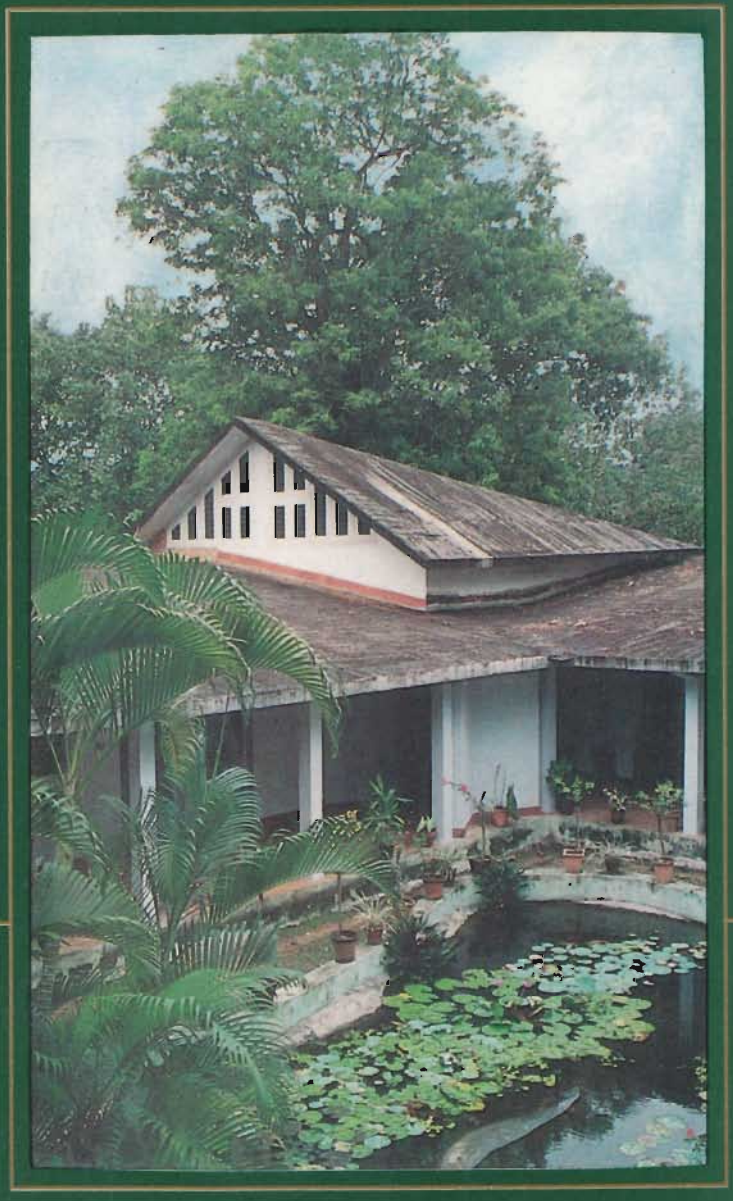
Kerala Forest Research Institute

Peechi



Kerala Forest Research Institute

The Science and Technology policy adopted by the Government of Kerala during the fifth five year plan envisaged the establishment of autonomous Institutions to undertake research in areas which are important for the economic development of the State. Since forests play an important role in the economy of the state and fulfill a number of economic, social and environmental objectives, the Government felt that application of latest technology relevant to the state could considerably enhance the contribution of forestry to the needs of Kerala. Also, in the wake of a challenge posed by rapidly depleting forest resources of the State, scientific management of forests to increase their productivity seems inevitable. This necessitated the establishment of the Kerala Forest Research Institute (KFRI) under the Science and Technology umbrella of the State. The institute was registered as a Society on 3rd July 1975 under the Travancore-Cochin Literary, Scientific and Charitable Societies Act, 1955.

Endowed with magnificent forests ranging from evergreen to dry deciduous, which cover nearly a quarter of its geographical area, Kerala's economy is strongly interlinked with its forests. In addition to providing direct or indirect employment to one out of every ten persons in the State and providing timber, fuelwood and other utilisable goods, forests fulfill several not-so obvious functions - environmental and aesthetic, which ensure the quality of our environment and the sustenance of our life supporting systems. However, over the years the natural forest cover of the State has been shrinking at an alarming rate due to outright clearance for raising commercial plantations and human interference. This has resulted in loss of genetic diversity, both plant and animal and degradation of the dynamic and delicately balanced structure of the forest ecosystem endangering its long-term sustenance and renewability. KFRI's mandate is to find out solution of some of these problems, especially how to make best use of cleared land and make them productive, and also how to manage the remaining natural stands in a sustainable manner.

Objectives

The main objective of the Institute is to undertake research in all aspects of forestry, wildlife management, and wood science and technology. Specifically, KFRI's aims are to :

* *Provide technical support to facilitate scientific management and utilization of forests for social benefits,*
* *Provide information and advice to wood-using industries and general public on forest related subjects,*
* *Contribute to our understanding of the natural processes and patterns in the functioning of the forest ecosystem and their interrelationships with the quality of the environment.*

These objectives are fulfilled by carefully selecting various thrust areas of research such as i. improving the productivity of plantations through standardising appropriate management inputs like soil treatments, pest and disease control, genetic improvement, etc., ii. evolving methods for sustainable management of natural forests, iii. enhancement of wood use efficiency through reduction of wastage, improved preservative treatments, and utilization of less-known non-conventional tree species to substitute popular forest timbers, iv. building a database and developing management methods for wildlife, and v. socio-economic analysis of forestry activities including study of the demand and supply of various forest products, needs of forest-based industries, and so on.

