 1518 and is also enlisted in the National Network of Botanical Gardens in India.

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 1988-85 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 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.). During 2018-19, a new accession of *Pseudoxytenanthera bourdillonii* (Peerumedu, Idukki) and a cultivated accession of *Sasa veitchii* (Wayanad) were added to the collection. Currently, the bambusetum with 66 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 diversity, 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 sig-

nificant. With this background, the KSCSTE- Kerala, 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 theme area, 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 area, 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 is also indicating that the visitors have acknowledged the educational and recreational value 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

conservation of butterflies. It involves recreation of lost habitats of butterflies through careful landscaping and host plant introduction. KFRI has set up three parks 1) KFRI main campus at Peechi, 2) KFRI subcentre at Nilambur and 3) Thenmala 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*), among other. 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*. More than 110 species of butterflies were recorded so far. Total number of individuals found during this period is 9798 belonging to the family Papilionidae, Pieridae, Lycaenidae, Nymphalidae, and Hesperiidae. To understand the relationship between the temperature & humidity and its influence upon the behavior of butterflies in garden, thermo hygrometers are placed at different sites. Based on requests from appropriate authorities, KFRI established 82 Butterfly Gardens in schools, colleges, research centres, Government offices and public firms. Butterfly gardens have become very popular in recent years.

Centre for Analytical Instrumentation – Kerala (CAI-K)

The Centre for Analytical Instrumentation – Kerala (CAI-K)" was established in KFRI as a collaborative programme of Kerala State Council for Science Technology and Environment (KSCSTE) and Kerala Forest Research Institute (KFRI). This Centre was inaugurated by Shri. Pinarayi Vijayan, Hon'ble Chief Minister of Kerala on 08 November 2018. The facility is an assemblage of sophisticated analytical instruments required for chemical, environmental and life sciences research. This State-of-Art facility caters to a wide range of researchers, students, government and non-governmental institutions and R&D labs in sophisticated analyses and instrumentation training. The major instruments presently avail-

able in the facility are gas chromatography-mass spectrometer, inductively coupled plasma atomic emission spectroscope, high performance liquid chromatograph, spectrophotometer, flame photometer, CHNS analyser, among others. The instruments are operated and maintained by dedicated trained staff personnels. Training of researchers, teachers and students in the different analytical methods through training courses, workshops and manuals is another activity envisaged for the Facility. Regular week long training programmes and internship programmes are conducted in the facility. All the information regarding the facility, instruments, sample submission procedures, charges and other details of analysis are available in the dedicated website www.caik.res.in.

Central Nursery

The Central Nursery, situated at the KFRI main campus has a collection of about 120 species high in demand under timber yielding, fruit bearing and medicinal categories of plants. 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 the other major responsibility of the Central nursery. The data generated in the nursery is used in the ongoing research programs and is useful in future research programmes too.

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 11000 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 that can be accessed by botanists and other researchers free of charge through the data portal at http://kfriherbarium.org/. 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 (10.52668o N; 76.35095o 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 State. Main objective is to collect seeds from superior trees/stands, process, grade, store and cater to the requirement 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 research in Seed Science and Technology on tropical forestry species of the Western Ghats and provide training to forestry professionals, researchers, students and others interested in seeds. During 2018-19 about 17 tonne seeds of 34 forestry species including teak (12.647 t) and other miscellaneous species (4.218 t) 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 over 0.5 hectares, consisting of 350 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 collected from the wild or through exchange with other Botanic gardens. In 2018-19, 100 plant accessions of 74 species were made through various plant collections, of which 32 are new introductions to the garden. The medicinal plants, such as, *Nothapodytes nimmoniana, Ophiorrhiza mungos, Salacia brunoniana, Ancistrocladus heyneanus*, among others, are a few among the introductions. As part of labeling the plants during this period, 165 metal boards were displayed for both field and potted plants including for special groups. A potential medicinal plant, *Salacia fruticosa* has been studied for floral biology as the species had low fruit set. During the period, 858 individuals comprising 29 groups covering school/college students, researchers and general public visited the garden.

Orchidarium and Fernery

The Orchidarium and Fernery are meant to provide artificial habitats for orchids and ferns and helps in the ex situ conservation, multiplication, besides providing materials for study purposes. 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 ornamental, rare, threatened, terrestrial, epiphytic species of Orchids and Ferns.

Palmetum

Palmetum is the live collection of indigenous and exotic palms. KFRI Palmetum was established in the year 2000. We have a collection of 135 species of palms under 52 genera. Of these, 75 are indigenous palms and 60 are exotic species with 8 species critically endangered, 9 endangered, 8 vulnerable and 23 near threatened categories as per IUCN standards. The exotic species include those which are commonly found in Indian parks, gardens and along avenues. Rare species like *Bentinckia condapanna, Bentinckia nicobarica, Rhopaloblaste augusta, Calamus nagbettai, C. brandisii, C. vattayila, Wallichia disticha, W. nana, Korthalsia laciniosa, Korthalsia rogersii, Licuala spinosa* and 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 DST in 1999 (presently funded by 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 archieved 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 like 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.

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 ecosystem and other land covers make strong imprints on the soil beneath them and the information 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 20 soil monoliths in the museum which depicts the variation in morphological properties of soil beneath different forest ecosystems in the Kerala part of the Western Ghats.

Teak Museum

Teak, scientifically called *Tectona grandis* L.f. (Family: Lamiaceae) is considered as a grand jewel in the diadem of tree species that occurs naturally in the tropical forests of the world. Teak also became an important plantation species and many of the milestone developments in the history of teak plantations took place in Kerala, India. 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 the natural forests. Recognizing the historical importance of Nilambur leading to a momentous shift from extraction and regulatory function of forestry to a phase of resource development, KFRI established a Teak Museum in its Sub-Centre campus at Nilambur and it was opened to the public on 21st May, 1995. The museum is the first of its kind in the world and aims at disseminating information on various aspects of teak, including history, cultivation, management, utilization, socio-economics, among others. In the museum, through exhibits and associated texts, information is provided on historic, aesthetic, scientific and cultural values of the species. Exhibits of historic and artistic values are displayed on the ground floor, while the first floor is mostly devoted for exhibits and information of scientific nature. The museum also has a world class library on teak and a mini 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, and utilization. In addition, various educational, extension and programmes like orientation programmes, workshops, nature study programmes and summer training course are also organized for various stakeholders. Other activities like contests, field trips and exhibitions, and documentary fests are also conducted for the students and the general public. The museum attracts large number of visitors including students, farmers and teak users.

Tree Health Helpline

The Tree Health Helpline was launched to help tree growers by giving them guidelines on pest attack and disease management associated with tree crops. Helpline attends queries related to tree planting and management, such as, site selection, species site matching, planting, thinning, soil testing, fertilizer application, pest, disease and weed management, multi-species interactions, landscape level forestation programmes, tree/wood sample identification, preservative treatments and economic valuation. Total of 378 queries were registered during this period. The major tree species queried about were *Tectona grandis, Swietenia mahagoni, Artocarpus heterophyllus, Santalum album, Mimusops elangi, Ficus religosa, Dalbergia sessoides, Albizia spp., Mangifera indica* and garden plants. The problems were multidisciplinary. It includes pest attack, wood quality, fungal attack, seedlings, soil queries, fertilizer applications, seed processing, planting methods, species information, volume of timber, harvesting time, physiological problems, parasitic problems, species–site matching, micronutrient deficiency, social issues, species identification, calculating the volume of timber, seeds, suitable intercrops, and availability of seeds. As a part of customizing Tree Health Helpline, a helpline for children was launched on 28th February 2019 , National Science Day.

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*, 90 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 and 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. The wildlife museum receives large number of visitor's including students, researchers, govt. officials and general public.

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 No., date of collection, collector(s) name, herbarium No. 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 few Indian species for mutual exchange of xylarium samples.

RESEARCH AND EXTENSION

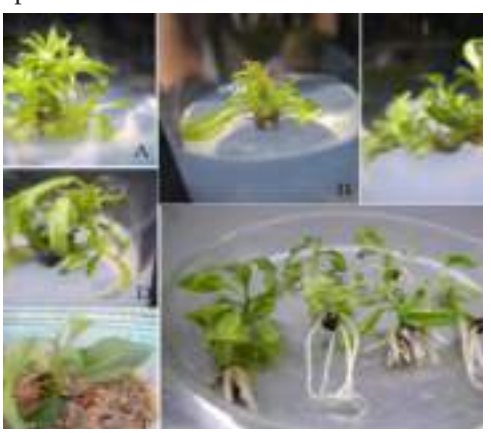
Completed Research Projects

KFRI Research Report No 538

Propagation and planting of *Embelia ribes* and *E. Tsjeriam-cottam*-two threatened medicinal plants

(A.V. Raghu, E.M. Muralidharan, T.K. Hrideek)

Efficient micropropagation methods for *Embelia ribes* and *E. tsjeriam-cottam*, two medicinally important species from family Myrsinaceae, were standardized by axillary bud proliferation. Effect of plant growth regulators like BAP, Kinetin, IAA and IBA were studied for shoot multiplication and root development. Ex vitro rooting was also attempted in *E. tsjeriam-cottam*. The study highlighted promising results in shoot multiplication in both species by using combinations of cytokinins and auxins. In *E. ribes* good results were obtained by using Kinetin (1.0 mg/I) with IAA (0.1 mg/I) and in *E. tsjeriam-cottam*, it was BAP (1.0 mg/I) with IAA (0.1 mg/I). Best root induction was obtained in half strength MS basal media with IBA (1.0 mg/l) in both the species. The survival rate was low in *E. ribes* due to shoot decaying but in *E. tsjeriam-cottam* 70 per cent survival was observed in both ex vitro and in vitro rooted plants.

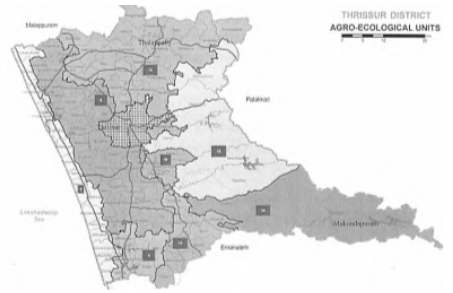


KFRI Research Report No 539

Analysis of soil samples from kanor tree crops and agroforestry systems of Thrissur District, Kerala

(M.P.Sujatha, S.Sandeep)

This study was carried out as part of a new programme initiated by the State Planning Board for developing soil based plant nutrient management plan for agro-ecosystems of Kerala. This was implemented through the State Agricultural Department and coordinated by National Bureaux of Soil Survey and land use Planning, Bangalore. The institutions involved in this venture were KVKs, KAU, ICAR institutes (IISR, Calicut; CTCRI, Trivandrum), KFRI, Peechi, ICRI, Pambadum para, Department of Agriculture, among others. KFRI was given the responsibility of analysing 13,745 soil samples from various agro ecosystems of Thrissur district for macro, secondary and micronutrients and on line transmission of data generated through the web site to enable the preparation of soil health cards for the farmers by the State Department of Agriculture. Results revealed that the soils of the district, in general, were in acid range and relatively more acidity was in rice and vegetable growing areas. Extremely acid soils of the district were concentrated mainly in pokkali and to some extent in kole lands also. Among the nutrients, excess levels of P were well pronounced in all the crops



and agro ecological units. Even though, deficiency of available Ca2+ was not dominant in the district, soils from all the vegetable growing areas were deficient in this nutrient. Deficiency of Mg 2+ was well pronounced in the district and was severe in all the cropping systems and the severity was more in vegetable growing areas. Similarly, all the agro ecological units of the district had acute deficiency of this nutrient. Deficiency of B was well pronounced in the district in general as well as in all the crops and agro ecological units. However, based on the study, it is concluded that soil fertility status of the district in general is depleting with imbalanced content of nutrients caused by the indiscriminate use of chemical fertilizers.

KFRI Research Report No 540
Certification of planting material of bamboos
(E.M.Muralidharan, R.C. Pandalai)

Certification of planting material of bamboos was envisaged by the National Bamboo Mission as a measure to improve the productivity of bamboo plantations in the country through use of superior planting stock. Bamboo plants being unique in their biology, growth and mode of propagation, present hurdles in identification of species, genetic improvement and quality control in the nurseries. An attempt to streamline the quality control procedures and set standards for quality planting stock has been made. The framework for an institutional mechanism to ensure production of genuine; quality planting of the priority bamboo species was developed, which consists of procedures to validate the identity of mother plants used for multiplication by experts in taxonomy, selection of superior clumps, maintenance of rhizome/clone bank of the superior mother plants, maintenance of quality of plants produced through the different modes of multiplication viz. seeds, vegetative propagation, and rhizome transplanting or tissue culture. Proforma for collecting the essential information about the source of multiplied plants, documentation at every stage of the plant production to ensure traceability of each propagate to the mother plant and details of the labelling are aspects covered in this study. The objective of certification is to ensure that the bamboo planting material coming under purview carries an assurance on the correct identity of species and clone and that it meets the prescribed standards of quality in propagation and nursery procedures and also provides with a means of verification of the claims through proper documentation and on-site inspections. To this end, the recommendation is to set up a Committee under the auspices of National Bamboo Mission (NBM) that will approve Bamboo Nursery Certify-

ing Agencies having the required expertise, who will then assess the nurseries and issue certificates if the requirements are complied with. Bamboo propagates carrying the label of "Certified Bamboo Planting Material" sold from a Certified Bamboo Nursery will therefore be an assurance of plant quality and health and the correct species and clone. The norms for certification of bamboo planting material has been approved by NBM and the documents were uploaded on their website.

KFRI Research Report 541
Factors affecting roosting ecology of birds in Kerala
(E.A.Jayson)

A study on the communal roosting behaviour and patterns of roosting in birds to elucidate the controlling factors was carried out in Kerala, India. Direct observation and field surveys were conducted in ten districts in the State, namely, Thiruvananthapuram, Kollam, Alappuzha, Ernakulum, Thrissur, Malappuram, Palakkad, Kozhikode, Kannur and Kasaragod for locating and studying different aspects of communal roosts covering, location of roosts, roosting trees and threats to roosts. Factors affecting the communal roosts were analysed to ascertain the reasons of shifting the roosts. Twelve species of birds were found to roost communally in Kerala and eight out of these, were wetland birds and four species land birds. A total of 258 communal roosts were recorded and four types of communal roosts were recorded, namely, of wetland species alone (44 nos.), land bird roost (131 nos.), mixed species roosts (66 nos.) and of birds of prey (11 nos.). Prominent communal roosting species were House crow (*Corvus splendens*), Common myna (*Acridotheres tristis*), little cormorant (*Phalacrocorax Niger*), Night heron (*Nycticorax nyclicprax*), Pond heron (*Ardeola grayii*), Indian darter (*Anhinga melanogaster*), Brahminy kite (*Haliastur Indus*) and Black kite (*Milvus migrans*). Highest number of communal roosts were recorded from Malappuram District followed by Ernakulum and Thrissur Districts. Highest number of wetland bird communal roosts were recorded from Palakkad and Thrissur Districts. Most of the communal roosts were recorded from the coastal areas and midlands. Overall, 81 per cent of the communal roosts were within 15 mtrs. distance from the nearest road. Among those de-

pendent on human presence for the protection of their roosts from predators are 93 per cent of land birds, 82 per cent of mixed species and 75 per cent of wetland species. The communal roosts of wetland birds were near the prominent wetlands, streams or near paddy fields. Only 59 per cent among them were within 15 mtrs distance from the road. Wetland birds were communally breeding and roosting in same locations. Conflicts arose as local people resorted to various methods to get rid of the roosting sites over the foul odour in the atmosphere as a result of the waste generated from the leftover food materials, including fish. This rendered the birds no place to establish communal roost in private properties. Consequently, most of the roosts were established and maintained in public properties owned by the Government or other public agencies. The study highlight that, shifting of roosts is normal among wetland birds, even if trees are intact, whereas, the land birds never shifted the location from the preferred trees. The communally roosting land birds selected the roosting sites mainly to avoid the predators, evident from majority roosts being found near the road sides, municipal parks, or in taxi stands, wherein human movement and presence is apparent. Other wetland birds roosted away from the human locations by selecting Islands surrounded by water or in isolated mangrove patches encircled by water. Birds of prey being carnivores, never selected the sites with human presence as they defended themselves. The authorities have to prioritise and save the communal roosting trees of these birds that are under threat in public places and resolve the rising conflicts between the local people and communal roosting birds.