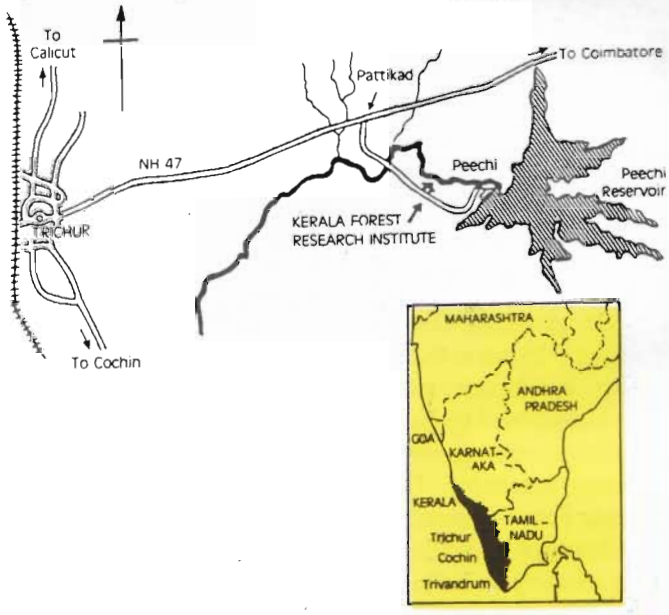
Location

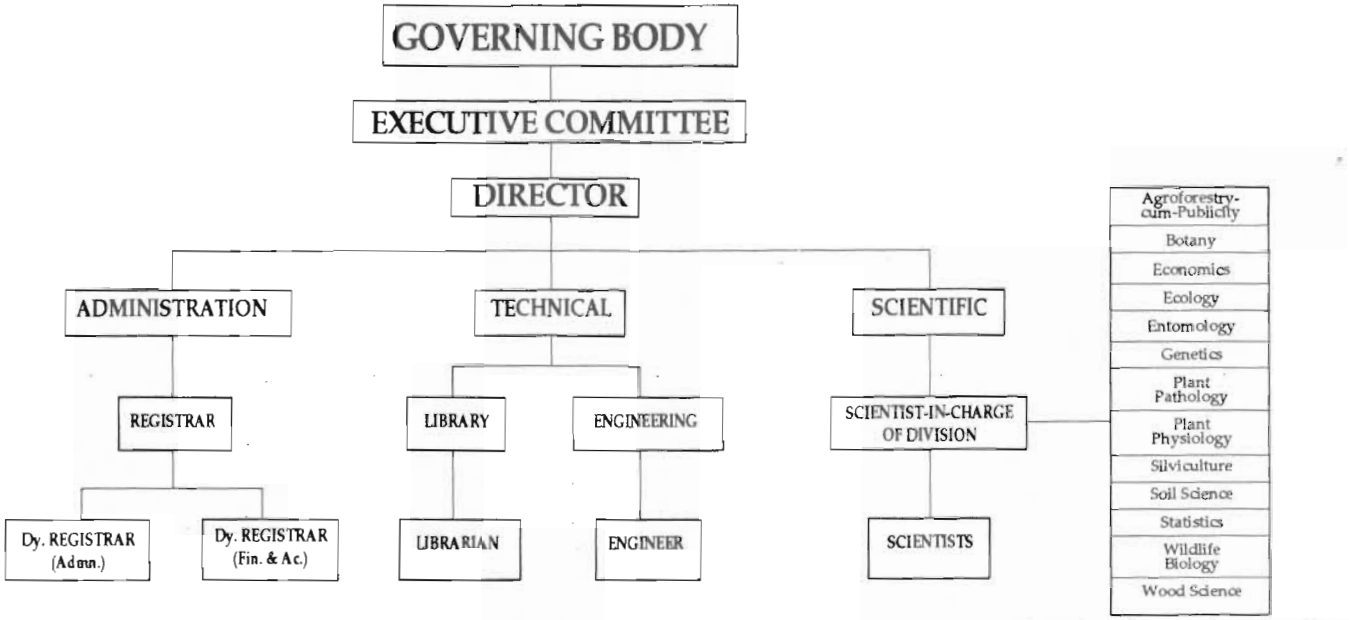
KFRI is strategically located in the midst of forest in Central Kerala at Peechi, about 20 km east of Trichur town. The main campus extends over an area of 28 ha which forms part of the picturesque reserve forest in the Peechi Forest Range. The Institute has two Subcentres, one at Nilambur in North Kerala stretching over an area of 43 ha and the other at Velupadam, Palappilly in Central Kerala having about 38 ha of land.

Organisation

The control, administration and management of the Institute are vested with the Governing Body, appointed by the Government of Kerala. The Minister for Forests is the Chairman of the Governing Body and the Chairman, State Committee on Science, Technology and Environment (STEC) is the Vice-Chairman. Other members of the Governing Body are Secretary, Planning and Economic Affairs; Secretary, Finance; Secretary, Forests and Wildlife; Principal Chief Conservator of Forests; Vice-Chancellor, Kerala Agricultural University; IG of Forests (Government of India) and representatives of forest industries and forestry scientists.

An Executive Committee consisting of six members of the Governing body chaired by the Chairman , STEC oversees the formulation of policies and their implementation. The Director, appointed by the Government, is the Head of the Institute and is responsible for day-to-day administration and implementation





of programmes. He is the member-secretary of both the Governing Body and the Executive Committee. The Committee meets as often as necessary and at least once in three months. A review committee appointed by the Governing Body evaluates the activities of the Institute once in every five years.

The Institute is organized into small structural units called Divisions. The Administration division is headed by the Registrar; there are 13 research divisions representing the following disciplines:

Agroforestry, Botany, Ecology, Economics, Entomology, Genetics, Plant Pathology, Plant Physiology, Silviculture, Soil Science, Statistics, Wildlife Biology, and Wood Science.

At present, there are 45 Scientists engaged in active research programmes, with 27 of them possessing doctoral degrees. Most of the Scientists are with extensive research background in India and abroad and also possess expertise in handling multi-disciplinary projects. In addition to the scientific personnel, there are 19 technical and 85 administrative and supporting staff.

INFRASTRUCTURE AND FACILITIES

The Institute's main campus at Peechi consists of a group of buildings built on either side of a 175 m long corridor, designed to blend with the natural sylvan landscape. The plans were drawn up by Mr. Laury W. Baker, a well known architect. Several low-cost construction techniques were used, including absence of external plastering and painting. The total floor area is about 4640 m^2. Residential accomodation has been provided to the majority of the employees. The main campus at Peechi has 72 houses. The Institute also has a guest house at Peechi.

Over the 18 years since the establishment of the Institute, necessary infrastructural facilities have been built up which

include laboratories, library and other facilities attached to various Divisions. The laboratories of different Divisions are well equipped with all modern facilities to undertake research of both disciplinary and multi-disciplinary nature. Some of the equipments available in the Institute include :

Ultra-centrifuge, High speed centrifuge, Cryomicrotome, Leaf area meter, Flame photometer, Automatic weather station units, Porometer, Plant canopy analyser for leaf area index, Oxygen electrode system, Pressure chamber for plant water potential measurement, Stereo and binocular microscopes with automatic photomicrographic attachments, Millipore filter system, Portable infra-red gas analyser, Portable photosynthesis system, Osmometer, Electrophoresis system, Lyophilizer, Controlled growth and seed germination chambers, Spectrophotometers, Homogenisers, Horizontal shaker, Electronic balances and so on.

The Subcentre at Nilambur, located about 140 km from Peechi, is provided with all facilities for laboratory work, and raising experimental plantations and nurseries. It has a guest house and six residential houses to accomodate staff. A

A 175 metre long corridor is a link between the laboratories, the library and administration

A side view of office-cum-laboratory building of the Subcentre at Nilambur

A view of the Field Research Centre at Palappilly

bambusetum containing 21 bamboo species collected from all over India, is maintained at the Subcentre. A separate Teak Museum cum Research Centre for displaying artefacts, utility items made of teak wood and to conduct research on various aspects of teak also has been established at Nilambur. The construction of the building is over and very soon it will be made functional.