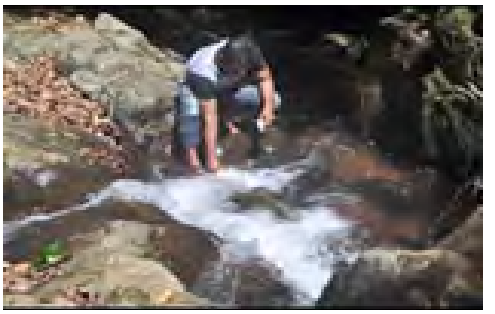
KFRI Research Report 542

Assesment of ecosystem services for conservation and management of sacred groves in Kerala part of Western Ghats

(U.M.Chandrashekara, K.A.Sreejith, S.Sandeep, G.E.Mallikarjuna Swamy, V.B.Sreekumar, M. Amruth)

The present study was conducted in five Sacred Groves (SGs), namely, Kammadam Kavu, Karimanal Chamundi Kavu, Mani Kavu, Poyil Kavu and Valliyotu Kavu of Kerala. Two approaches adopted were: firstly, to assess ecosystem services of well-managed SGs as an opportunity for the conservation and management of SGs of the Western Ghats and secondly, to identify direct and indirect drivers of degradation of SGs, to compile and

share useful information for planning interventions to combat forest degradation, reduce vulnerability and promote sustainable management of SGs. Here, level and intensity of disturbances are qualitative in nature and the disturbance variables, namely, a) loss of forest land, b) pre-mature fall of trees, c) trespass, d) illegal collection of biomass, e) dumping of solid waste, f) anti-social activities and g) use of SG area as playground were identified. By analysing the intensity and frequency of each type of disturbance, the frequency of disturbance and Index of Human Disturbance Value (IHD) were calculated. The frequency of disturbance in SGs ranged from 24 per cent to 58 per cent with lowest value for Kammadam Kavu and highest value for Mani Kavu. However, the level of disturbance caused due to various anthropogenic activities was more in Karimanal Chamundi Kavu followed by Mani Kavu, Foyil Kavu, ValIiyottu Kavu and Kammadam Kavu. A total of 418 angiosperm species, 36 species of Vesicular-arbuscular mycorrhiza (VAM fungi), 151 butterfly species and 106 bird species were recorded from these SGs. Among them, sixty angiosperm species, five species of butterflies and eight species of birds were endemic to the Western Ghats. However, a negative correlation (R=-0.945) between Index of Human Disturbance (IHD) values and total number of endemic species in these SGs was recorded. In addition, significant reduction in tree density (R= -0.941), tree basal area biomass and carbon stock in tree biomass with increase in level of disturbance were recorded. The studies on soils of SGs thus indicated that there is a significant decrease in moisture content, C, N, P, K, Ca and Mg with disturbances. Sustaining a good mix of tree species in the groves would supplement the soil organic matter and help sustain the ecosystem in a pristine state. Water analysis showed that the SGs maintain perennial streams with all the physical and chemical parameters within the prescribed ranges.



KFRI Research Report 543

BTSG Kerala Monitoring of productivity in bamboo plantations (U.M.Chandrashekara,V.P.Raveendran)

The study aimed to monitor the productivity of different species of bamboo planted in Kerala by the Forest Depart-

ment and farmers. The survey conducted in 1107 hectares (ha) of bamboo plantations raised by the Forest Department indicated that *Bambusa bambos* is planted comparatively in a large area (776 ha) followed by *Dendrocalmus strictus.* (188 ha), *Dendrocalmus sikkimensis* (96 ha) and *Bambusa bambos* var. *gigantea* (47 ha). On hectare basis, the estimated number of culms in plantations of four species ranged between 3,146 and 25,209 (*B. bambos*: 10,840 ha, *D. strictus*: 25,209 ha, *D. sikkimensis*: 3146 ha and *B. bambos* var. *gigantea*: 4,844 ha). In these plantations, the estimated number of new culms per ha ranged from 506 to 3,338 (*B. bambos*: 3,338 ha, *D. strictus*: 2,748 ha, *D. sikkimensis*: 506 Ha and *B. bambos* var. *gigantea*: 765 ha). In the State, 57 farms where 26 species of bamboos are planted were surveyed. *B. vulgaris* was the most preferred species for planting in farms (34 farms) followed by *B. vulgaris* cv. *wamin* (30 farms) and *Bambusa tulda* (27 farms). The estimated total green weight per clump ranged from 24.22 to 1767.3 kg with highest value in *Bambusa longispiculata* and lowest in *D. sikkimensis*. Similarly, the clumps of *B. longispiculata* produced more quantity of green weight in the form of new culms (229.2 kg per clump). In order to compare different species planted in a given year for parameters like total green weight of a clump and annual green weight production in a clump, 22 species planted in the year 2011 were selected. Values for both the parameters were significantly high (P: S 0.05-0.01) in *B. bambos* followed by *D. strictus* and low in *D. membranaceus*. The study also indicated that the stock of bamboo in plan-

tations of the State is showing a decreasing trend. The study further discusses certain management options for enhancing and sustaining the bamboo resource availability in the State. In farms of both private and government sectors, the cultivation of bamboo species differ based on preferences. The need for assessment of bamboo species preferred by farmers and quantity of propagules required, so as to generate them in adequate quantities is highlighted.

KFRI Research Report 544

Population structure, carbon sequestration, litter dynamics, propagation, economics and livelihood potential of *Munrochloa ritcheyi* and *Ochlandra setigara* - Two rare bamboo species of Kerala

(Kuruvilla Thomas, K.K.Seethalakshmi, E.M.Muralidharan, V.Anitha)

Southern Western Ghats of India are recognized for their bamboo diversity with a high degree of endemism. Out of the 22 naturally occurring bamboo species in this area, 17 are reported to be endemic. *Munrochloa ritchiei* and *Ochlandra seti-*

gera are two rare and endemic bamboo species of the Western Ghats with highly scattered distribution in Nilambur Forest Division. Due to vigorous growth and addition of biomass in every year, in the form of new culms leading to clump expansion, bamboos can play a major role in carbon sequestration. Technologies for large scale production of bamboo planting stock are essential for this and not much focus was given on these aspects. In this regard, the study addresses the population structure, carbon sequestration and litter dynamics as well as development of suitable propagation protocols for mass multiplication of these two species.

The study highlights that both *M. ritchiei* and *O. setigera* can accumulate biomass especially in culms and rhizome. The standing stock biomass of *M. ritchiei* was 70.6±37.9 t ha-1 while in *O. setigera*, it was 73.4±30.3 t ha-1 and the stem followed by rhizome recorded the highest contribution to the total biomass. The nutrient status of the biomass components and soil of the stands indicated a higher accumulation of nutrients like N, P, K, Ca and Mg. This can be lost through the illegal felling and uprooting these bamboo species. They can sequester considerable amount of carbon in the biomass. Total carbon storage of *M. ritchiei* was 30.1±14.9 ha-1 and the soil carbon stock up to a depth of 60 cm was 84.799±19.202 t ha-1. Similar carbon storage of natural stand was observed in *O. setigera* 30.7±13.2 t ha-1 and soil carbon sequestration were to the tune of 117.538±29.919 t ha-1. High biomass productivity and carbon sequestration of these bamboo species suggest that they can contribute to carbon sequestration potential of terrestrial biomes. From the litter dynamics and decomposition studies, it can be concluded that litter decay and release of nutrients vary among the species studied. The nutrient release was faster in early phases of decomposition and slowed down later indicating the availability of the nutrients to the growth of bamboos. The slow rate of decomposition of bamboo litter on the soil surface indicates the potential of the litter to be used as an organic mulch to conserve moisture in agricultural soils. Experiments on propagation of both species indicated the possibility of vegetative propagation using culm cuttings and offsets. The economic potential and uses of *Ochlandra setigera* is very low. According to craftsman, this species is not suitable to craft works. It may useful to paper and pulp industry. At present, there is no information regarding the usage of this species.

KFRI Research Report 545

Bird hazard to aircraft in INS-GARUDA, Naval Air Station, Kochi

(E.A.Jayson, D.N.Mathew)

INS Garuda is an Indian Naval Air Station located near Kochi, in the State of Kerala, India, which is a major naval air-training Centre as well as an operational base. The operational area of the INS Garuda, Naval Air Station had frequent incidence of birds striking the aircraft. The study was conducted in INS Garuda and the surrounding 10 kms area during January 2016 to January 2018 with the financial support from Indian Navy. The broad objectives of the study were to find out the composition of bird community in INS Garuda and also to suggest methods to reduce the bird population in INS Garuda. Twenty-seven taxa of birds were identified from the INS Garuda and 30 species from the surrounding area. Out of these, three species were migratory and other species were resident birds. Highest number of bird species were recorded in December 2017 and lowest in February 2016 and August 2017 inside INS Garuda. In the same way, highest number of bird species were recorded during December 2017 and lowest during October 2016 and February 2017 outside INS Garuda. The main species of birds involved in bird strike were Red wattled Lapwing, Blue rock Pigeon and Black kite. Many suggestions were given in each month after the field visit and most of them were implemented in time. Out of the three species causing bird strikes in the INS Garuda only one species, Red wattled Lapwing can be controlled from within INS Garuda. The control of other two species can be carried out only through the cooperation of civil authorities and local people (Blue Rock Pigeon and Black Kite). This area is a metropolitan area of Cochin Corporation typically with the waste dumps. Scaring or dispersing birds away from airports is usually difficult because birds are tenaciously attracted to available food, water, and cover. As long as these attractants exist, such bird incidence will occur. A wildlife hazard management plan should be implemented to make address the issue. Near-miss events occur much more frequently than bird strikes. Recent advances in commercially available, digital avian tracking radars enabled biologists to automatically monitor and assess near-

miss events. A combined dataset of bird strikes and near-misses provides BASH managers with a more responsive metric to evaluate the success of their program over time than by using only the bird-strike dataset.

KFRI Research Report 546

Foraging ecology of selected birds in the kole wetlands of Kerala, India (E.A.Jayson)

Kole wetlands of Thrissur is one of largest, highly productive and threatened wetlands in Kerala and has been declared as Ramsar Site in 2002 which comes in the Central Asian Flyway of migratory birds. The intensive study areas for foraging ecology of birds were selected after a reconnaissance survey and observations on feeding behaviour was made with the help of spotting scope (I Ox-45x), HD Video cam and binocular (7 X 50). The feeding behaviour of birds (food and feeding patterns of selected species) in the Kole wetlands was studied through direct observation and the Focal-Animal Sampling methods. Bird community of Kole wetlands, roosts in the vicinity of the Kole wetlands were observed and the leftover food materials which were seen in the roosts were collected and identified. Resource quantification was done to estimate the food availability of birds in the Kole wetlands. Data regarding their diet composition during breeding season was also recorded. A total of 214 samples were collected from the heronries. Water analysis was carried out to check the aquatic health status. Important physiochemical properties like pH, temperature, total dissolved solids, total hardness, total alkalinity, chloride, sulphate, iron, dissolved oxygen, biological oxygen demand, salinity, electrical conductivity, nitrate-N, fluoride, phosphate and total, suspended solids were analysed during March 2016 to November 2017. Water samples (Pre-Monsoon, Monsoon and post-Monsoon) were collected from 10 different areas of Pullazhi, Adatt, Enamavu, Manakody and Kanimangalam. Kole wetlands of Thrissur; Pullazhi, Adatt, Enamavu, Kanjany, Manakody and Kanimangalam were the intensive study areas and from each area four samples were collected using gill net and "petty and para" system (during the dewatering period) in a year. A structured questionnaire survey was conducted among the farmers and people surrounding Kole wetlands to assess the extent of crop loss due to birds and to understand people's preception on conservation of birds. The study elucidated the food and feeding behaviour of selected wetland birds, assessed the food availability of selected wetland birds and the extent of crop loss due to birds and highlights people's perception on conservation of birds.

KFRI Research Report 547

Structure, composition, dynamics and management of 'vayal' ecosystem in Periyar Tiger Reserve

(K.A.Sreejith, V.B.Sreekumar, K.K.Ramachandran)

Marshy grasslands (vayals) of Periyar Tiger Reserve (PTR) were studied for its distribution, extent, floral and faunal inventory, mapping and conservation and management issues. In this study, 140 vayals has been inventoried and mapped from PTR. The total extent of vayals in PTR is 281.45 ha and Anakallu vayal in Pamba Forest Range is the smallest one with an extent of 0.02 ha and Poovarashu vayal in Thekkady Forest Range is the largest vayal with an extent of 28.49 ha. A total of 277 angiosperms were recorded through floral inventory which belong to 168 genera under 65 families. In majority of vayals, presence of non-marshy species was documented. Invasion of 50 tree species and 21 exotic weed species indicates the degradation of these wetland ecosystem. This invasion of non-marshy species resulted in decrease in the extent of marshy grasslands over a period of time and the process is still continuing. The percentage of reduction over a ten-year period varies 8-27 per cent depending on the degradation level of vayals. From 140 vayals surveyed, 23 species of amphibians, 24 species of reptiles, 63 species of birds, and 19 species of mammals were recorded. During this study the endemic and IUCN listed frog, *Raorchestes travancoricus* was found from eight new locations and was the first report of this rare species from a Protected Area which were considered to be the last refuge for this frog.

Monthly soil moisture percentage varies from 28-118 per cent and found to be a good indicator to understand the degradation level of the system. Since vayals are wetland systems, soil moisture plays a regulating role, character and fate of the system. Decrease in soil moisture level gradually results in degradation, drying and further invasion of non-vayal species. Hence, vayal management system should focus on this root cause of decrease in soil moisture and should take necessary steps to maintain its optimum level. It is also found that the clay content of the soil is reduced in degraded vayals which further reduce the water holding capacity of the system. Through large number soil samples studied for a period of one year, it is found that 70-74 per cent moisture is the minimum soil moisture level to be maintained which may reduce the invasion of non-swampy species and keep the system intact wetland. It is also noteworthy that among the five vayals which were studied in detail, three were below optimum level in which Pothukandam vayal requires special attention which had a low moisture value of < 40 per cent throughout the year. The

study highlights that vayals have soil organic carbon contents 2-3 times higher than other natural forest systems in the Western Ghats. Hence, we suggest to prepare a priority list of vayals to be managed based on a primary screening of soil moisture value and clay content.

KFRI Research Report 548

Population analysis seed biology and restoration of *Hopea erosa* and *H. racophloea* two critically endangered trees of the Western Ghats

(P.K.Chandrasekhara Pillai, P.A.Jose, P.Sujanapal, R.Jayaraj, T.K.Hrideek)

The study envisaged to understand population structure, reproductive biology and seed biology including seed storage and biochemical variation during shelf life. The genus *Hopea* belongs to the family of Dipterocarpaceae comprises 104 species, naturally distributed in Sri Lanka, southern India to southern China, and southward throughout Malaysia to New Guinea. Most of them are canopy trees found in wet evergreen forests (100-1000 m asl). Eighteen species were reported from South Asia and 10 species from India. They are the source of 2 damar resin used in varnishes. Wood is durable and used for making boats, bridges and house construction. *Hopea* is one of the significant groups of trees and some of them are red listed by the IUCN. Seven species of *Hopea* are reported from Kerala, and all of them are endemic to Western Ghats. Among them, *H. erosa* (Bedd.) van Sloot. and *H. Jacobi* C.E.C. Fisch. are critically endangered. *H. glabra* Wight & Arn., *H. racophloea* Dyer and *H. utilis* (Bedd.) Bole are endangered, whereas *H. parviflora* Bedd. and *H. ponga* (Dennst.) Mabb. are vulnerable. Information on population structure, reproductive biology and regeneration potential of most of the species are meagre. *Hopea erosa* and *H. racophloea* are threatened species, which are sparsely distributed in the Kerala part of Western Ghats. Population of *H. erosa* is reported from the evergreen forests of northern part and *H. racophloea* from the evergreen forests of southern part. *Hopea erosa* is a sub-canopy tree of about 18 m height mostly distributed on banks of streamlets. *Hopea racophloea* is a tall tree up to 35 m height. Extensive studies have not been undertaken on these two species except for a few reviews. A preliminary work revealed anti-oxidant activity of wood and leaf extracts of *H. erosa*. Population structure, reproductive biology and regeneration potential of these two species were lacking. Timing of recurring biological events provides background for collection and to understand regeneration process of the species. Information on reproductive biology is

important for developing strategies to conserve and restoration. Investigation on biochemical changes during shelf life of seeds helps to assess possible reason for poor viability. Towards this end, the study focused on *H. erosa* and *H. racophloea*, the threatened species in the Kerala part of Western Ghats.

KFRI Research Report 549

Establishment of permanent plots in all forest types for continuous monitoring of climate change induced variations

(V.B.Sreekumar, K.A.Sreejith, T.V. Sajeev, G.E.Mallikarjuna Swamy)

Long-term monitoring plots provide vital information on the flora, vegetation ecology, ecosystem dynamics, climate change and anthropogenic impact on biodiversity. Six, one-hectare permanent plots were established in evergreen, moist deciduous, dry deciduous and shola forests for long term monitoring to analyze the pattern of ecosystem dynamics and temporal changes in the floristic and biodiversity composition. Each one ha plot was in turn subdivided into 100 quadrats of 10 x 10 m size, with quadrats permanently marked. 5904 individuals were counted which constituted 149 species. Number of individuals was greater in two sites of evergreen forests (1905 individuals ha-1 and 1393 individuals ha-1), followed by shola forest (738 individuals ha-1), moist deciduous forest (703 individuals ha-1) and dry deciduous forest (286 individuals ha-1). Species-level basic information such as location of trees per plots, girth distribution pattern and frequency of distribution in various forest types were generated which form the baseline information for monitoring the changes. Further, these plots can be used for monitoring of species-wise regeneration pattern, phenology, seed dispersal, soil micro-flora, among others.

KFRI Research Report 550

Re-investigating the permanent plots established by KFRI to measure the dynamics of tree community

(K.A.Sreejith, V.B.Sreekumar, U.M.Chandrashekara, T.V.Sajeev)

More than sixty locations in natural forests of Kerala were revisited to observe and document the current status of permanent plots established by Kerala Forest Research Institute during last three decades. Due to poor maintenance and absence of long-term monitoring, majority of the plots could not be relocated. Those sites which still had signs of plots, such as, corner stone, tagged/painted trees could be traced and thus 14 plots were re-established for understanding the current pattern of tree diversity and dynamics. Among these 14 plots, 11 were having the primary data collected during 2002 at the time of its establishment that was compared with current vegetation data. By comparing all these plots in general there was a decrease in total number of individuals from 4982 to 4392 but the total basal area got increased from 453.8 m2 (2002) to 501.3 m2 (2012). The mortality rates in majority of plots were higher than the recruitment rate. The mortality was not restricted to any particular girth class and not related to any particular species. Ten years of monitoring is not sufficient to understand the dynamics of tree community. Thus, to understand the impact of climate change and related factors, site specific long-term monitoring and weather data collection is essential.

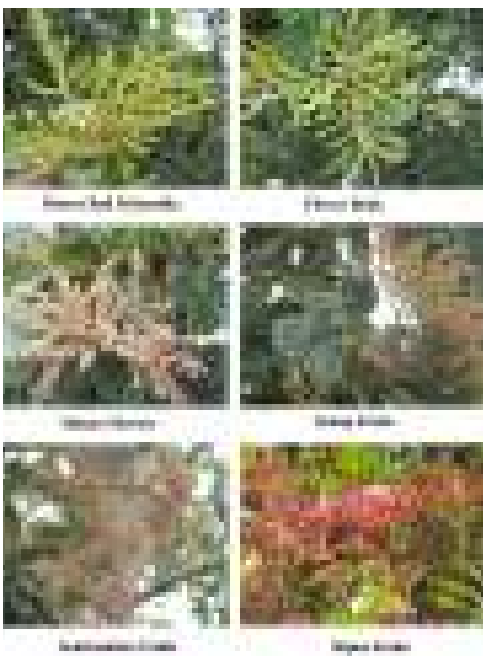
KFRI Research Report 551

Study on reproductive constrains and seed characteristics of *Terminalia paniculata* Roth.

(P.K.Chandrasekhara Pillai, T.K.Hrideek)

Terminalia is the second largest genus of the family Combretaceae, an important timber tree genus comprising about 100 species distributed all over the tropical regions of the world. It is known for considerable economic importance in terms of wood and non-wood produces like tannins and are used in traditional folk medicine. About 24 species of *Terminalia* have been reported from India. Six species are naturally found in different forest types of Kerala. Among them, *T. paniculata* has poor regeneration status. The species is one of the large sized multipurpose tree species belongs to the family. Population of the species is declining due to overexploitation and poor regeneration status. Various phytochemical studies revealed its traditional medicinal properties. Considering these amazing characteristics, the species requires an urgent attention and support to maintain the natural population in its native range. Detailed studies to understand reproductive constraints of the species are scanty. In this context, the study

was undertaken to examine reproductive constraints and seed characteristics of *T. paniculata*. Mature trees were selected from Peechi-Vazhani Wildlife Sanctuary, (Thrissur District, Kerala) based on vegetative characteristics and reproductive capacity. The phenophases were recorded regularly during 2015-18 on the selected mother trees. Flower, fruit and seed production pattern were observed to assess reproductive capacity of the species. Reproductive phenophases were recorded visually in the field conditions. Thirty flower buds in each direction for all the four directions (North, East, West and South) of the selected mother trees were· marked at the time of bud initiation. Regular observations were made on the identified floral buds and recorded data regarding opening of corolla, anthesis, stigma receptivity, pollination, agents of pollination, fruiting, etc. Fruit development stages and fruit production patterns were assessed. Anthesis and stigma receptivity were also studied under laboratory condition. Pollen viability and germination were evaluated under different conditions and suitable breeding system was identified. Maturity index of fruits/seeds were determined to attain maximum viable seeds.

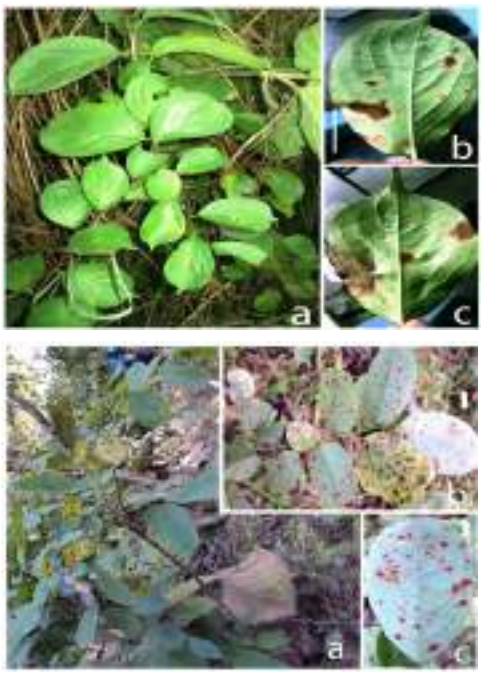


KFRI Research Report 552

Collection, Identification, documentation, exploration and conservation of biodiversity of parasitic foliicolous hyphomycetous fungi from Tarai forests flora of Uttar Pradesh

(Shambu Kumar)

Extensive surveys were conducted during 2014-2016 from Terai forests of Uttar Pradesh for the collection, identification, exploration and documentation of foliicolous hyphomycetous fungi. A total of 400 fungal samples showing leaf diseases were collected. The microscopic observation and morphological examination of collected foliicolous fungal samples depicted 250 fungal samples showing leaf spots belonging to hyphomycetous fungi and remaining 150 to other groups (non-hyphomycetous fungi). The collected fungal specimens were studied morpho-taxonomically and 250 foliicolous hyphomycetous fungi belonging to 30 genera were identified. Among these 250 hyphomycetous fungi, 233 were already reported genera, while total 17 foliicolous hyphomycetous fungal samples were proven as new taxa



(species) for science, after critical morphological examination and comparison with closely similar taxa. The novel discovered foliicolous hyphomycetous taxa were belonging to nine genera, represented by 5 species of *Corynespora gussow*,1 species of *Curvularia boedijn*, l species of *Exosporium* Link, l species of *Monilochaetes* Halsted, 1 species of *Parapyriculatia* Ellis, 1 species of *Passalora* Fr., 2 species of *Periconia* Tode ex Fries, 4 species of *Pseudocercospora* Speg, and 1 species of *Zasmidium* Fr. These novel taxa were morpho-taxonomically described, illustrated and discussed in details as per new ICN's rule. The preserved herbarium (Fungarium) specimens of 17 novel taxa were deposited as holotype in internationally recognized herbaria, Ajrekar Mycological Herbarium (AMH), ARI, Pune and Herbarium Cryptogamae Indiae Orientalis (HClO), Indian Agricultural Research Institute (IARI), New Delhi and duplicate of the same as isotypes were retained in the departmental mycological herbarium of the Institute for future reference. Based on survey and collection of foliicolous hyphomycetous fungi from different forest sites of eleven districts, it was found that sites of Gorakhpur and Mahrajganj districts have more hyphomycetous fungal diversity. The study suggested the conservation of these areas.

KFRI Research Report 553
Digitisation of selected Books in KFRI Library-Phase 2
(K.F. George)

Four hundred and seventy-three books have been digitized and made available in KFRI library portal and can be searched by author, title and subjects. A significant advantage of digitizing older document is to make them accessible and searchable for future use. Once a document has been properly digitized, it becomes immortal and can remain accessible long after the original has ceased to exist. The same resources can be accessed by a number of users at any time. The option of digital access further aids in preservation of originals through reduced need for physical handling.

KFRI Research Report 554
Developing a digital library for the Teak Museum
(N.Sarojam, Sani Lookose)

Teak (*Tectona grandis*) is a highly researched tropical timber tree owing to its

superior wood quality and high accessibility as a profitable plantation species. In view of importance, much research has been done on this timber world over. Research results of the work carried out on different aspects of the species have come out in different forms and the large amount of information generated are widely scattered. Teak museum, established by the KFRI at Nilambur in 1995 aims to disseminate information on various aspects of teak. Organisation of a library with a collection of all published documents on teak at the museum will help to make available any information published on teak. Pooling of information generated on teak at the teak museum will facilitate further research and generate more information on teak. As it is kept in its digital form, storage and retrieval is easy. Sharing of information is also possible as it is in electronic form. Documents in electronic form are organised using an open source software. Research outcomes and descriptions on different aspects available in many forms, were assembled in an easily searchable DVD and made available at the Teak Museum, Nilambur. Regular updating of the database and the collection of remaining documents is to be continued.

KFRI Research Report 555

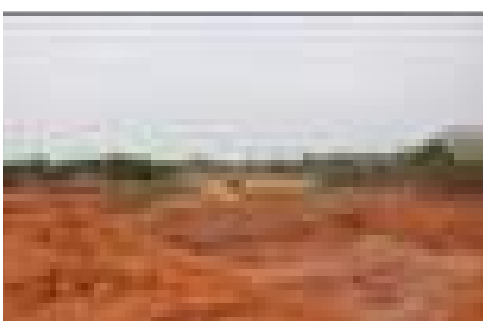
Developing strategies for bio-cultural restoration conservation and management of lateritic biotopes in north Kerala

(K.A.Sreejith,V.B.Sreekumar, T.V.Sajeev, S.Sandeep, T.K.Hrideek, M.Amruth)

The lateritic biotopes of Northern Kerala along with its different ecological sub-units and microhabitats were studied to document its biodiversity and land use change over the years. Being a human dominated landscape, this system is facing various threats which were identified and analysed. Lateritic hillocks, Sacred Groves (SGs), Kaanams and Kuthiru were the major ecosystems documented during the study which are abodes of biodiversity and provide various valuable ecosystem services. A total of 80 SGs, 02 Kaanams and 16 Kuthiru were documented and mapped during the study. A total of 970 species of angiosperms belonging to 138 families were identified and listed, out of which 138 are endemic, 4 are endangered and 14 are vulnerable species and one critically endangered species were also documented. In the lower fauna, 112 species of spiders, 25 species of grasshoppers, 42 species of odonates, 140 species of butterflies and 321 moth species were documented. Among higher group of animals, 215 birds (3 vulnerable, 5 near threatened under IUCN), 27 reptile species (one near threatened), 20 amphibians (one endangered), 68 fish species (one near threatened) and 25 mammal species were documented. Among these, seven species of reptiles are new report to lateritic biotope. Among different ecological sub units, lateritic, hillock was richer in floral and faunal component. This exhaustive documentation of biodiversity is the scientific validation against the prevailing 'waste land' concept on lateritic hillock.

The presence of rich biodiversity and its interactions with the landscape elements provide valuable ecosystem services to

the society. The hillock serves as a water holding unit which recharges ground water and there are perennial water flows associated with kaanam as a part of lateritic hillock. Mass blooming of the plants on the rocky plateaus offers abundant food supply for the pollinators, which are supporting various crops and homestead plants of various adjoining ecological units. The presence of different pollinator groups, such as, Lepidoptera, Orthoptera, Aves and Chiroptera in turn facilitates the crop production. On the other hand, larger animals including birds have a major role in seed dispersal. Seed dispersers play critical roles in the natural regeneration of vegetation and maintaining biodiversity. Hence, the lateritic hillock and associated ecological subunits are interacting with each other and support the society by providing various ecosystem services such as recharging ground water, increasing agriculture/crop productivity, provision for food, nutrient cycling, carbon sequestration etc. The land use and land cover pattern indicated that around 40 per cent of the paddy cultivated areas were converted for infrastructure development and mixed cultivation. Lateritic biotopes (60 %) were converted for other purposes, such as, infrastructure, monoculture plantations and laterite mines. Cashew cultivated area (84 %) was replaced by rubber plantations and infrastructures. There is also a considerable increase in the mining area during last three decades. Increase in population and high population density lead to over exploitation of natural resources and change in traditional land use pattern, and lead to a drastic change in land use and structure. Most of the lateritic exposed area and wetlands were converted into industrial and residential areas. The conversion of biodiversity rich biotopes for infrastructure development, mines and monoculture plantations adversely affected the landscape. By enlisting and understanding the severe threats faced by the lateritic biotope, human centric restoration and conservation strategies were also suggested.