The Subcentre at Palappilly, established in 1992, is known as Velupadam Forest Research Centre; it is about 40 km from Peechi. The Centre has facilities for conducting laboratory experiments, and nursery and field trials.

Library

KFRI has one of the best scientific libraries in Kerala with about 12,500 books, 6,000 back volumes of journals and 7,000 reprints of scientific papers covering all disciplines related to forestry. Current subscriptions to journals, which used to be over 250 during 1980's has come down to about 150 titles due to paucity of funds. A computer database on Indian Forestry literature is being steadily bulit up to provide literature search service. A modern microfilm reader cum printer is an added facility for utilizing microforms, a number of documents are available in microforms. An art and photography section attached to the library renders assistance to scientists and research students. Regular services of the library include Current Awareness Service, Reference Service, Document Delivery Service, etc.

Current journals section of the library

Desk top publishing facility in the library

The Library has a Bamboo Information Centre (BIC-India), established with the support of the International Development Research Centre (IDRC), Canada. The main objective of BIC is to assemble and disseminate bamboo information from the South-Asia region. The Centre has modern desk-top publishing and photocopying facilities. BIC publishes half yearly BIC-India Bulletin and occasional Information Bulletin on popular aspects of bamboos. The Centre maintains a database of bamboo literature which can be searched to retrieve the desired information. The Centre will be publishing soon a directory of scientists working on bamboos and a compendium on Indian bamboos.

Herbarium, Medicinal Plant Garden and Orchidarium

The Botany Division of the Institute has an internationally recognized herbarium with 7,000 specimens of over 2,000 spe-

A view of the medicinal plants garden

cies of forest plants. This serves as a basic reference material for plant taxonomists. A new herbarium building is being constructed to accomodate ever increasing reference collection. A total of 300 species of medicinal plants, collected mostly from Kerala forests, are maintained as a reference collection in the Medicinal Plants Garden of the Institute. There is an Orchidarium, which has live collection of about 70 various wild orchids collected from the Kerala forests.

Insect Collection

The Entomology Division has an excellent collection of insects including butterflies belonging to various groups. It is being made use of by students and researchers for authentic identification of forest insects.

Xylarium

A Xylarium in the Wood Science Division , which contains 567 reference samples of timbers collected from Kerala and elsewhere, caters to the need of wood anatomists / technologists, foresters, traders and others in facilitating the correct identification of wood.

Wood Treatment Plant

The Wood Science Division of the Institute has a pilot-scale wood preservative treatment plant. It has a treatment cylinder of 2 m long and 30 cm diameter and an electrically operated drying kiln of 1m^3 capacity. The facility is being used for studying treatability and treatment schedules of different timbers, and drying characteristics of various wood specimens.

Other facilities

The Institute has a permanent mist chamber facility includ-

Butterfly collection in the Entomology Division

Tissue culture facility in the Genetics Division

ing a hardening chamber and two field mist tents to facilitate clonal propagation of various tree species.

A tissue culture facility has been established in the Genetics Division to micropropagate the medicinal plants, canes, and other plant species which are not easily propagated either through seeds or vegetative cuttings.

Recently, a glass house has been constructed for conducting glass house experiments.

The Institute has a centralised computer facility, which includes 386 and 486 AT with Laser Printer to meet modern data processing requirements.

Drying Kiln in the Wood Treatment Plant

SCIENTIFIC RESEARCH

Research undertaken by the Institute has been directly related to the priorities of the forestry sector of Kerala. KFRI carries out research on all aspects of forestry including plantation forestry, management of natural forests, the forest environment, man-forest interactions, wildlife biology and management, wood science and utilization of timber, etc.

The Project approach

All research studies are carried out through carefully formulated and documented time-bound research projects. The

Mycorrhizal experiments are in progress in the glasshouse

research projects are of two kinds :

1. Projects financed by the Institute utilizing State Government Funds , and
2. Projects sponsored by Departments of Government of India and other organizations, both National and International; and public as well as industries.

The research programmes are identified taking into account of their environmental and social relevance by Scientists in the Institute, sponsors, or other interested agencies, and discussed in various fora within the Institute as well as in the Research Advisory Committee consisting of senior forest officers of the State and representives from other research organizations. On completion of the project a report is prepared, approved and published in the case of Institute reports. For sponsored projects, the report is sent to the sponsoring agency. This is in addition to scientific papers published in national and international journals.

RESEARCH ORGANIZATION

The 13 Research Divisions represent the main units of the Institute. Each Division has, on an average 4 to 5 Scientific and 2 to 3 supporting staff, headed by a Scientist-in-Charge, directly responsible to the Director. The method of recruitement of scientists is flexible, apart from selection by advertisement in national and international media, meritorious candidates are contacted directly on the advice from experts in the field and terms of appointment negotiated with them by the Executive Committee. The scale of pay and promotion of scientists follow the CSIR standards. While the Divisions are organised discipline-wise, inter-disciplinary research is encouraged in the implementation of projects by pooling scientists from appropriate divisions, as most practical problems transcend discipline boundaries. Wherever feasible problems are broken up into their disciplinary components and entrusted to appropriate Divisions/Scientists and a project coordinator is made responsible for the implementation of such multi-disciplinary projects. The various discussion groups and committees encourage close interaction amongst the scientists of different disciplines. The progress of projects is monitored through periodic reviews in the Internal Research Committee (IRC). So far, the Institute has undertaken 176 research projects of which 91 have been published in the form of research reports.

Initially, most of the research projects used to be financed through the Institute's funds received from the State Government and only a few projects were sponsored by other agencies including government and private organizations. However, over the years this trend has changed due to national and international acceptance of KFRI as a centre of eminance in tropical forestry research. Except a few, now most of the projects are sponsored by various agencies.

Brief details pertaining to various divisions giving their objectives and thrust areas of research are highlighted below.

Agroforestry-cum-Publicity

In the wake of intensive deforestation due to conversion of forest land to other land uses and in order to meet the increasing demand of fuelwood, fodder, timber, green manure, etc. growing trees in combination with agricultural crops and/or live-

stock on the same unit land either simultaneously or in sequence appears to be the only alternative to provide the basic needs of people as well as to safeguard the ecological balance. In Kerala, several agroforestry practices exist and among them the homestead farming is the most important. However, it is a well known fact that these systems are not as productive as expected. A seperate Division of Agroforestry cum Publicity was established in KFRI in 1991 with a mandate to study various ecological, social and economical features of these land use systems and to evolve appropriate strategies to make them more productive and sustainable. Apart from research works on agroforestry system, the Division also undertakes extensive extension activities.