KFRI Research Report 556

Ecology and conservation genetics of *Atuna indica* and *Hydnocarpus longipedunculatus* -two rare and endemic trees in the Kerala part of the Western Ghats

(P.A. Jose)

A study on the ecology and conservation

genetics of two rare and endemic tree species, viz. *Atuna indica* and *Hydnocarpus longipedunculatus* of the Kerala part of the Western Ghats were carried out. The population survey enabled to locate three populations of *A. indica* in the evergreen forests at an altitude above 400 asl at Kakkayam, Kozhikode District and Nadugani Ghat of Malappuram District and two populations at Kulamavu forests in Idukki district for *H. longipedunculatus*. Sample plots were laid and population structure and diversity of the species were analyzed. A total of 89 adult individuals of girth 2:30 cm, 68 seedlings and 1 sapling were recorded in *A. indica* whereas 76 adult individuals with girth 2:30 cm, 25 seedlings and 1 sapling of 1m height were recorded in *H. longipedunculatus*. The age-wise distribution revealed a decrease in pre-reproductive individuals in both the taxa. The population diversity analysis showed relatively low IVl values for both genera. The extremely low number of flowering individuals with pest incidence during flowering and fruiting stages, resulted in extreme low seed output in *A. indica*. The flower infestation, fruit damage by giant squirrels, poor seedling bank in situ, etc. were the reproductive barriers of *H. longipedunculatus*. The assessment as per IUCN guidelines, suggested the placement of both the genera under Critically Endangered (CR). The presence of moderate to high nitrogen, low to moderate phosphrous and moderate to high potassium in the soil were identified as the edaphic requirements for these species in situ. The percentage of polymorphic loci, total genetic diversity and genetic variation within populations were comparatively low for both the genera. However, the percentage of effective alleles and genetic diversity among populations were higher than that of other woody species. In general, the diversity analysis pointing towards unfitness of the populations and subsequent low adaptiveness to the changing environments of the species.

ONGOING RESEARCH PROJECTS

INTERNATIONAL

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

2. Study on diversity and current status of fish and fisheries in GEF-Munnar landscape project area (T.V. Sajeev, V.B. Sreekumar) United Nations Development Programme

3. Study on the impact of invasive plant species on ecology of GEF-Munnar landscape project area (T.V. Sajeev) United Nations Development Programme

4. Conservation of critically endangered cycad, *Cycas annaikalensis* in India (P. Balakrishnan) Mohammed Bin Zayed Species Conservation Fund, Abu Dhabi.

NATIONAL

5. Network project on conservation of lac insect genetic resources (T.V. Sajeev, T.K. Hrideek, M. Amruth) Ministry of Agriculture, GOI

6. Annual Action Plan of BTSG-KFRI (E.M. Muralidharan, T.K. Dhamodaran, U.M. Chandrashekara, N. Sarojam, V. Anitha, V.P. Raveendran, G.E. Mallikarjuna Swamy, A.V. Raghu, P.K.C. Pillai, K.V. Mohammed Kunhi, V.B. Sreekumar, Suma Arun Dev) National Agroforestry and Bamboo Mission, Ministry of agricultur, GOI

7. Tools for management and harvesting of bamboo (E.M. Muralidharan, P.K.C. Pillai) National Agroforestry and Bamboo Mission, Ministry of agricultur, GOI

8. Exploration of medicinal plant resources of Lakshdweep islands with special reference to indigenous knowledge (P. Sujanapal) National Medicinal Plants Board, Ministry of AYUSH, GOI

9. Documentation of population demography and genetic structure of teak for developing sustainable conservation strategies and resource management (Suma Arun Dev, P.K.C. Pillai) DBT, GOI

10. Management of destructive invasive alien species in the high range mountain landscape of Munnar in the Western Ghats of Kerala (T.V. Sajeev, T.K. Hrideek) DST, GOI

11. Authentication of major commercially traded raw drugs in the ayurvedic systems of medicine in India (Suma Arun Dev, P. Sujananpal, R. Jayaraj, V. Anitha) National Medicinal Plants Board, Ministry of AYUSH, GOI

12. The medicinal plants market in south India: economic value and tribal rights (V. Anitha, P. Sujanapal) National Medicinal Plants Board, Ministry of AYUSH, GOI

13. Establishment of a herbal garden as a peri-urban green space of Nilambur, Malappuram District, Kerala (U.M. Chandrashekara) National Medicinal Plants Board, Ministry of AYUSH, GOI

14. Facilitating the establishment of bamboo and cane enterprises through training and technology transfer (K.V. Mohammed Kunhi, E.M. Muralidharan,) The National Science and Technology Entrepreneurship Development Board (NSTEDB), DST-i-STED, GOI

15. Exploration of medicinal plant resources of Panju islands of Maharashtra (P. Sujanapal) National Medicinal Plants Board, Ministry of AYUSH, GOI

16. Collection, Identification, documentation, exploration and conservation of biodiversity of parasitic foliicolous hyphomycetous fungi from Tarai forests flora of Uttar Pradesh (Shambu Kumar) DST-SERB, GOI

17. Exploring the possibility of developing semiochemical based control strategy for the management of *Cossus cadambae* - the borer pest of *Tectona grandis* through isolation and identification of its pheromone system (T.V. Sajeev) DST-SERB, GOI

18. Demographic survey and restoration of two endangered variants of 'Daruharidra', *Berberis tinctoria* Lesch. and *Coscinium fenestratum* (Gaertn.) Colebr. in the Western Ghats (P. Sujanapal, V.B. Sreekumar) National Medicinal Plants Board, Ministry of AYUSH, GOI

19. Biodiversity characterization at community level in India using earth observation data (K.A. Sreejith, V.B. Sreekumar) DBT and DoS, GOI

20. Population dynamics of selected endemic and threatened trees in the protected areas of Kerala: Temporal analysis in the context of climate change (P.A. Jose, K.A. Sreejith) DBT, GOI

21. 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 phytopathogen-

ic fungi (Shambu Kumar, G.E. Mallikarjuna Swamy) DBT, GOI

22. 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 (U.M. Chandrashekara) National Medicinal Plants Board, Ministry of AYUSH, GOI

23. 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 (P.A. Jose, P. Sujanapal) National Medicinal Plants Board, Ministry of AYUSH, GOI

24. Genome wide and geospatial approaches for enhancing the adaptive potential of threatened rattan resources in India (Suma Arun Dev, V.B. Sreekumar) DBT, GOI

25. Biological management of pest and diseases of selected commercially important medicinal plants (G.E. Mallikarjuna Swamy, T.V. Sajeev) National Medicinal Plants Board, Ministry of AYUSH, GOI

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

STATE

27. Development of biomarkers as a predictive tool for organophosphate toxicity in terrestrial ecosystem (R. Jayaraj, Suma Arun Dev) Kerala State Council for Science Technology & Environment

28. Bioactivity guided fractionation and mechanistic elucidation of biomolecules from *Cocculus laurifolius* DC. of Southern Western Ghats (R. Jayaraj, P. Sujanapal) Kerala Biotechnology Commission

29. Economic valuation of ecosystem services from the moist deciduous forests of Kerala (V. Anitha, K.A. Sreejith, S. Sandeep, V.B. Sreekumar) Kerala Forest Development Fund

30. Development of management protocols for already established invasive alien species in the protected and other forests of Kerala (T.K. Hrideek, G.E. Mallikarjuna Swami, A.V. Raghu, P. Sujanapal) Kerala Forest Development Fund

31. DNA Barcoding - a promising molecular tool for timber forensics (Suma Arun Dev, V.B. Sreekumar) Kerala Forest Development Fund

32. Chemistry and transformation of clay minerals under continuous teak rotations of Kerala Western Ghats (S. Sandeep, M.P. Sujatha) Kerala State Council for Science Technology & Environment.

33. Evaluation of selected clones of teak through multisite testing to identify site specific clones for large scale plantation (T.K. Hrideek, A.V. Raghu, M. Amruth) Kerala Forest Development Fund

34. Sophisticated analytical instrumentation facility (R. Jayaraj, S. Sandeep) Kerala State Council for Science Technology and Environment & KFRI

35. Flood mapping of Palakkad, Thrissur and Ernakulam Districts (Shijo Joseph, K.A. Sreejith, V.B. Sreekumar) Kerala State Disaster Management Authority

36. Impact of flood on floral elements and soil biota in Pamba, Periyar, Bharathapuzha and Chalakkudy Rivers in Kerala (V.B. Sreekumar, G.E. Mallikarjuna Swamy, K.A. Sreejith, S. Sandeep, T.V. Sajeev, A.V. Raghu) Kerala State Biodiversity Board

37. Chemistry and transformation of clay minerals under continuous teak rotations of Kerala Western Ghats (S.Sandeep, M.P. Sujatha) Kerala State Council for Science Technology & Environment

KFRI PLAN GRANTS

38. Plant growth promoting rhizosphere and rhizoplane fungi of grasses and their ability to control important fungal diseases of forest nurseries (G.E.Mallikarjuna Swamy)

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

40.Genetic improvement of selected tree species - Phase I: establishment of germplasm collection at KFRI (T.K. Hrideek, E.M. Mualidharan, P.K.C. Pillai, A.V. Raghu)

41. Genetic improvement of selected tree species- Phase I: plus tree selection, standardization of the propagation techniques, establishment of seed orchard and clonal hedge garden (T.K. Hrideek, E.M. Muralidharan, A.V. Raghu, P.K.C. Pillai)

42. Compilation of Indian Forestry Abstracts (IFA) Phase III (K.F. George)

43. Evaluation of clonal teak plantations with particular reference to growth and wood properties (T.K. Hrideek)

44. Long term monitoring of *Strobilanthes kunthianus* in Eravikulam National Park - Phase I (K.A. Sreejith, V.B. Sreekumar, T.K. Hrideek, R. Jayaraj)

45. Establishment of Nodal Centre of alien invasive species research and management (T.V. Sajeev, V. Anitha, T.K. Hrideek, A.V. Raghu)

46. Restoration and reassessment of selected IUCN listed endangered trees in the Western Ghats (P.A. Jose, P. Sujanapal, V.B. Sreekumar)

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

48. Studies of the effect of elicitors and precursor feeding on in vitro production of secondary metabolites and plant growth in *Oroxylum indicum* (A.V. Raghu, E.M. Muralidharan, T.K. Hrideek)

49. Mapping, biodiversity inventory and tree health assessment of KFRI campus (K.A. Sreejith, Shijo Joseph, V.B. Sreekumar, T.V. Sajeev, G.E. Mallikarjuna Swamy)

ONGOING EXTENSION PROJECTS

1. Establishing Tulasivanam (Collection of Thulasi plants) at Niyamasabha complex of Kerala (A.V. Raghu)

2. Preparation of compensatory mangrove afforestation and conservation plan related to the widening and improvement of NH 17 from Kannur to Vegalam in the State of Kerala (P. Sujanapal)

3. A proposal for publishing an introductory, pictorial book (Coffee- Table Book) on the forest wealth of Kerala (A.V. Raghu)

4. Regional-cum-facilitation Centre for sustainable development of medical plants (Southern Region) (U.M. Chandrashekara)

5. Observation of world environment day - River cleaning activities (A.V. Raghu)

6. KFRI - KILA Bambusetum (A.V. Raghu)

7. Preparation of a handbook on woody plants endemic to Kerala (P.A. Jose)

8. Implementation of Harithakeralam programme at KFRI (V.B. Sreekumar)

ONGOING ESTABLISHMENT PROJECTS

1. Maintaining Permanent Plots – Phase II (K.A. Sreejith)

2. Maintenance and enrichment of Microbial Collection (G.E. Mallikarjuna Swamy)

3. Maintenance of Wildlife Museum (P. Balakrishnan)

4. Maintenance of Butterfly garden at KFRI-Peechi campus & establishment of new gardens in schools (T.V. Sajeev)

5. Maintenance and enrichment of Insect Collection (T.V. Sajeev)

6. Enrichment and maintenance of Medicinal plant garden (P.A. Jose)

7. Maintenance of KFRI Herbarium (V.B. Sreekumar)

8. Maintenance of Arboretum and Palmetum at Peechi campus (V.B. Sreekumar)

9. Tree Health Help Line (T.V. Sajeev)

10. Strengthening and enriching Institute Central Nursery (P. Sujanapal)
11. Commercial Nursery- Palappilly (A.V. Raghu)
12. LAN, Internet and Website (T.K. Hrideek)
13. Research Monitoring and Evaluation Unit (T.V. Sajeev)
14. Wood Processing and Preservative Treatment Plant (V.B. Sreekumar)
15. Monitoring of Teak Experimental plots, clonal Multiplication area (CMA) and production of superior clonal plants (T.K. Hrideek)
16. Maintenance of Orchidarium and Fernarium (P. Sujanapal)
17. Maintenance of Research Nursery for Bamboos (V.P. Ravendran)
18. Maintenance of Forest Seed Processing Unit (P. Sujanapal)
19. Maintenance of Bambusetum (A.V. Raghu)
20. Maintenance of Arboretum at Palappilly (A.V. Raghu)
21. Bamboo Processing Centre (Mohammed Kunhi)
22. Maintenance and enrichment of Bio-Resources Nature Park (U.M. Chandrasekhara)
23. Maintenance of Field Research station at, Devikulam (T.K. Hrideek)
24. Maintenance of Field Research Station, Kottapara, Ernamkulam (T.K. Hrideek)
25. Maintenance of field trial plot of *Ochlandra* at HNL, Kottayam and germplasm at FRC Palappilly (E.M. Muralidharan)
26. Soil health restoration programmes through participatory approach (M.P. Sujatha)
27. Upgradation and maintenance of soil museum at KFRI (M.P. Sujatha)
28. Campus Garden Development (P.A. Jose)
29. Research Management (T.V. Sajeev)
30. Updation of KFRI Library Portal (K.F. George)
31. Field Research Centre (FRC), Palappilly- Eco Tourism and Conservation Awareness Programmes (A.V. Raghu)

PUBLICATIONS

Research Papers in Journals

1. Aparna, C.R., Nishi Sahu, Deori Maushumi, Suma Arun Dev, Yadav, V. P., and Ghosh, I. 2018. Metagenomic exploration of microbial signatures on periyar river sediments from the Periyar Tiger Reserve in the Western Ghats. Genome Announcements 6(11): e00154-18.

2. Babita Mishra, Sandeep Chakraborty, Sushant Arade, Sruthi Subbanna and Viswanath Syam. 2018. Assessment of heartwood and oil content of *Santalum album* Linn. in natural and naturalized populations across contrasting edapho-climatic conditions in India. Indian Forester 144 (7): 675-685.