Agroforestry in homesteads : coconut-cocoa-arecanut- banana model

Botany

The Division of Botany is mainly engaged in taxonomic studies on forest plants, viz. their correct identification, nomenclature, classification, distribution, uses and other factors of interest of individual species, genera or families or the floristic accounts of specific areas. With this broad objective, the Division undertakes studies to prepare floristic inventories, detailed studies on plant groups of special interest like rosewood, canes, bamboo etc. Survey of medicinal and other useful plants of the State are also taken up. The Division also conducts floristic studies in connection with environmental impact assessment programmes, assessment of biodiversity and studies on endemic, rare, threatened, and endangered forest plants of the State. Evaluation of plant resources of specific localities of interest is yet another mandate of the Division.

Ecology

For better management of our natural forests a thorough understanding of the ecology is essential and the very fact that studies on the vegetation aspects of the forest ecosystem are of prime importance makes Ecology a foremost discipline in forestry research. The research interests of Plant Ecology includes identification of the various components of the forest flora, determination of the composition of various associations found in forest formations, studies on the plant diversity, phenological patterns, etc. so as to bring out detailed information on the forest ecosystem as a whole.

Entomology

The Entomology Division evaluates the present and potential insect pest problems relevant to all aspects of forestry practice in Kerala, develops suitable methods to reduce the economic loss caused by pests, and disseminates this information to the Forest Department and other users. In addition, limited fundamental studies are carried out on the insect fauna and ecology of insects. The latter studies provide baseline

Damage caused to the trees during selection felling operations in wet evergreen forest

information, necessary for developing ecologically sound pest-management practices and increasing our knowledge of the biodiversity and the role of insects in forest ecosystems. The Division also renders insect identification services to other research organizations in selected groups of Lepidoptera. The Division has addressed itself to several emerging and long-standing pest problems as well as other research areas. Many investigations were carried out in collaboration with other Divisions. The thrust of research activities has been in the following areas: control of termites affecting eucalypt plantations, pests of teak - their ecology and control, microbial control of insect pests, pests of fast-growing hardwoods, pest incidence in natural forests, pests of stored timber, biodiversity studies.

Forest Economics

Research on the application of economic principles to for-

A solar light trap at Nilambur to monitor teak defoliator moth populations (left) ; Defoliator larvae feeding on a teak leaf (right)

estry problems as related to economic growth and human welfare is carried out in the Division of Forest Economics. As Forest Economics enables the foresters to take decision in the light of social costs and benefits of various resource management options, the importance of forest economics for analysing forestry problems has been widely recognised, especially in the context of increasing gap between demand and supply of forest resources. The main focus of the work of the Economics Division is to provide a better socio-economic insight into different aspects of forestry. Various aspects of forest economics on which the Division carries out research are farm forestry, socio-economics and techno-economic aspects of forest-based industries, human ecology and socio-economic interactions and economics of forest management.

Eligma narcissus feeding on the foliage of Ailanthus triphysa

Genetics

In recent times due to significance attached to afforestation and reforestation programmes, forestry has become synonymous with the plantation forestry. As the advantage of using genetically superior trees in increasing the productivity of plantations is well established, the main objective of the Division is genetic improvement of various forest plantation species for producing superior planting stock. The Division is engaged in the identification of natural variability in the base population of various tree species and exploitation of the available variability to evolve improved strains with desirable qualities like faster growth, good form, disease and pest resistance and better wood quality. Species and provenance selection, survey and selection of plus trees, progeny trials, clonal and seedling seed orchard establishment and floral biological studies are the main areas of research.

Plant Pathology

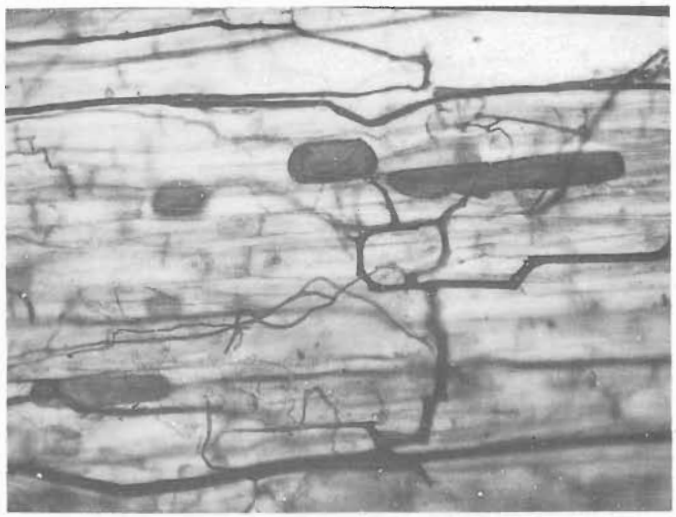
Diseases are one of the major constraints in achieving expected yield from forest plantations in the humid tropics. They affect wood production both quantitatively and qualitatively. Unlike in agricultural crops disease control in long rotation tree crops provide serious challenges. The Division of Pathology is geared up to tackle disease problems in nurseries, plantations and natural forests. Efforts are directed towards developing ecologically sound remedial measures through biological means and tree improvement to reduce the economic loss due to serious disease in plantations and nurseries. Some fundamental studies such as macrofungal flora of Kerala forests, cultivation of edible mushrooms, association of mycorrhiza and nitrogen fixing symbionts with plantation tree species and role of microorganisms in insect pest control and leaf litter decomposition are also carried out to generate base- line data which will help to understand the ecosystem as a whole in a better way. In addition, microbiological problems of wood such as decay, sapstain, etc. are also investigated to reduce the loss of this precious resource. The Division renders services to the Forest Department in man-

A plus tree of Ailanthus triphysa

aging disease problems in nurseries and plantations.

Plant Physiology

Study of various phenomena related to growth and development of trees come under the domain of the Division of Plant Physiology. The major objective of the Division is to conduct research on the functional aspects of forest trees. The division's main research interests are concentrated around ecophysiology and vegetative propagation. Various aspects of ecophysiological research on different plantation species like eucalypts, acacia, teak, cashew, oil palm, etc. include water relations, canopy gas exchange studies, microclimate and light utilisation, etc. In future, such studies will also be extended to different natural forest ecosystems. Another area of major research i.e., vegetative propagation has covered eucalypts, bamboos, rattans, teak, etc. Studies on prolonging seed viability and standardising nursery management practices for bamboos and reeds are also being conducted.



Hyphe and vesicles of VA mycorrhiza in the roots of Acacia auriculiformis

Tissue culture of bamboo, Bambusa bambos

Silviculture

Silviculture, occupying a pivotal position in forestry, is an applied science which rests ultimately upon the fundamentals of natural and social sciences. Various treatments of forest stands that may be applied to maintain an enhanced productivity form an integral part of silviculture. In an institute like KFRI with various disciplines, the Silviculture Division, which forms the link between theory and practice, has been conducting research on techniques of afforestation, management of plantations, developing nursery techniques for various species, establishment of live germplasm collections, developing multi-tier forest system with operation research and establishment of green belt plantation around industrial areas to control pollution.