3. Bharath Nair and Mallikarjunaswamy, G.E. 2018. *In vitro* efficacy of *Trichoderma harzianum* against major fungal pathogens of teak and mahogony seedlings. International Journal of Life Sciences A9: 49-54.

4. Bharath Nair and Mallikarjunaswamy, G.E. 2018. Rhizoplane and rhizosphere mycoflora of *Cynodon dactylon* (l.) pers. grass and their antagonistic activity against fungal diseases of mahogany seedlings. International Journal of Current Research in Life Sciences 07: 2179-2182.

5. Bhaskar D., Easa, P. S. and Hochkirch, A. 2018. Digitalisation of Indian Orthoptera types deposited in British Natural History Museum, London (NHMUK) and a checklist to Orthoptera of Kerala, India. Metaleptea 38 (1). 19-20.

6. Bhasakar D., Easa, P.S., Sreejith, K.A., Skejo, J. and Hochkirch, A. 2019. Large scale burning for a threatened ungulate in a biodiversity hotspot is detrimental for grasshoppers (Orthoptera: Caelifera). Biodiversity and Conservation https://doi.org/10.1007/s10531-019-01816-6

7. Bindhu, T.K., Sheema, D.P., Udhayan, P.S., Rini Vijayan, K.P. and Raghu, A.V. 2018. *In vitro* conservation of *Ipomea mauritiana* Jacq. International Archive of Applied Sciences and Technology 9(1): 13-18.

8. Chandrashekara, U.M. and Reshma, P.K. 2019. Science educational and recreational benefits of the bio resources nature park at Nilambur, Kerala, India. Current Science 117(2): 188-189.

9. Delmy Abraham, Bharath Nair and Mallikarjunaswamy, G.E. 2019. Antimicrobial and GCMS analysis of chloroform extract of *Pseudarthria viscida* (l.) wight and arn. and associated major fungal endophyte. International Journal of Advanced

Research 7: 105-113.

10. Divya Soman, Anitha, V. and Anju Arora. 2018. Bioremediation of municipal sewage water with *Azolla microphylla*. International Journal of Advanced Research 6(5): 101-108.

11. Divya Soman and Anitha, V. 2019. A critical review on the valuation of ecosystem services from the forests of India. International Journal of Research and Analyical Review. www.ijrar.org (E-ISSN 2348-1269, P- ISSN 2349-5138).

12. Greeshma, P. and Jayson, E.A. 2018. Asian openbill stork (*Anastomus Oscitans*), not a nut cracker: A study from kole wetlands of Thrissur, Kerala. Informatics Studies 4(1): 19-28.

13. Greeshma, P., Riju P. Nair, Jayson, E.A., Manoj, K., Arya, V. and Shonith, E.G. 2018. Breeding of woolly-necked stork, *Ciconia episcopus* in Bharathapuzha River Basin, Kerala, India. Indian Birds 14 (3): 86-87.

14. Greeshma, P., Jayson, E.A., Manoj, K. and Riju, P. 2018. Status and composition of heronries in Thrissur District, Kerala, India. Eco Chronicle 13(1): 1-6.

15. Greeshma, P. and Jayson, E.A. 2018. Is floating and wading, a common behavior of Indian pond heron (*Ardeola grayii*)? International Journal of Entomology and Zoological Studies 6(1): 179-180.

16. Greeshma, P. and Jayson, E.A. 2018. Scavenging by house crow (*Corvus splendens*) on its own species. Journal of Bombay Natural History Society 114: 37.

17. Harishma, K.M., Sasi, R., Sreekumar, V.B. and Sandeep, S. 2018. Distribution mapping and conservation of *Bruguiera sexangula* (lour.) poir., Kerala, India. International Journal of Life Sciences Research 6 (4): 142 - 146.

18. Hrideek, T.K., Geethu, P.D., Jijeesh, C.M. and Suby. 2019. Standardisation of propagation through stem cuttings in *Celastrus paniculatus* Willd, a threatened medicinal plant. Medicinal Plants 11 (3): 253-264. doi : 10.5958/0975-6892.2019.00034.0

19. Hrideek. T.K., Geethu, P.D., Jijeesh, C.M., Raghu, A.V. and Muraleekrishnan, K. 2019. Standardization of adventitious root introduction in stem cuttings of *Cyanometra travancorica* Bedd Willd., an endangered tree species of Western Ghats. Vegetos 32(1): 11-18. https://doi.org/10.1007/s42535-019-00002-x.

20. Jithin, K.V., Jose, P.A., Sanil, M.S. and Binoy, N.M. 2019. *Lepisanthes ferruginea*

(Radlk.) Leenh. (Sapindaceae)- A new distributional record for the mainland India. Indian Journal of Forestry 42(1): 31-33.

21. Jose, P.A., Kuruvila, S.T. and Binoy, N.M. 2018. Distribution and population status of *Kingiodendron pinnatum* (Angiosperms: Fabaceae): An endemic and endangered legume tree in southern Western Ghats, Kerala, India. Journal of Threatened Taxa 10(7): 11963-11968

22. Jose, A.C., Sudhin, P.P., Prasad, P.M. and Sreejith K.A. 2018. Spider diversity in Kavvayi river basin, Kerala, Southern India. Current World Environment 13(1). http://www.cwejournal.org?p=18890

23. Josna. V.K.J., Mallikarjunaswamy, G.E. and Sajeev, T.V. 2018. Effect of nickel on bacterial population in soil. International Journal of Research in Applied Science and Engineering Technology 6: 1971-81.

24. Kavitha, C., Sujatha, M.P. and Royal Tata. 2019. Spatial variation in soil micronutrients as influenced by agroecological conditions in tropical humid region. Journal of Tropical Ecology. DOI 10.1007/s42965-019-00037-w

25. Mallikarjunaswamy, G.E. and Bharath Nair. 2018. *Colletotrichum* diseases of forest nurseries and their biological management *in vitro* using rhizoplane mycoflora of grasses. International Journal of Research in Applied Science and Engineering Technology 6: 4356-4361.

26. Manjaiah, K.M, Sandeep, S., Ramesh, T. and. Mayadevi, M.R. 2018. Soil organic carbon stocks under different agroforestry systems of north-eastern regions of India. Agroforestry https://doi.org/10.1007/978-981-10-7650-3-11.

27. Modhumita Ghosh Dasgupta, Kandasamy Ulaganathan, Suma Arun Dev and Swathi Balakrishnan. 2019. Draft genome of *Santalum album* L. provides genomic resources for accelerated trait improvement. Tree Genetics and Genomes 15: 34 https://doi.org/10.1007/s11295-019-1334-9.

28. Muhammad, A.A., Tan, M.K, Abdullah, N.A., Azirun, M.S., Bhaskar, D. and Skejo, J. 2018. An annotated catalogue of the pygmy grasshoppers of the tribe Scelimenini Bolívar, 1887 (Orthoptera: Tetrigidae) with two new *Scelimena* species from the Malay Peninsula and Sumatra. Zootaxa 4485. pp70. ISBN 978-1-77670-477-4.

29. Ramachandra, T.V., Divya Soman, Naik, A.D. and Chandran, M.D. 2017. Appraisal of forest ecosystem goods and services: challenges and opportunities for conservation. Journal of Biodiversity 8(1): 12-33. DOI: 10.1080/09766901.2017.1346160.

30. Ramesh, T., Bola, N.S., Kirkham, M.B., Wijesekara, H., Manjaiah, K.M., Rao, C.S., Sandeep, S., Rinklebe, J., Ok, Y.S., Choudhury, B.U., Wang, H., Tang, C., Wang, X., Song, Z. and Freeman, O.W. 2019. Soil organic carbon dynamics: Impact of land use changes and management practices: A review. Advances in Agronomy 156: 3- 107.

31. Renuka, R., Sandeep, S. and Sujatha. M.P. 2018. Phosphorus transformations in mangrove soils under microcosm study. International Research Journal of Environmental Sciences 7 (12): 21- 35.

32. Sajitha, K.L., Suma Arun Dev and Maria Florence, E.J. 2018. Biocontrol potential of *Bacillus subtilis* B1 against sapstain fungus in rubber wood. European Journal of Plant Pathology 150: 237-244.

33. Sandeep, S., Ninu, J.M. and Sreejith, K.A. 2019. Mineralogical transformations under fire in the montane grassland systems of the southern Western Ghats, India. Current Science 116 (6): 966 - 971.

34. Samitha, K.A., Rajathy Sivalingam and Sandeep, S. 2018. Assessing soil quality in pine apple (*Ananas comosus*) cultivated areas of Ernakulam district. International Journal of Life Sciences Research 6 (4): 321-326.

35. Shambhu Kumar and Raghvendra Singh. 2018. *Curvularia martyniicola*, a new species of foliicolous hyphomycetes on *Martynia annua* from India. Studies in Fungi 3(1): 27–33. Doi 10.5943/sif/3/1/4 [ISSN 2465-4973].

36. Shambhu Kumar, Raghvendra Singh, Singh, D.P. and Kamal. 2018. *Crousobrauniella*, an interesting new foliicolous hyphomycetous fungus from Uttar Pradesh, India. Kavak 50: 64–68.

37. Suma Arun Dev, Saju K. Michael, Anitha, V. and Feroze, M. 2018. Particularly vulnerable Cholanaickan tribals are prone to sickle cell disease in near future. Current Science 114 (1): 22-23.

38. Suma Arun Dev, Balakrishnan, S., Kurian, A. Sreekumar VB. 2019. Narrow gene pool can threaten the survival of *Calamus nagbettai* R.R. Fernald & Dey, a highly endemic dioecious rattan species in the Western Ghats of India. Journal of Genetics 98: 100. https://doi.org/10.1007/s12041-019-1147-5

39. Yasodha, R., Vasudeva, R., Balakrishnan, S., Sakthi, A.R., Nicodemus, A., Nagarajan, N., Rajashekar, B., Bachpai, V.K.W., Pillai, P.K.C. and Suma Arun Dev. 2018. Genome sequencing of a high value tropical timber tree, Teak (*Tectona grandis* L. f): Insights into SSR diversity, phylogeny and conservation. DNA Research 25 (4): 409-419.

Chapter in Books

1. Anitha, V., Joseph, N., Krishnakuma, R.J., Nipin, M. and Soman, D. 2018. The medicinal plants sector supporting livelihood and industry: problems and probable explanations in Kerala, India. In: Prospects in Conservation of Medicinal Plants (Eds. Raghu, A.V. et al.), KSCSTE-KFRI, Peechi, Thrissur, ISBN: 81-85041-99-7.

2. Suma Arun Dev, Remya Unnikrishnan, Jayaraj, R., Sujanapal, P. and Anitha, V. 2018. DNA barcoding – a prospective tool to address illicit trade and conservation issues in medicnal plants. In: Prospects in Conservation of Medicinal plants (Eds. Raghu, A.V. et al.), KSCSTE-KFRI, Peechi, Thrissur, ISBN: 81-85041-99-7.

3. George, K.F. 2018. RFID Technology in libraries. Source: In: Librarians role of teaching (Eds. Francis, A.T., Chelatayakkot, V. and Sathian, K.P.), Daya Publishing House, New Delhi, pp. 87-94.

4. George, K.F. 2018. Data curation in digital library. Source: In: Role of libraries in creating knowledge society (Eds.Thanuskodi, S. et al.), Algappa University, Karaikudy, Tamil Nadu, pp. 15-19.

5. George, K.F. 2019. KFRI library portal: A gate way to forestry information. Siddharth Books, Delhi, pp. 308-312.

6. Greeshma, P. and Jayson, E.A. 2018. Asian openbill stork (*Anastomus oscitans*); not a 'Nut-cracker': a study from kole wetlands of Thrissur, Kerala. In: Indian Hotspots: Vertebrate Faunal Diversity, Conservation and Management Volume 1 (Eds. Sivaperuman and C. Venkataraman, K.). DOI: 10.1007/978-981-10-6605-4_19, pp. 139-149.

7. Greeshma, P. and Jayson, E.A. 2018. Breeding ecology of yellow-wattled lapwing, *Vanellus malabaricus* in the kole wetlands of Thrissur. In: Advances in Fish and Wildlife Ecology and Biology Vol.7, Daya Publishing House, pp. 225-231.

8. Hrideek, T. K., Suby and Amruth, M. 2018. Biology and cultivation of teak crops of Kerala an overview. In: Proceeedings of Gregor Mendel Foundation (Eds. Radhakrishnan V.V., Hrideek, T.K., Raghu A.V. and Chandranmohan K.T.), Calicut University, Kerala, India (ISBN: 978-81-935133-0-9), pp. 132-141.

9. Hrideek, T.K., Suby and Amruth, M. 2019. Unique metabolites from alien invasive plants. In: Plant Metabolites: Methods, Applications and Prospects. (Eds. Swapna, T.S., Shiburaj, S. and Sabu, A). Springer Publication.

10. Hrideek, T.K., Delna Davis., Muraleekrishnan, K. and Suby. 2018. Study on juve-

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EXTENSION AND TRAINING ACTIVITIES

TRAINING PROGRAMMES CONDUCTED

1. Two days Training cum Exposure visit for B.Sc Forestry students, Telengana, 03-04-2018 to 04-04-2018, supported by Forestry College and Research Institute, Telangana (V.P. Raveendran, K.V. Mohammed Kunhi, A.V. Raghu)

2. Two days Training Course on 'Medicinal Plant Cultivation', 15-05-2018 to 16-05-2018, supported by Agriculture Department, Kodakara (A.V. Raghu, P. Sujanapal, K.V. Mohammed Kunhi, V.P. Raveendran, M. Amruth)

3. Training on 'Teak: Nursery Management and Cultivation', 17.05. 2018, supported by KFRI Plan Grants (A.V. Raghu, T.K. Hrideek, P. K. Chandrasekhara Pillai, K.V. Mohammed Kunhi)

4. National Childrens' Science Congress 2018 - Southern Regional Workshop, 23-07-2018 to 25-07-2018, supported by Kerala State Council for Science Technology and Environment (V.P. Ravendran, K.V. Mohammed Kunhi, A.V. Raghu)

5. One Day Training on 'Nursery Techniques on Bamboo', 01-08-2018, supported by Kerala State Bamboo Mission (E.M. Muralidharan, V.P. Raveendran)

6. Two-day Training Workshop on 'Tiger Reserves and Ecotourism', 18-09-2018 to 19-09-2018, supported by Ministry of Environment, Forests and Climate Change, Government of India (V.P. Raveendran, K.V. Mohammed Kunhi, A.V. Raghu)

7. Training Programme on 'Bamboo Propagation and Plantation', 01-01-2018 to 15-10-2018, supported by Kerala Bureau of Industrial Promotion (K-BIP)–KSBM (V.P. Raveendran)

8. One Week compulsory Training Course on 'Conservation and Development of Medicinal Plants and Benefit Sharing with Local Communities', 22-10-2018 to 26-10-2018, supported by Ministry of Environment, Forests and Climate Change, Government of India (A.V. Raghu, M. Amruth, V.P. Raveendran, K.V. Mohammed Kunhi)

9. Training cum Exposure visit on 'Conservation and Livelihood of Kerala Forest' for PGDFM Students, Indian Institute of Forest Management (IIFM), Bhopal, 10-12-2018 to 21-12-2018, supported by IIFM, Bhopal (V.P. Raveendran)