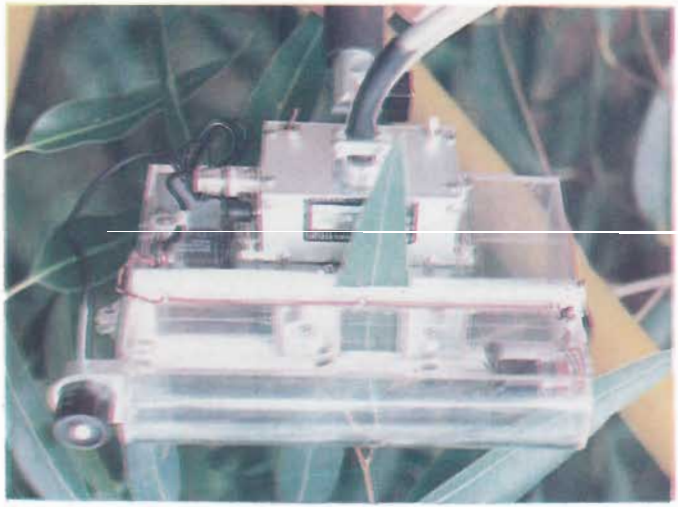
Witch's broom disease of Dendrocalamus strictus caused by mycoplasma like organisms

Soil Science

Studies on the nature and properties of soils in different forest ecosystems are essential for understanding soil-tree interactions. A thorough knowledge on the nature and properties of soils is, thus, important for proper management of the environment and utilization of resources. The mandate of Soil Science Division is to enhance the forest productivity by suitable soil management measures and preserve the existing natural forests. The thrust areas of research in the Division are plantation forestry, reforestation of degraded land, management of natural forests, and soil and moisture conservation activities in the degraded forest lands.

Statistics

Statistical aspects of various research investigations undertaken by the Institute, involve designing experiments, sample survey and also statistical analysis of data. The division assumes a consulting and collaborative role in respect of these functions with regard to the research projects in different disciplines. It has also undertaken independent research projects in the field of biometrics and econometrics. The Division has presently initiated investigations on research methodology by way of developing new statistical techniques suited to specific needs. Developing appropriate software for statistical analysis in forestry has also become part of the Division's activities in the recent times. The services of the Division are extended to the Forest Department by way of statistical consultancy to some of the investigations undertaken by the Department. Results from most of the studies conducted by the Division have direct implications on the management of plantations in the state and in framing the forest management policies at large.



Photosynthesis measurements on Eucalyptus tereticornis

Wildlife Biology

The forests of Kerala contain a rich fauna which include a wide variety of birds and mammals. The most endangered animals include Nilgiri tahr, tiger, lion-tailed macaque, Malabar civet, Malabar giant squirrel, Great Indian Hornbill, etc. The Division is engaged in documenting the distribution and monitoring of the wildlife in various sanctuaries and national parks in Kerala. Detailed studies on the ecology and behaviour of selected animal species are also being carried out in Sanctuaries and National Parks which will help to manage them in a better way.

Wood Science

Wood, though a renewable resource, is being depleted rapidly due to various reasons. Effective utilization of this resource calls for understanding the anatomical, physical and chemical characteristics of this uniquely complex material. The main objectives of the Division of Wood Science are to unlock the untapped potentials of the available resources of wood in Kerala and to increase the service life of wood by appropriate treatments. The main thrust areas of research in which the Division has undertaken a number of problem-oriented projects are techno-economic study of saw milling industry, and increasing the quality and service life of raw material like bamboos, canes and rubberwood, database on indigenous and exotic tree species, utilization of non-conventional timbers for furniture, etc.

Malabar giant squirrel (Ratufa indica maxima) in Parambikulam Wildlife Sanctuary

Rusty spotted cat (Felis rubiginosa), an endangered cat species, located for the first time in Kerala forests

SOME NOTABLE RESEARCH ACHIEVEMENTS

Since its inception, the Kerala Forest Research Institute has served as a knowledge bank for forestry related subjects and has provided information, advice and technology packages to government officials, Forest Department personnel, forest-based industries and the general public. Some of the major achievements of the Institute are given below:

Termite control: Simple and effective methods were developed and standardised for protecting young eucalypt plantations from termite attack, which often resulted earlier in loss of upto 80% of the field planted stock.

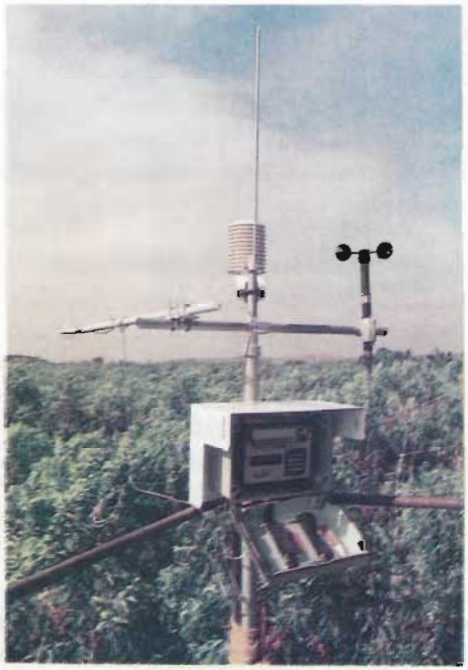
Polyurethane foam nursery: Developed a simple polyurethane foam method for germination and initial maintenance of seedlings of forest tree species. This cost effective method has found

wide application in seed testing and raising of seedlings for a variety of purposes.

Disease control: Methods were developed for protection against nursery diseases of several forest tree species, especially eucalypts which often resulted in total loss of nursery stock earlier, completely upsetting the planting programmes.

Taungya impact: A comprehensive study on the impact of taungya cultivation in forest plantations could bring out comparative advantages and disadvantages of various taungya crops practiced in forest plantations, especially in relation to soil erosion.

Vegetative propagation of bamboos, reeds and canes: Methods developed in the institute have facilitated quick and large scale propagation of bamboos, reeds and canes through hormone treatment. Large scale multiplication of plants is possible by this method. This method of propagation is highly useful to bamboos and reeds which are monocarpic.



An automatic weather station mounted on the scaffold tower in Acacia auriculiformis plantation to monitor the microclimate

Preservative treatment of rubberwood: A simple and safe diffusion treatment using borax-boric acid was developed for protecting rubber wood against insects and fungi. This preservative treatment has opened up enormous opportunities for use of rubberwood for furniture and other purposes.

Volume-weight relationship of timber: Volume-weight relationship of harvested and stacked eucalypt timber was determined to facilitate price fixation for timber by the Forest Department.

Investigative reporting: Services were rendered to the State Government and other agencies including the High Court of Kerala in investigative reporting on forestry and land use problems referred to the Institute.

Wildlife in Silent Valley: A study was carried out on the wealth of wildlife in Silent Valley which formed an important database leading to declaration of Silent Valley as a National Park and subsequently as part of the Nilgiri Biosphere Reserve.

Vegetation map: A detailed vegetation map of Parambikulam Wildlife Sanctuary was prepared using aerial photographs. This is being used by the State Forest Department in the management of the Sanctuary.

Productivity of Social Forestry plantation: Yield tables were prepared for *Acacia auriculiformis* plantations in the State to determine the productivity of these plantations. The yield tables will be useful in planning of future planting and harvesting.

Afforestation of Pattikkad Hills: A typical degraded hill top at Pattikkad was afforested with suitable species as a demonstration of what can be accomplished in bringing the degraded areas back under forest cover, a prime need of the present decade.

Dry zone afforestation: Studies conducted at Mulli in Attappady dry zone area (rainfall 600-700 mm per year) standardised planting methods to ensure better survival of seedlings through moisture conservation and prevention of run-off water. *Acacia planifrons* was found to be the most suitable species followed by *Cassia siamea* and *Albizia lebbeck.*

Wood balance study: A wood balance study with reference to Kerala showed that of the 14.6 million m^3 of wood used in Kerala annually, about 83% are used as fuel (domestic and industrial needs). The rest is used for construction purposes and as raw material for industries. The bulk of the wood came from homesteads and rubber plantations, a small part through imports and around 5% from Government forests.

Vector of sandal spike disease: It is almost a century since the sandal spike disease was first described. However, till now the true identity of the insect vector of this disease was unknown. Studies at KFRI proved conclusively that, a sap sucking insect, *Rederator bimaculatus* is the vector of sandal spike disease.

Biocontrol of *Hyblaea puera:* A nuclear polyhedrosis virus was identified as a potential biocontrol agent against *Hyblaea puera,* the teak defoliator. If successful this will help to increase the productivity of teak thereby increasing the economic return to the Forest Department considerably.

Germplasm collection of *Dalbergia* species, bamboos, reeds and canes: A germplasm of Dalbergias comprising of 13 species is established in Nilambur. Seven species of Ochlandra (reeds) and 20 species of canes (rattan) are maintained as a live collection in the Institute's campus. A germplasm collection of bamboos is maintained at Palappilly.

Plantations with indigenous species: A study on the plantation potential of a few indigenous timber species of Kerala showed that *Haldina cordifolia* (Manjakkadambu), *Pterocarpus marsupium* (venga) and *Grewia tilifolia* (Chadachy) are most suited for raising plantations both in pure and mixed stands. Experimental

Clonal propagation of Eucalyptus tereticornis

plantations of these species were raised successfully at Nilambur.

Water consumption by some tree species in Kerala: A recent study showed that water use by various indigenous and exotic trees varies greatly depending upon the season and tree species. In terms of volumetric equivalent the per tree consumption of water by *Eucalyptus tereticornis* varies between 18-44 liters/day irrespective of planting density. It is 13-40 l/tree day for *E. grandis;* 10-25 l/tree/day for *Acacia auriculiformis;* 48 l/tree/day teak and 360 l/tree/day for cashew.

Establishment of teak seed stands and seed orchards: The Institute rendered necessary expertise and technical know-how to the Kerala Forest Department in selecting 750 ha of teak seed stands and establishing 30 ha of teak seed orchards in Kerala.

Multilocational provenance trials of eucalypts: Provenance trials having over sixty provenances belonging to five species of *Eucalyptus* from Australia were established at four locations in Kerala.

Identification of canes: An anatomical method for the identification of South Indian rattans has been developed. Characterization of South Indian rattans has been done and a classification system was proposed for preparing Indian Standards.

Oil curing of canes: A cost-effective curing technique for improving the quality of cane furniture was evolved. Curing of canes gave a uniform ivory white colour without affecting its strength properties and durability. A curing unit was set up at Nilambur for demonstration purpose. This technique has already attracted the attention of the cane furniture manufacturers.

Prolonging the service life of bamboo poles: A treatment schedule has been standardised for increasing the service life of bamboo poles used as props for banana, betel vines, etc. by three times that of normal poles. This technique will help the farmers to save extra expenditure for poles while raising successive crops.

THRUST AREAS OF CURRENT RESEARCH

In view of growing importance of forests in production and environmental conservation, the Institute has identified several research projects which are directly relevant to the Kerala situation. To meet the requirement of the forest department, industry and public, with which KFRI maintains close liaison in various ways, a number of research projects are being undertaken on wide ranging topics. Current research project programmes fall under the following thrust areas identified below.

Cane curing unit at Nilambur

Reforestation of degraded lands

One of the prime needs of the present decade is prevention of deforestation and bringing the degraded areas back under forest cover. While the Institute is not primarily involved with afforestation *per se* special methods and techniques suitable for reforestation of difficult areas form subject of study as follows.

* *Use of mycorrhizal and nitrogen fixing symbionts in reforestation of degraded lands.*
* *Establishment of green belt around polluting industries.*
* *Ecorestoration of a micro-watershed in critical areas.*
* *Participatory action research programme for afforestation of wastelands.*

Improvement of productivity of forests

Forest productivity, in terms of economically useful products can be improved by plantation forestry and scientific management of natural forests. This is particularly important as there are serious constraints to increasing the area under forests.

Cane furniture made from cured cane

Plantation forestry

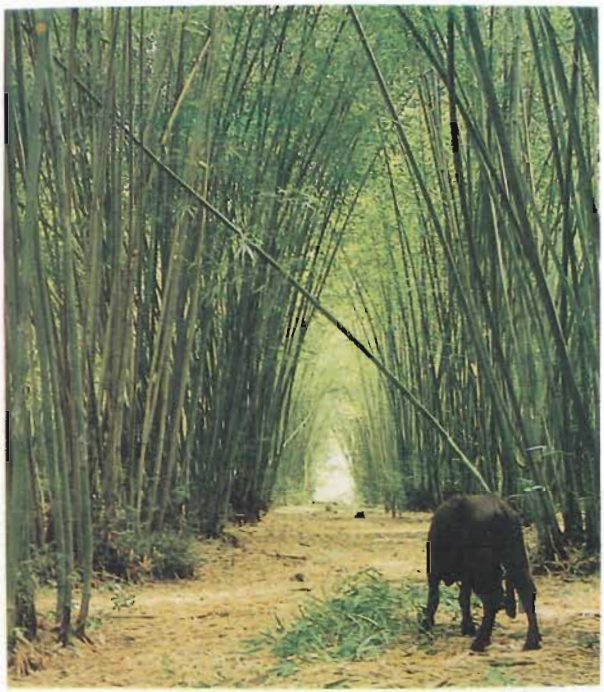
Presently plantations cover 17% of the State's forest area and it is a major investment in the forestry sector. The major planation are those of teak and eucalyptus covering an area of 75,000 and 40,000 ha, respectively. Other plantation species include *Ailanthus triphysa, Bombax ceiba, Acacia auriculifomis, Paraserianthes falcataria,* tropical pines, etc. covering an area of another 40,000 ha. The major problem in plantation forestry has been low productivity and the research undertaken by KFRI is geared to solve some of the technical problems in this respect. Several research programmes are being carried out in KFRI to achieve this goal. These include