10. Exposure visit to Kerala for farmers of Maharashtra as part of Training Programme on 'Bamboo Cultivation & Processing', 04-12-2018 to 07-12-2018, supported by ATMA Pune, Maharashtra (V.P. Raveendran)

11. Green Skill Development Programme - Certificate Course on 'Value Addition & Marketing of NTFPs (Plant Origin) - Bamboo Craft', 05-11-2018 to 16-11-2018 & 02-01-2019 to 20.02.2019, supported by Ministry of Environment, Forests and Climate Change, Government of India and Kerala State Council for Science Technology and Environment – Environment Information System hub (V.P. Raveendran)

12. Green Skill Development Programme - Certificate Course on 'Valuation of Ecosystem Services & Green GDP', 21-11-2018 to 07-12-2018, supported by Ministry of Environment, Forests and Climate Change, Government of India and Kerala State Council for Science Technology and Environment – Environment Information System hub (V. Anitha, V.P. Raveendran)

13. Green Skill Development Programme Certificate Course on 'Propagation and Management of Bamboo', 05-11-2018 to 16-11-2018 & 02-01-2019 to 31-01-2019, supported by Ministry of Environment, Forests and Climate Change, Government of India and Kerala State Council for Science Technology and Environment –Environment Information System hub (V.P. Raveendran)

14. Green Skill Development Programme - Certificate course on 'Forest Entomology and Pest Control', 05-09-2018 to 31-03-2019, supported by Ministry of Environment, Forests and Climate Change, Government of India and Kerala State Council for Science Technology and Environment –Environment Information System hub (T.V. Sajeev)

15. Training programme on "Remote Sensing, GI and Resources Mapping" during the period 27-31 May 2019.– Self Generating fund (Rs. 4000 as fee from each participant). 20 participants completed the programme and awarded certificates (K.A. Sreejith, Shijo Joseph, V.P. Raveendran)

EXTENSION & OUTREACH ACTIVITIES

Manalipuzha Conservation Jalaraksha– Jeevraksha scheme

Manalipuzha river originates from Peechi-Vazhani Wildlife Sanctuary and has a stretch of 32 kms before it joins Kurumali river. Rejuvenation of the river is a major task in the "Jalaraksha- Jeevaraksha" project funded by NABARD, is headed by Thrissur Jilla Panchayat along with District Soil Conservation Department, Thrissur. The main objectives of the project are to survey the area on both sides of the river to fix its boundaries, survey stone laying and planting tree saplings along the sides of the river. Biological restoration along the sides of the river for protection of nearby land from floods and landslides and to regulate the stream course is an integral part of the project. The technical opinion on the ecological measures to be adopted is done KFRI, Peechi. The technical support from KFRI includes developing designs for biological restoration along the stream banks, selection of appropriate plant species for each terrain and the distribution of seedlings. The planting and maintenance activities done through MNREGS and blue army are also regularly monitored by the expert team from KFRI.

Puthur Zoological Park - Landscaping activities

KFRI has undertaken the landscaping activities on different units of Puthur Zoological Park. As per the Order No. SPV 253/18 dated 14-3-2019, the E tender submitted by KFRI for supplying palms and bamboos for landscaping the Zoo at a total budget of Rs. 23, 00,750 Lakhs. The palms and bamboos proposed include species indigenous to the Western Ghats and ornamental varieties to be raised in KFRI and to be supplied to Puthur zoo. Palms are represented by 24 genera with 36 species and bamboos include 9 genera with 21 species.

Field Research Centre (FRC), Palappilly opened for Public

FRC at Palappily has been opened to public for familiarization of the facilities of FRC from 1st January 2019 onwards. This facility has drawn a lot of attention from public, college students and school children.

First Question Launched

KFRI has launched First Question- a dedicated Helpline for answering questions which children ask about nature. This was formalized by Dr. Haridasan, former Director, FRLHT at KFRI. The Helpline is in response to the fact that children ask a large number of unique questions to satisfy their query for knowledge.

First Question logo release and inaugural speech by Dr.Haridasan

India International Science Festival (IISF)-2018

Participation in the Mega Science Expo organized by the Department of Science and Technology, Govt. of India, in connection with India International Science Festival during 5-8, October 2018 at Lucknow, Uttar Pradesh. Dr. A.V. Raghu, Scientist, KFRI participated on behalf of KSCSTE, Thiruvananthapuram. illustrated activities through poster display as well as brochures, newsletters and other extension materials were distributed to the larger scientific community who were interested. A large crowd of researchers, educationists, students and other public interested in science and technology visited the stall and gone through activities, mission and vision. Many expressed their interest in working with KSCSTE and its affiliated institutes as a scientist/researcher. On an average of 2000 people visited the KFRI stall each day.

Bambusa bamboos in high floodwaters along the banks of Bharathapuzha River

Kerala experienced massive floods during June to September 2018 that resulted in huge losses. A good number of landslides happened all over of the State, especially along river banks. In this context, KFRI has carried out studies to assess the potential of *Bambusa bamboos* growing along the sides of Bharathapuzha river on river bank conservation. The study led by Dr. Syam Viswanath and Dr. A.V. Raghu concluded the efficiency of bamboo clumps in river bank stabilization during floods.

Academic Training Programme

KFRI has organized an academic training programme on Biodiversity to the High School teachers of Kerala on 14 November, 2018. Dr. Kuttikrishanan, Director, Sarvasikha Abhiyan inaugurated the programme. Dr. Syam Viswanath, Director, KFRI and Dr. S. Pradeepkumar, Member Secretary, KSCSTE attended the inaugural function. Dr. Easa P.S., Rtd. Director, KFRI and Dr. Kunjikrishnanan, among others, delivered lectures to the participants. Around 40 teachers from different districts participated the programme (Fig. 4). Dr. K.A Sreejith, Scientist, KFRI was the Programme Coordinator and Dr. A.V. Raghu, Scientist, KFRI, was the Training Coordinator of this programme.

Cleaning drive at Ponnani riverbanks

As a part of Ministry of Environment, Forest and Climate Change (MoEF & CC) funded "Beat Plastic Pollution", KFRI organized a massive cleaning programme at the river banks of Ponnani, Malappuram District of Kerala. As a part of this programme, several awareness programmes to public, kudumashree, teachers and school students, among others, were organized. Several posters, brochures and pamphlets were published. Besides, various competitions at kindergarten, schools and others were conducted. A letter of appreciation from MoEF & CC,GOI, for the exemplary efforts in this regard was handed over to Dr. A.V. Raghu, Scientist,

on behalf of KFRI by the Hon. Speaker of Kerala State, Sri. P. Sreeramakrishnan, at Ponnani.

KFRI-KILA Bambusetum

With an objective of familiarizing various types of bamboos to the officials, people's representatives and farmers who came for attending programmes at Kerala Institute of Local Administration (KILA), Kerala Forest Research Institute (KFRI), Peechi established a Bambusetum at KILA Campus, Mulamkunnathukavu, Thrissur, Kerala. This programme was jointly inaugurated by the Directors' Dr. Syam Viswanath, KFRI and Dr. Joy Elamon, KILA on 26th September, 2018 .

IRDP Vipananamela Exhibition

The State Poverty Alleviation Unit (PAU) organizes an IRDP Vipanana mela at the district headquarters every year in connection with the Onam celebrations of the State. This attracts large numbers of visitors to the exhibition venues each year where products and services of most Government Departments are showcased. KFRI participated in the IRDP vipananamela at Thrissur, Palakkad, Kozhikode and Kannur Districts as a first timer. Besides, showcasing various products and services offered by KFRI, the Institute also aims to spread awareness on the ecological uniqueness of the districts and natural resource utilisation of Kerala in an effort to contribute to the Haritha Keralam Mission of the Government of Kerala.

Summer School Programme

KFRI organized one-day Science Programme to the students as a part of summer school programme organized by State Library Council and Kerala State Council for Science and Technology on 15th April, 2018. The programme attended by about 350 students was coordinated by Dr. A.V. Raghu. Dr. V.B. Sreekumar and Dr. K.A. Sreejith were the resource persons .

FAO Supported TCPP roject on 'Strengthening Capacity of Forest Research Institute, Myanmar

Training on forestry extension was organised for the Researchers (12 Nos.) of the Forest Research Institute (FRI) and Forest Staff of the Department of Forest, Myanmar from 23rd to 27th August 2018 at the FRI, Myanmar as part of FAO Supported TCPP Project on 'Strengthening Capacity of Forest Research Institute Myanmar' (TCP/MYA/3607). Methods adopted in the training sessions included presentations, group and individual exercises and audio visual aids including screening of documentaries.

Training programme on Medicinal Plants Cultivation

Two day programme on Medicinal Plants cultivation was organized by Kerala Forest Research Institute from 15th to 16th, May 2018 at Extension and Training Division, KFRI Peechi. The programme was funded by Agriculture Department, Govt. of Kerala. Dr. A.V. Raghu, Scientist coordinated this programme.

Two-Day National Seminar organized

Two day National Seminar funded by SN College, Allathur, on 'Re-thinking Ecological Conservation: Emerging Perspectives and Approaches' was jointly organized by Kerala Forest Research Institute and SN College, Alathur at SN College Alathur. Dr. A.V. Raghu coordinated the programme. The seminar was inaugurated by Dr. Syam Viswanath, Director, KFRI. Dr. T.V. Sajeev, Senor Principal Scientist, KFRI, Dr. P. Pramod, Principal Scientist, SACON, Coimbatore, Sri. L.Namassivayam, Kerala Natural History Society, Dr. V.B. Sreekumar, Scientist, KFRI, Dr. Stephen Sequiera, Maharaja's College Ernamkulam, and Dr. P. Balakrishnan, Scientist, KFRI handled various academic sessions in this seminar.

എസ്എൻ കോളേജിൽ ദേശീയ സെമിനാർ തുടങ്ങി

ആലത്തൂർ

മണ്ണ്, കാട്, പുഴ തുടങ്ങിയ നമ്മുടെ പ്രകൃതിവിഭവങ്ങൾ പുഷണത്തിന് വിധേയമാവുന്ന കാലത്ത് നാം തുടരുന്ന പ്രകൃതി സംരക്ഷണ മാതൃകകൾ അപര്യാപ്തമാണെന്ന് കേരള വനഗവേഷണ സ്ഥാപനം ഡയറക്ടർ ഡോ. ശ്യാം വിശ്വനാഥ് പറഞ്ഞു. ആലത്തൂർ എസ്.എൻ കോളേജിൽ ദേശീയ സെമിനാർ ഉദ്ഘാടനം ചെയ്യുകയായിരുന്നു അദ്ദേഹം. കാലാവസ്ഥ വ്യതിയാനത്തെ നേരിടാൻ നാം മുതലാളിത്തത്തെ എതിർക്കുവാൻ പര്യാപ്തമാവണമെന്ന് കേരള വന ഗവേഷണ സ്ഥാപനം റിസർച്ച് കോ–ഓഡിനേറ്റർ ടി വി സജീവ് പറഞ്ഞു.

പ്രിൻസിപ്പൽ ഡോ. ഇ എൻ ശിവദാസൻ അധ്യക്ഷനായി. ഡോ. ആർ ബിന്ദു, വി ദേവദാസ്, ഡോ. ജെ ഷെറീന, ഡോ. എ വി രഘു, എന്നിവർ സംസാരിച്ചു. രണ്ടാം ദിനത്തിൽ ശാസ്ത്രജ്ഞരായ ഡോ. ടി വി സജീവ്, ഡോ. വി ബി ശ്രീകുമാർ, ഡോ. പി ബാലകൃഷ്ണൻ, കേരളവർമ്മത്തുർ സലീം

ആലത്തൂർ എസ്എൻ കോളേജിൽ ദേശീയ സെമിനാർ കേരള വനഗവേഷണ സ്ഥാപനം ഡയറക്ടർ ഡോ. ശ്യാം വിശ്വനാഥ് ഉദ്ഘാടനം ചെയ്യുന്നു

അലി സെന്റർ ഫോർ ഓർണി തോളജിയിലെ സീനിയർ ശാസ്ത്രജ്ഞൻ ഡോ. പി പ്രമോദ് എന്നിവർ ക്ലാസെടുക്കും.

ACADEMIC PROGRAMMES

Doctoral Degree awarded

Sl. No	Student	Supervising Guide/Co-Guide	Thesis Title	University	Month/ Year of Award
1.	Lathika C.	Dr. M.P. Sujatha	Potential of urban waste compost for organic farming	CUSAT	08-08-2018
2.	Kavitha C.	Dr. M.P. Sujatha	GIS based soil fertility mapping in Agroecosystems of Thrissur District,- Kerala	CUSAT	17-092018
3.	Soumya R.	Dr. T.V. Sajeev	Ecology, phenology and social contexts of invasion by selected alien plants in Kerala	FRI-DU	18-12 2018
4.	Maneetha T.K.	Dr. T.V. Sajeev	Faunal responses of biological invasion: A case study of the Giant African snail (*Achatina fulica* Bowdich) infestation in Kerala	FRI-DU	20-12-2018
5.	Sijimol K.	Dr. V.B. Sreekumar Dr. Suma Arun Dev	Molecular systematics and phylogeny of the genus *Ochlandra* Thw. (Poaceae)	FRI-DU	26-02-2019

Ongoing Programmes

SERB-DST-GOI- Post Doctoral Programme

1. A.P.Zaibin - Using soundscapes to examine spatio-temporal ecological dynamics and assess biodiversity of a Protected Area in the Western Ghats (01 April 2017-31 March 2019)

KSCSTE-Back to Lab Research Fellowship

1. Keerthy Vijayan - Tracking the invasion of *Achatina fulica* and its role in spreading the rat lung worm *Angiostrongylos cantonensis* (15 December 2016 to September 2020)

2. Neetu R.S. - Evaluation of phytochemical profiles of selected medicinal plants from different agro-climatic condition of Kerala (01 April 2017 to 31 March 2019)

Doctoral Programmes

Sl. No.	Name of Student	Guide/Co-Guide	Topic
FOREST RESEARCH INSTITUTE Deemed to be University			
1.	Neethu R.S.	Dr.T.V.Sajeev	Regional differences in phenotypic and phytochemical profiles of selected medicinal plants in Kerala
2.	Keerthy Vijayan	Dr.T.V.Sajeev	Tracking the invasion: Molecular phylogeography and phyloclimatic modelling of the giant African snail (*Achatina fulica* Bowdich) in south India
3.	Bharati Patel	Dr.T.K.Hrideek /Dr.P.Balakrishnan	Diversity and abundance of tree-microhabitats and its potential as indicators of vertebrate diversity in tropical rainforests of the Western Ghats
4.	Arya Krishnan	Dr.K.A.Sreejith	Stand structure, diversity and dynamics of moist deciduous forests in Peechi-Vazhani Wildlife Sanctuary, Kerala

COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY			
5.	Anoja Kurian	Dr.E.M. Muralidharan	Molecular studies on rattans of south India
6.	Vidya R Sankar	Dr.E.M. Muralidharan	Study of the constraints in efficient micropropagation of Bamboo
7.	Alex C.J.	Dr.T.V.Sajeev	Ecology of Kavvai river basin: A fragmented Landscape in Kerala
8.	Greeshma P.	Dr.E.A.Jayson	Foraging ecology of selected birds in the kole wetlands of Thrissur, Kerala
9.	Divya Soman	Dr.M.P.Sujatha/ Dr.V.Anitha	Assessment of ecosystem services from Parambikulam Tiger Reserve
10.	Renuka R.	Dr.S.Sandeep	Chemistry of mangrove soils in Kerala.
11.	Vishnu P.S.	Dr.S.Sandeep	Pedogenesis and geochemical transformations in forest ecosystems of the Western Ghats, Kerala
12.	Harishma K.M.	Dr.V.B.Sreekumar/ Dr.S.Sandeep	Modeling carbon sequestration and its dynamics in the mangrove systems of Kerala
13.	Ninu Jose	Dr.S.Sandeep	Molecular fingerprints and geochemical interaction of organo-nano composite from Forest floor humic acid in the Western Ghats, Kerala
14.	Thasni V.M.	Dr.V.B.Sreekumar	Seasonal influence on phenology of woody species in a tropical moist deciduous forest of southern Western Ghats, India
15.	Remya Unnikrishnan	Dr.Suma Arun Dev	Molecular diagnostic markers for authentication and early sexing of *Coscinium fenestratum* (Gaertn.) Colebr
16.	Swathi Balakrishnan	Dr.Suma Arun Dev	Molecular characterization and adaptive genetic diversity linked to wood property traits for sustainable management of teak genetic resources
17.	Alina Paul	Dr.R.Jayaraj	Bioactivity and mechanistic studies of certain botanical extracts for their potential application as biopesticides

UNIVERSITY OF CALICUT			
18.	Mohamad Anaz K.	Dr.N.Sasidharan	Systematic studies, utilization and conservation of the genus *Salacia* (Celastraceae) in South India
19.	Sandeep Das	Dr.P.S.Easa	Ecology and behaviour of amphibians of Eravikulam National Park, with special reference to bush frogs
20.	Dhaneesh Bhasker	Dr.P.S.Easa	Diversity and fire induced behavioural dynamics of short-horned grasshoppers (Insecta: Orthoptera: Caelifera) in Eravikulam National Park and Parambikulam Tiger Reserve, Western Ghats
21.	Rajkumar K.P.	Dr.P.S.Easa	Herpetofaunal diversity in swamp (Vayal) ecosystems in Periyar Tiger Reserve, Western Ghats
22.	Rini Vijayan	Dr.A.V.Raghu	Micropropagation of selected species of *Embelia* Burm.f., characterization and in vitro production of secondary metabolites
23.	Riju P	Dr.E.A.Jayson	Assessment of human-wildlife conflict and mitigation measures in Malappuram District,Kerala, India
24.	Bharath Nair	Dr.G.E.M Swamy	Biocontrol potential of rhizosphere and rhizoplane fungi of grasses against certain fungal diseases of forest nursery seedlings
25.	Sanil. M.S.	Dr.V.B.Sreekumar	Systematics and phylogeny of dipterocarps in the Western Ghats, India
26.	Sanal C. Viswanath	Dr.T.K.Hrideek	Studies on plus tree selection, variability and seed biology of *Terminalia paniculata* Roth. (Combretaceae) in Kerala part of peninsular India
27.	Muraleekrishnan K.	Dr.T.K.Hrideek	Studies on variability, phenology and management methods of the alien invasive tree, *Senna Spectabilis* (D.C.) Irwin & Barneby in Kerala, India

28.	Subin K	Dr.P.A.Jose	Conservation biology of *Atuna indica* (bedd.) Kosterm. and *Hydnocarpus longipedunculatus* Robi et al., two endemic tree species of the Western Ghats of Kerala
29.	Suby	Dr.T.K.Hrideek	Studies on the impact of allelochemicals of *Senna spectabilis* (DC.) Irwin and Barneby invasion in Wayanad, Kerala
30.	Abdulla Naseef	Dr.K.A.Sreejith	Ecophysiology of mangroves in Kerala: An enquiry through plant functional traits
31.	Nimisha E.S.	Dr.V.B.Sreekumar	Plant - frugivore interaction and seed dispersal syndromes in Shola forests of the Western Ghats, India
32.	Sreeja C.S.	Dr.A.V.Raghu	Effect of elicitation and precursor feeding on the production of Oroxylin A. Chrysin and Baicalein in in vitro cultures of *Oroxylum indicum* (L.) Kurz.

Masters Attachment Programmes

Sl No.	Guide	Name of Student	Topic	College/University
1.	Dr. Mallikarjuna Swamy	Sruthi Narayanan	Synthesis of nanoparticles of biocontrol agents and their antagonistic efficacy	Nehru Arts & Science College, Bharathiar University
2.		Jeena Rose Pious	Diseases of trees of arboretum and their in vitro management	Zamorian's Guruvayoorappan College, Calicut
3.		Karthika T.	Diseases of palms and their in-virtro management	
4.		Amrita Dinesh	Mycosynthesis of silver nano particles using *Gliocladium roseum* and *Penicillium multicolor* and its antimicrobial efficacy against selected pathogens	M.E.S. College
5.	Dr.P.A Jose	Merin Santhosh	Development of clonal propagation protocols for three redlisted trees of the Western Ghats, Kerala	Christ College (Autonomous), Irinjalakuda, Thrissur
6.		Anu N.A	Ecological studies of *Vatica chinensis* L. a threatened tree of Kerala	Christ Colloge (Autonomous), Irinjalakuda, Thrissur
7.		Sreejisha P.K.	Seed biological studies of threatened tree of the Western Ghats, Kerala	Zamorian's Guruvayoorappan College, Calicut
8.		Krishnasree P.S.	Floral biological studies of *Salacia oblonga* and *S. gambleana* : Two high valued medicinal plants of Western Ghats, Kerala	

9.	Dr.V.Anitha	Vinay Goyal IAS	Impact of the Forest Rights Act, 2006 on the sustainable livelihoods of the malayan tribal community in Thrissur district, Kerala	Public Administration, Jawaharlal Nehru University, New Delhi
10.	Dr.K.A.Sreejith	T.Aswin	Variation in different leaf traits among selected invasive species in a moist deciduous forest patch in the foothills of Western Ghats	The Zanorin's Guruvayurappan College, University of Calicut
11.		Nijesh S	Diversity of ant fauna in KFRI Subcentre campus Velupadam	Bharathiyar University, Coimbatore
12.		Archana A.S.	Diversity of ant fauna in KFRI Sub Centre Campus, Nilambur	
13.		Jifi K.C.	Variation in root anatomical traits of selected hydrophytes and mangroves	Little Flower College, Guruvayur
14.		Sinosha Wilson	Variation in leaf anatomical traits of selected invasive species	
15.		Sisira K.V.	Variation in temperature tolerance of selected invasive species	
16.	Dr.T.V.Sajeev	Akshaya Unni V.	Land use changes at Kuzhur Panchayat, Thrissur	Christ Colloge, Irinjalakuda, Thrissur
17.		Kripa Mariya Thomas	Flood inpacts at Chalakudi area, Thrissur	
18.		Binu Johns	Flood mapping of Kuzhur Panchayath, Thrissur	
19.		Veena A.V.	Climate Change susceptibility assessment for Irinjalakuda Municipality	

20.		Lekshmi P.Kumar	Studies on the endophyte associations in high risk alien invasive plants of Kerala	Cochin University of Science &Technology
21.		Mariya A. Joseph	Taxonomic work of predatory mite on *Flemingia macrophylla*	Vimala College, Thrissur
22.		Anu Nixon	Sloss hypothesis: a case study from natural and in situ conservation area	
23.		Anjitha V.P	Comparative analysis of mimicry in butterflies	
24.		Akshara B.D.	Analysis of flood impact in Thalikulam Grama Panchayath	Calicut University
25.	Dr.V.B.Sreekumar	Akshara H.	Effect of flood on riparian vegetation in Chalakkudy River in Kerala	PSGR Krishnammal College for Women, Coimbatore
26.		Anagha D.	Developing restoration protocols for flood affected areas of Pamba River, Kerala	Zamorian's Guruvayoorappan College, Calicut
27.		Athira V.	Developing restoration protocols for flood affected ares of Bharathapuzha River, Kerala	
28.		Tinu Jose	Mapping of vegetation communities in Parambikulam region	Kerala University of Fisheries & Ocean Studies (KUFOS)
29.		Rahul Satheesh	Mapping of flood inundated areas	
30.		Sajin Mohan	Mapping of KFRI campuses	

31.	Dr.Shjio Joseph	Ancy C. Stoy	Mapping of vegetation communities at Eravikulam region	
32.		Dona Paul	Mapping and inventory of agroforestry systems in high lands in Kerala	Cochin University of Science &Technology
33.		A.H.Sanjana	Mapping of flood using Remote Sensing data	Bharathidasan University
34.		Harsha Prasad	Biodiversity characterisation	Kannur University
35.		Amruthraj K.V.	Agroforestry Systems	
36.		Rahul Padmanabhan	Forest Survey	
37.	Dr.S.Sandeep	Gopika P.	Evaluating soil erosion in Kulathupuzha land scape	Sreesankara College, Kalady
38.		Sreelekshmi Unnikrishnan	Evaluating soil erosion in Parambikulam land scape	
39.		Surabhi C.	Mapping mangroves in Kerala Coast	
40.		Aleena P.P	Layer charge alterations under rhizozphere	Mother Arts & Science College, Peruvallur, Calicut University
41.	Dr.R.Jayaraj	Shahana Femi T.	Insecticidal properties of certain botanicals	The Zamorian's Guruvayoorappan College, Calicut
42.		Nidheena P.	Screening certain plants for bioaccumulation properties	
43.		Reshma R	Phytochemical studies of *Mangifera indica*	Little Flower College, Guruvayur
44.		Greeshma T.	Phytochemical studies of medicinal plants	
45.		Haritha M.	Environmental quality assessment	
46.		Keerthy Jose P	Analysis of the flavonoid Quercetin in *Allium cepa* and *Allium cepa* var. *aggregatum*	Department of Chemistry The St. Aloysius College Thrissur, Kerala

47.	Dr.Shambhu Kumar	Vandana M.S.	Characterization and pathogenicity of causal organisms associated with leaf blight disease of *Cinnamomum zeylanicum* Blume and assessment of fungicidal efficacy of two aromatic plant leaf extracts against isolated pathogens	SNGIST Arts & Science College, M.G University
48.				
49.				
50.				
51.	Dr.T.K.Hrideek	Anjusha A.	Invasive biology	Kannur University Thalassery campus
52.		Athira K.P.	Invasive microbial association	
53.		Prajna K. Pappan	Invasive biology	
54.		Srijena S.	Clonal propagation of teak plus trees	MES Kalladi College, Mannarkkad

Internships/Hands-on-Training Programmes

No	Guide	Name of Student	Topic	College/ University
1.	Dr.T.V.Sajeev	Neethu.N.	Forest Entomology	S.N. College, Alathur
2.		Roniya Varghese		
3.		Sowparnika P.		
4.		Keerthy P.		
5.		Aswathy Krishnan		
6.		Midhula M.R.		
7.	Dr.V.Anitha	Adhik C.A	Study on marketing of NTFPs and its influence in the llife of tribal people	University of Madras
8.		Revathy M	Use of alternate energy and sustainable tourism: A case of backwater tourism in Kerala	Dr. John Matthai Centre, University of Calicut
9.		Farseeda K	The effects of Ockhi on fishermen	
10.		Annie Pinto	Small scale business sector after GST implication	
11.	Dr.T.K.Hrideek	S.Sreeparvathi	A study on distribution of Invasive alien plant species in KFRI campus and impact of *Sphagneticola trilobata* on the germination of *Eleusine coracana*	C.M.S. College, Kottayam
12.		Greeshma K.Shine	A study on status Invasive alien plant species in KFRI campus and impact of *Mikania micrantha* on the germination of *Eleusine coracana*	
13.		Shancy Abraham	An identification Keys of Palms and Rattans Species based on seed Architecture	C.M.S. College, Kottayam
14.		Rameesa Banu	Taxonomy and morphological studies on *Wallichia* with special reference to *Wallichia Nana* (Arecaceae)	

15.	Dr.V.B.Sreekumar	Riya Paul	Estimation of curcumin from *Curcuma longa* collected from two different locations)	
16.		Niranjan V.	General awarness on Forest Botany	Christ University, Bengaluru
17.		Amy Jose Kollannoor		
18.		Jesny Jose		
19.		Riya Shaji		
20.		Joshna Reji		
21.	Dr.Suma Arun Dev	Afsana Ghan	Hands on Training in Molecular Biology	St. Thomas College, Thrissur
22.		Nimmi. C. Dominigose		
23.		Hridya Sundaresan		IISR, Tirupathi
24.		Silva Shihab		Sahrudaya Engineering College, Kodakara
25.		Gopika Menon		
26.		Bristo Lawrence		
27.		Anju P.M.		
28.		Mijil Martin		Forestry College, Vellanikkara
29.		Azhar Ali A.		

ENDOWMENT AWARDS

---------- Dr. C. Chandrasekharan Memorial Endowment ----------

The 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 certificate. Mr. R. Roshnath is the recipient of the 9th Dr. C. Chandarasekharan Endowment Award for innovative Research in Conservation of Forests. Shri. Surendrakumar IFS, Principal Chief Conservator of Forests (Wildlife) and Chief Wildlife Warden, Kerala Forests and Wildlife Department, Thiruvananthapuram handed over the award to him and also delivered the Dr. C. Chandarasekharan memorial lecture on 29th March 2019 at KFRI

---------- Dr. K. M. Bhat Memorial Endowment ----------

The family of late Dr. K.M. Bhat has instituted an award for the best emerging Scientist of KFRI, below 35 years of age among the Research scholars of KFRI. The Endowment of Rs. 50,000/- donated by the family of Dr. K.M. Bhat is managed as fixed deposit. The Award consists of a Certificate, Gold medal and Cash prize of Rs.5,000. The 9th Dr. K.M. Bhat Memorial award was awarded to Dr. C. Kavitha of Soil Science Department, KFRI, Peechi. The award was presented to her by Dr. Mohan Varghese, Senior Principal Scientist, ITC Ltd and Mrs. Kusuma Bhat (W/o Late Dr. K.M. Bhat) on 26th November 2018 in a function organized at KFRI.