TEAK

* *Soil nutrient management for teak plantations.*
* *Study of impact of mixed vegetation on the growth of teak plantations.*
* *Studies on growth performance of teak nursery stock from genetically better sources for developing improved plantation technology.*
* *Quantification of soil and water loss from teak and eucalypt plantations.*
* *Effect of faster growth on wood quality of teak.*
* *Bio-control of the teak defoliator, Hyblaea puera using Nuclear Polyhedrosis Virus (NPV) and insect parasitoids.*
* *Establishment of permanent plot to demonstrate the effect of protecting teak plantations from insect attack.*
* *Tracing the epicentres of teak defoliator outbreaks in Kerala.*

EUCALYPTUS

* *Tree improvement of Eucalyptus for disease resistance and higher productivity.*
* *Enhancing the productivity in Eucalyptus grandis through fertilizer inputs and cost effective treatments.*
* *Studies on water use, assimilation and growth of eucalyptus.*



A view of the Dendrocalamus longispathus plantation at Nilambur

BAMBOOS AND RATTANS

* *Silviculture, management and utilization of bamboo resources of Southern India.*
* *Management and utilization of rattan resources of India.*
* *Propagation of bamboos, rattans and medicinal plants by tissue culture methods.*
* *Under planting of rattans in rubber plantations.*

MISCELLANEOUS

* *Litter dynamics, microbial associations and soil studies in Acacia auriculiformis plantations in Kerala.*
* *Management of bark feeding caterpillar Indarbela quadrinotata in Albizia plantations.*
* *Fungicidal management of quick wilt disease of pepper in forest plantations.*

A panoramic view of Silent Valley where multidisciplinary ecosystem studies on various aspects are being conducted

Management of natural forests

In addition to their role in ensuring environmental stability, natural forests, especially evergreen and moist deciduous, form an important source of timber and other forest products. Although the natural forests are being exploited for our immediate advantage by selective harvesting of desirable species, we know little of the dynamics of these forest ecosystems and the long-term impact of these operations on their sustainability and resilience. Studies being undertaken in this area are:

* *Studies on the flora of Reserves, Wildlife Sanctuaries with emphasis on endemic species.*
* *Studies on the epiphytic flora in the tropical forest ecosystem of Western Ghats with special reference to Nilgiri Biosphere.*
* *Flowering and regeneration techniques of reeds.*
* *Establishment of a permanent sample plot for long-term monitoring of ecological processes.*
* *Ecological studies in disturbed forest ecosystem with special reference to moist-deciduous forests.*
* *Vegetation mapping of the grassland forest ecosystem in Western Ghats of Kerala for afforestation programmes.*
* *Preparation of forest maps, vegetation mapping and analysis of Wildlife Sanctuaries using remote sensing technique.*
* *Preparation of an illustrated manual of commercial non-wood forest produce plants of Kerala.*

Enhancement of wood-use efficiency

Considering the ever shrinking resources of wood it has become necessary to minimize wastage of valuable timber species and enhance the utilization of less-known, miscellaneous species. The projects being undertaken on these aspects include:

* *Upgradation of rubberwood for better utilization.*
* *Wood properties of some less-known timber species in Kerala.*
* *Use of nonconventional timbers for bee hives.*
* *Studies on the growth and prevention of sapstain fungi in rubberwood and their effect on strength properties.*

Furniture made from eucalypt wood

Agroforestry

The main objective of agroforestry research is to optimise production and economic return per unit area of agricultural lands and home gardens. The following research projects have been initiated to understand the existing agroforestry systems available in the state and to understand their structure and functioning.

* *Agroforestry models in Kerala.*
* *Structure and function on the home garden agroecosystem in Kerala.*
* *Studies on growth and architecture of tree species of home garden agroforestry systems of Kerala.*

Wildlife management

About 20% of the forest area in the state has been constituted as wildlife sanctuaries and national parks. For scientific management of these areas, knowledge of the ecology and behaviour of individual species, community ecology and habitat-species interaction is essential. The following projects were undertaken with these objectives.

Habitat Utilization

* *Status, habitat utilization and movement pattern of large mammals in Wildlife Sanctuaries,*
* *Ecology and behaviour of Malabar Giant Squirrel,*
* *Survey of small mammals and primates in Wildlife Sanctuaries and adjacent areas,*
* *Pray-predator studies,*
* *Distribution of mammals and birds in Wildlife Sanctuaries and National Parks.*

Man-Wildlife Conflicts

* *Man-wildlife conflicts in Wildlife Sanctuaries and adjacent areas.*

Ecological Studies

* *Ecology and behaviour of sambar deer (Cervus unicolor Niger) in the Wildlife Sanctuary.*
* *Ecology and population dynamics of endangered primates.*
* *Survey of stream fishes, their habitat, distribution and behaviour ecology.*
* *Crop damage by wild animals in Kerala and evaluation of control measures.*
* *Wildlife census of Kerala.*
* *Standardization of indirect evidences of wild animals for field identification and preparation of a field guide.*
* *Preparing a management plan for project elephant areas in Kerala.*

Socio-economic analysis of forestry activities

Population growth and the resultant increase in demand for various forest produce and the emergence of forest based industries consequent to recent technological developments have accentuated forest land use conflicts. No policy or management practice can succeed unless the needs and aspirations of the

population, particularly of those living in the immediate vicinity of forests are taken into consideration. An understanding of socio-economic aspects of forestry activities is sought by the following studies:

* *Evaluation of forest schemes under Western Ghats Development Programme.*
* *Evaluation of Social Forestry Plantations under the World Bank Scheme in Kerala.*
* *Economics of forest plantations in Kerala*
* *Teak plantations in Nilambur : An economic review.*

Fundamental studies in forestry-related disciplines

While our efforts are focussed primarily on applied research its success depends on the availability of fundamental knowledge. The Institute carries out basic research in the relevant disciplines to the extent it is needed. Over the years, the scientists have gathered and published considerable information of fundamental value in the major forestry-related disciplines to provide a strong base for solving some of the practical problems. The following studies are intended to generate basic data in forestry related disciplines.

* *Macrofungal flora of Peechi-Vazhani Wildlife Sanctuary.*
* *Water use of indigenous and exotic trees.*
* *Demonstration cum research plot on multitier forestry through operational research.*
* *Impact of upland management activities on down stream ecosystems.*
* *Use of alternative materials as containers for raising seedlings.*
* *Structural dynamics of teak stands in Kerala.*
* *Analysis of data from long-term trials.*
* *Statistical analysis package for forest mensuration.*
* *Expert system for designing experiments in forestry.*
* *Cambial activity and juvenile wood formation in teak.*

COMMUNITY INTERACTIONS/SOCIAL BENEFITS OF RESEARCH

Since its inception the Institute has maintained close liaison with the State Forest Department, wood-based industries, public and other institutions related to forestry. It is because of the Institute's commitment to applied research, every year KFRI is approached by various agencies for solving some of the forestry based problems. Institute takes up several studies at the request of various funding agencies, including consultancy services for private/government organizations on payment basis on advising or conducting experiments or for turn-key operations such as installation of a wood preservation plant. KFRI also renders short-term training courses to foresters and other end users in plant protection methods, timber treatment, computer applications, etc. The publicity wing of the Institute popularises re-

A study of the cellular structure of cane in cross section helps in identification and assessing its utilization potential

Changing face of "Evergreen" - the Institute's Newsletter

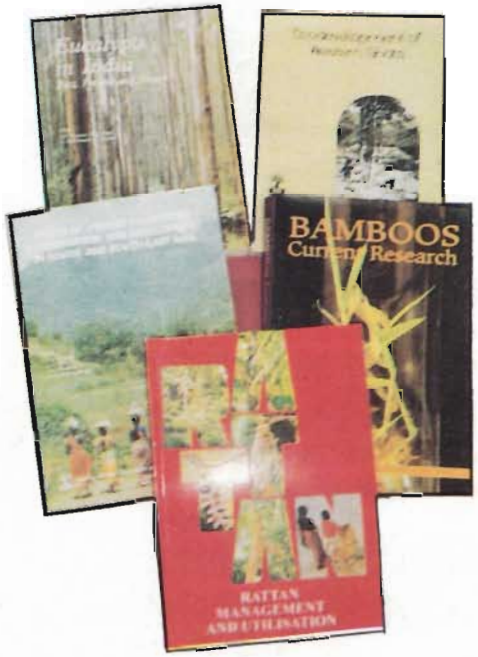
search findings and forest conservation needs by organizing exhibitions, lectures, seminars, etc. Some of the research work done at KFRI which has social relevance is given below:

* *Durable bamboo poles as props for banana and betel vine.*
* *Cost effective methods to save the wood against damage by insects and fungi.*
* *Quality improvement of canes for better furniture.*
* *Termite control in buildings.*
* *Information on medicinal plants for Ayurveda physicians and traders*
* *Timber identification service for appropriate end use*
* *Information on Kerala timbers*
* *Vegetative propagation of bamboos and reeds*
* *Handbook of forest trees of Kerala forests*
* *Demand and supply of wood in Kerala and their future needs.*

In addition, the Institute renders service to the Forest Department by undertaking soil studies to facilitate the preparation of management plans. Help is also rendered for controlling pest and disease problems in nurseries and plantations raised by the Forest Department. Wood identification is another important area in which services of the Institute are regularly used by the public works department, construction corporation and other wood users. KFRI library provides excellent facility for students, researchers, scientists from other Institutions and officials from the Forest Department.

Dissemination of information

The research findings emanating out of research projects are disseminated through workshops, seminars, interaction meetings and publications. "Evergreen", the newsletter of the Institute, published twice a year in March and September, provides information on reports, scientific papers and information bulletins published from time to time, current research, interim



Seminar proceedings published by the Institute

results, new research projects and other activities of the Institute.

Publications

Right from its inception in 1975, KFRI has published 91 research reports, 250 scientific papers, 12 information bulletins and two handbooks. KFRI research reports have achieved world-wide recognition. Due to high level of original scientific research numerous scientific papers authored by KFRI scientists are published in international and national journals of repute.

BIC-India Bulletin, a semi-annual publication of the Bamboo Information Centre is published in January and June each year.

Since 1989, an annual interaction seminar with the Kerala Forest Department is held to discuss research results and their field application. Various National and International Seminars organised so far by the Institute are:

Some of the BIC publications brought out recently

Training programme for rural women

1. National Seminar on Eucalypts in India - Past, Present and Future, January 1984, Peechi.
2. National Seminar on Ecodevelopment of Western Ghats, October 1984, Peechi.
3. International Bamboo Workshop, November 1988, Cochin.
4. MAB regional training workshop on Tropical Forest Ecosystem Conservation and Development in South and Southeast Asia, May 1989, Trichur.
5. Rattan (Cane) Seminar, India January 1992, Trichur.
6. National Seminar on Socio-Economic Research in Forestry, May, 1992, Trichur.
7. IUFRO Symposium on Impact of Diseases and Insect Pests on the Tropical Forests, November 1993, Peechi.

In collaboration with various government departments, the Institute has organised the following training courses/workshops for the benefit of the government officials/private and public industries/general public.

Inauguration of Rattan (Cane) Seminar India

1. Training workshop for carpenters on *Rubberwood Utilization*, 12-16 March 1990.
2. *Innovative Uses of Timber in House Construction*, 1-2 March 1991.
3. Timber training course, 7-12 October 1991.
4. Training programme for rural women on *Species Diversity Protection, Conservation and Sustainable Management of the Tree Components in the Homegarden Agroforestry Systems*, 19-20 June 1993. (Sponsored by M.S. Swaminathan Research Foundation, Madras.)
5. Training programme on *Community Participation in Biodiversity Conservation*, 16-21 November 1993. (Sponsored by M.S. Swaminathan Research Foundation, Madras.)

In addition, occasional short training programmes for the benefit of the IFS officers are also conducted by the Institute.

KFRI - A RECOGNISED CENTRE FOR DOCTORAL RESEARCH

The Institute has been recognised by the Kerala Agricultural University, Calicut University, Indian Council for Forestry Research, & Education - a Deemed University and Cochin University of Science & Technology for their Ph.D. degree programmes. A number of Scientists of the Institute are recognised as guides for supervising the students. Research fellows attached to different research projects are encouraged to do their Ph.D. under the concerned scientists of KFRI.

Recently, steps have been taken to get KFRI recognised by the Cochin University of Science & Technology for conducting 1-year M.Phil. (Forestry) degree course.

In addition to research, KFRI Scientists are also associated with selected teaching courses offered to undergraduates and post graduate students of College of Forestry, Kerala Agricultural University.