Kerala Forest Research Institute Peechi
(A unit of Kerala State Council for Science, Technology & Environment. Govt. of Kerala)
INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st MARCH 2019

EXPENDITURE	Sch	31.03.2019 (Rs)	31.03.2018 (Rs)	INCOME	Sch	31.03.2019 (Rs)	31.03.2018 (Rs)
Infrastructure Strengthening (Non Plan)	IX	1,68,23,375.76	1,71,70,768.50	Grant from Government of Kerala	VI	11,71,98,867.96	14,88,31,764.24
Salaries and Allowances (Non Plan)	X	7,97,38,873.00	11,05,91,867.00	Other Receipts	VII	1,35,58,937.96	1,46,13,733.26
Depreciation	IV	2,40,32,447.21	2,30,64,891.93	Depreciation transferred to Capital Reserve		2,40,32,447.21	2,30,64,891.93
Other Project Expenses		5,16,21,173.31	6,60,46,706.50	Income from other projects		5,16,21,173.31	6,60,46,706.50
Project Expenses under plan scheme		3,41,95,557.16	3,56,82,862.00				
TOTAL		**20,64,11,426.44**	**25,25,57,095.93**	**TOTAL**		**20,64,11,426.44**	**25,25,57,095.93**

Kerala Forest Research Institute Peechi
(A unit of Kerala State Council for Science, Technology & Environment. Govt. of Kerala)
BALANCE SHEET AS ON 31st MARCH 2019

LIABILITIES	Sch NO.	As at 31.03.2019 (Rs)	As at 31.03.2018 (Rs)	ASSETS	Sch	As at 31.03.2019 (Rs)	As at 31.03.2018 (Rs)
Reserves and Surplus	I	23,17,83,359.42	21,13,86,505.37	Fixed Assets	IV	18,19,93,352.57	17,72,46,319.52
Current Liabilities & Provisions	II					2,08,71,779.00	52,21,958.00
Creditors for Expenses		64,84,844.00	62,29,020.00	Capital Work in Progress			
Creditors For Fixed Assets		6,10,453.00	16,67,414.00		V		
Other Liabilities		35,60,540.00	18,28,711.00	**Current Assets, Loans and Advances**		24,47,91,938.66	23,70,69,599.88
Provisions		11,73,58,038.00	14,62,89,577.00	Cash With Banks		56,797.00	44,843.00
				Cash in Hand		61,60,155.15	23,60,428.00
Unspent Balance of Grant-in-Aid(Net)	III	10,10,58,076.15	5,84,80,176.26	Loans and Advances		69,81,288.19	39,38,255.23
Significant Accounting Policies and Additional Information	XI			Other Current Assets			
TOTAL		**46,08,55,310.57**	**42,58,81,403.63**	**TOTAL**		**46,08,55,310.57**	**42,58,81,403.63**

INSTITUTIONAL COMMITTEES

RESEARCH COUNCIL

Chairman

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

Members

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.

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

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

Dr. C. T. S. Nair,
Former Director, KFRI &
Former Executive Vice President,
KSCSTE·

Dr. R. V. Varma,
Former Chairman,
Kerala State Biodiversity Board,
Lakshmipuram, Royal Avenue,
Thrissur-680 020.

Member & Ex-Officio Convener

Director,
Kerala Forest Research Institute.

Management Committee

Director, KSCSTE - Kerala Forest Research Institute	:	Chairman
Shri. K.B. Santhosh Kumar, Addln. Secretary & Joint Chief Protocol Officer, General Administration Department, Thiruvananthapuram	:	Member
Member Secretary, Kerala State Council for Science,Technology and Environment	:	Member
The Executive Director, KSCSTE - Centre for Water Resources Development and Management, Kunnamangalam (P.O), Kozhikode	:	Member
Dr. U.M. Chandrashekhara, Scientist F, KSCSTE - Kerala Forest Research Institute	:	Member
Registrar, KSCSTE - Kerala Forest Research Institute	:	Convener

1.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
	The Additional PCCF (Administration)		
7.	The Additional PCCF(Southern Region)	…	Member
8.	The Additional PCCF (Protection)	…	Member
9.	The Additional PCCF (Vigilance)	…	Member
10.	The Additional PCCF (Northern Region)	…	Member
11.	The Additional PCCF (BDC)	…	Member
12.	The Additional PCCF (IHRD)	…	Member
13.	The Additional PCCF (SA&NO)	…	Member
14.	The Principal Chief Conservator of Forests Wildlife & Chief Wildlife Warden	…	Member
15.	The Principal Chief Conservator of Forests (Social Forestry)	…	Member
16.	The Principal Chief Conservator of Forests (Vigilance)	…	Member
17.	The Principal Chief Conservator of Forests (Dev. & PFM)	…	Member
18.	The Chief Conservator of Forests (Protection)	…	Member
19.	The Chief Conservator of Forests (FMlS)	…	Member
20.	The Chief Conservator of Forests (HRD)	…	Member
21.	The Chief Conservator of Forests (Administration)	…	Member
22.	The Chief Conservator of Forests (Vigilance)	…	Member
23.	The Chief Conservator of Forests (Social Forestry)	…	Member
24.	The Regional Chief Conservator of Forests (North)	…	Member
25.	The Regional Chief Conservator of Forests (South)	…	Member
26.	The Conservator of Forests (Biodiversity)	…	Member
27.	The Deputy Conservator of Forests (Research) North	…	Member

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

2. Internal Research Group (IRG)

Director	:	Chairman
Dr. U.M. Chandrasekhara	:	Convener
Dr. S. Sandeep	:	Assoc. Convener
All Scientific staffs		Members

3. Ph.D & M.Sc. Student Attachment Programme Advisory Committee

Dr. M.P. Sujatha	:	Chairman
Dr. K.A. Sreejith	:	Member
Respective Research Guides	:	Invitees
Dr. T.V. Sajeev	:	Convenor

4. Equipment/Infrastructure Development Committee

Dr. R. Jayaraj	:	Chairman
Dr. T.K. Hrideek	:	Member
Dr. V. B. Sreekumar	:	Member
Mr. P.I. Sherief	:	Member
Purchase-in Charge	:	Convener

5. Purchase Committee

Dr. T.K. Dhamodaran, Registrar	:	Chairman
Deputy Registrar, Finance	:	Member
Dr. S. Sandeep	:	Member
Dr. E.M. Muralidharan	:	Convener

6. Library and Information networking Advisory Committee

Librarian	:	Chairman
Dr. M. Amruth	:	Member
Dr. Mallikarjuna Swamy	:	Member
Dr. Shijo Joseph	:	Member
Dr. Suma Arun Dev	:	Convener

7. Website & Software/ hardware Committee/ LAN

Dr. T.K. Hrideek	:	Chairman
Dr. M. Amruth	:	Member
Dr. K.F. George	:	Member
Dr. Shijo Joseph	:	Member
Smt. Ricy Eliner Varkey, Technical Officer	:	Convener

8. Kerala Forest Seed Centre Advisory Committee (to be constituted as per the Proceedings G53/KFRI/79/ dtd 31.10.2011

9. **Teak Museum & Nature Trial Advisory Committee**

Dr. U. M. Chandrasekhara	:	Chairman
Dr. K.A. Sreejith	:	Member
Dr. P. Sujanapal	:	Member
Dr. Sani Lookose- Curator	:	Convener

10. Campus/Garden Development Committee

Dr. P. A. Jose	:	Chairman
Dr. E. M. Muralidharan	:	Member
Dr. M.P. Sujatha	:	Member
Dr. P.K.Chandrasekhara Pillai	:	Member
Smt. M. K. Raji, Engineering Division	:	Member
Dr. V. B. Sreekumar	:	Convener

11. Editorial Committee for Journal of Bamboo and Rattan

Dr. E. M. Muralidharan	:	Chief- Editor
Dr. P. K. Thulasidas	:	Editor
Dr. A.V. Raghu	:	Editor
Dr. T.K. Hrideek	:	Editor
Dr. V. B. Sreekumar	:	Editor

12. Annual Report Committee

Dr. V. Anitha	:	Chairman
Dy. Registrar (Adm)	:	Member
Dy. Registrar (Accounts)	:	Member
Dr. Suma Arun Dev	:	Member
Dr. R. Jayaraj	:	Member
Dr. Shambu Kumar	:	Member
Dr. K.A.Sreejith	:	Convenor

13. Newsletter Committee (EVERGREEN)

Dr. A.V. Raghu	:	Chief Editor
Dr. M. Amruth	:	Associate Editor
Dr. P. K. Thulasidas	:	Associate Editor

14. Stores /Auction and Disposal Committee

Dr. G.E. Mallikarjuna Swamy	:	Chairman

	Dr. R. Jayaraj	:	Member
	Smt. Anuja Prasannan (Assistant)	:	Member
	Smt. Anupa Vasu	:	Member
	Stores-in Charge (K.P. Manoj)	:	Convener

15. Sports Committee

	Mr. V.P. Raveendran	:	Chairman
	Dr. T.K. Hrideek	:	Member
	Dr. Shambu Kumar	:	Member
	Mr. Jinesh, V.C.	:	Member
	Smt. K. Keerthy	:	Member
	Mr. P.I. Sherief	:	Convenor

16. Committee for Transformation of Official Language to Malayalam

	Dr. T.V. Sajeev	:	Chairman
	Smt. Annapoorni	:	Member
	Smt. Shirly Isaac	:	Member
	Dr. S. Sandeep	:	Convenor

17. Exhibition Advisory Committee

	Dr. K. V. Muhammed Kunhi	:	Chairman
	Mr. V. P. Raveendran	:	Member
	Dr. M. Amruth	:	Member
	Dr. A.V. Raghu	:	Convener

18. Seminar Committee

	Dr. Suma Arun Dev	:	Chairman
	Dr. Shambu Kumar	:	Member
	Dr. T.K. Hritheek	:	Member
	Dr. P. Sujanapal	:	Convener

19. Committee to Prevent Sexual Harassment on Women

	Dr. V. Anitha	:	Chairperson
	Dr. M.P. Sujatha	:	Member
	Ms. Maymol Joseph	:	Member
	Ms. C.K. Sindhumol	:	Member
	Dr. Suma Arun Dev	:	Convenor

20. Hostel/Guest House/ Cafeteria Advisory Committee

Dr. A. V. Raghu	:	Chairman
Mr. V. P. Raveendran	:	Member
Dr. K.A. Sreejith	:	Member
Smt. Sabitha Balakrishnan	:	Member
Mr. P. I. Sherief- Guest House in charge	:	Convener

21. Building Committee

Dr. T. V. Sajeev	:	Chairman
Dr. P. K. Thulasidas	:	Member
Smt. M. K. Raji		Member
Mr. P. I. Shereef	:	Member
Dy. Registrar (Accounts)	:	Member
Registrar	:	Convener

22. Vehicle Advisory Committee

Dr. P. Sujanapal	:	Chairman
Dr. K.A. Sreejith	:	Member
Dy. Registrar (Admn)	:	Member
Smt. C.K. Sindhumol (Assistant)	:	Member
Vehicle-in Charge (Mr. Shiju)	:	Convener

23. Endowment Committee

Director	:	Chairman
Dr. E. M. Muralidharan	:	Member
Muhammed Kunhi	:	Member
Dr. P. A. Jose	:	Member
Dr. R. Jayaraj	:	Member
Dr. P. Sujanapal	:	Convener

STAFF LIST

Scientific staff

1.	Dr. Syam Viswanath	Director
2.	Dr. U. M. Chandrashekara	Senior Principal Scientist
3.	Dr. E.M. Muralidharan	Senior Principal Scientist
4.	Dr. M. P. Sujatha	Senior Principal Scientist
5.	Dr. T. V. Sajeev	Principal Scientist
6.	Dr. V. Anitha	Principal Scientist
7.	Dr. K. V. Mohammed Kunhi	Principal Scientist
8.	Dr. P. A. Jose	Principal Scientist
9.	Dr. Suma Arun Dev	Senior Scientist
10.	Dr. Shambu Kumar	Senior Scientist
11.	Shri. V. P. Raveendran	Senior Scientist
12.	Dr. K. F. George	Senior Scientist
13.	Smt. Sani Lookose	Senior Scientist -Teak Museum Curator
14.	Dr. A. V. Raghu	Scientist
15.	Dr. T. K. Hrideek	Scientist
16.	Dr. P. Sujanapal	Scientist
17.	Dr. G. E. Mallikarjuna Swamy	Scientist
18.	Dr. V. B. Sreekumar	Scientist
19.	Dr. S. Sandeep	Scientist
20.	Dr. R. Jayaraj	Scientist
21.	Dr. K. A. Sreejith	Scientist
22.	Dr. P. Balakrishnan	Scientist
23.	Dr. M. Amruth	Scientist B

Administrative staff

1	Group Captain Biju B. IAF	Registrar
2	Sri. K. Satheesakumar	Dy. Registrar (Accts)
3	Sri. K. Venugopal	Dy. Registrar (Admin.)
4	Smt. Sabitha Balakrishnan	Assistant Registrar
5	Smt. Shirly Issac	Section Officer Gr. II
6	Sri. K. Kamalakaran	Section Officer

7	Sri. V.S. Krishnanunni	Section Officer
8	Smt. C.K. 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. P.S. Sudheesh	Assistant
14	Smt. P.S. Manju	Assistant
15	Smt. Aneesamole A	Assistant
16	Sri. K.M. Shiju	Assistant
17	Smt. Grace Andrews	PA to Director Gr.II
18	Sri. K .P. Manoj	Office superintendent
19	Sri. P. Rajeesh	Clerical Assistant Gr.II (Nilambur)
20	Sri. T. M. Abdul Vahab	Word Processing Assistant
21	Smt. P.K. Sughada Devi	Typist
22	Sri. P. K. Rajendran	Driver Gr. II
23	Sri. E. O. Mathai	Driver Gr. II
24	Sri. C. H. Herald Wilson	Driver Gr.II
25	Smt. A. M. Lalitha	Office Attendant Gr. V
26	Smt. T. G. Chandrika	Office Attendant Gr. IV
27	Sri. V. K. Mohandas	Office Attendant Gr. IV
28	Sri. E. P. Ulahannan	Office Attendant Gr. IV
29	Smt. K. Aparna	Office Attendant Gr.III
30	Sri. K. Abdul Jaleel	Office Attendant Gr.II
31	Smt. S. Ashamole	Office Attendant Gr.II
32	Smt. C. Sujatha	Office Attendant Gr.II
33	Sri. E. Hamsa	Office Attendant Gr.II
34	Sri. T. P. Valsan	Office Attendant Gr.II
35	Smt. P. Deepa	Office Attendant Gr.II (Nilambur)
36	Sri. C. P. Shoukathali	Helper Gr. IV (Nilambur)
37	Sri. K. Mohammed	Helper Gr. IV (Nilambur)
38	Sri. K.K. Mohammed	Helper Gr. IV (Nilambur)
39	Sri. A.V. Chamy	Helper Gr.II
40	Sri. T.S. Prakash	Helper Gr.II
41	Sri. M.S. SanthoshKumar	Helper Gr.II

42	Sri. T .P. John	Helper Gr.II
43	Sri. T. O. Simon	Helper Gr.II
44	Sri .M. K. Suresh	Helper Gr.II
45	Sri. I. O. Thomas	Helper Gr.II
46	Sri. N. Rajan	Helper Gr.II (Nilambur)
47	Sri. C .P. Ummer	Helper Gr.II (Nilambur)
48	Smt. P. S. Kadeeja	Helper Gr.II (Palappilly)
49	Smt. V. L. Alphonsa	Helper Gr.II (Palappilly)
50	Sri. K. A .Thankachan	Helper Gr.II (Kottappara)
51	Sri. C. B. Sajy	Helper
52	Sri. P. V. Santhosh Kumar	Helper
53	Sri. K. Rajan	Nursery Man Gr.II
54	Smt. S. Padmavathy	Nursery Man Gr.II
55	Sri. N. K. Rajan	Nursery Man Gr.II (Palappilly)

Technical Staff

56	Sri. P. I .Shereef	Technical Officer (Electrical) Gr.II
57	Smt. M.K. Raji	Technical Officer (Civil) Gr.II
58	Smt. Ricy Eliner Varkey	Technical Officer (IT)Gr.II
59	Sri. V.C. Jinesh	Technical Officer (Mechanical) (Palappilly)
60	Sri. M. R. Anilkumar	Technical Assistant Gr. IV
61	Sri. O.P Ranjith	Technical Assistant(Binder) Gr.II
62	Mohammed Habeebulla	Typist/Data Entry Operator

Annual Report 2018-19