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Two decades with the giant grass

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A score of years has passed since KFRI has been actively involved in research on bamboo. In this issue, *Evergreen* presents the highlights of the research work on bamboo done by KFRI scientists.

Bamboo is a giant grass, belonging to the subfamily Bambusoideae of Poaceae with about 110 genera and 1140 species in the world. India has the second largest resources of bamboo in terms of species diversity, habitating 18 genera and 128 species of which 7 genera and 27 species are known to occur in Kerala. Members of the genus *Ochlandra* which posses thin walled culms (stems) and mostly endemic to Western Ghats and Sri Lanka is popularly known as reed bamboo. As per the forest survey of India records, bamboo is distributed throughout the country and occupies 12.8 per cent of the forests.

A clump of Bambusa gigantea showing young suckers. Inset shows yellow bamboo culms with green stripes

Majority of bamboo species reproduce vegetatively by suckers for decades and at the end of a definite period, flowering starts synchronously in all the daughter clumps that originated from a parent clump even if they are geographically separated (gregarious flowering). The vegetative phase varies

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from one to 120 years among the species. The flowered clumps die after seed set (monocarpic). Lack of scientific management to protect natural regeneration from seed predators, fire, grazing and weeds have led to reduction in the area and density of bamboo stands. The discovery that bamboos form an ideal long-fibered raw material for paper and pulp industries was made in the early part of this century and since then due to the ever increasing demand, bamboo is extracted from natural forests without giving any attention for sustainable harvesting. KFRI, after realising the need to protect and enhance the dwindling bamboo resources, initiated research on bamboos soon after its inception and gave high priority for it during last decade.

Diversity and distribution in southern India

A field survey revealed that 24 species belonging to 9 genera are found naturally distributed and 10 species belonging to 5 genera are found introduced or cultivated in southern India. Since flowering materials are seldom available, a key based on the vegetative characters has been developed by KFRI for field identification (Kumar, 1996).

Growing stock estimation by remote sensing and GIS

A technique has been standardised for stock mapping of bamboos using large-scale aerial photographs and geocoded satellite data. The study conducted with the remote-sensed data IRS-1A, Liss I and Liss II (both digital and hard copy)and large- scale (1:15,000) black and white aerial photographs confirmed that the mapping and resource evaluation of bamboo in natural forests can be effectively and efficiently done (Nair and Menon, 1998). Geographic Information System (GIS), overlay, map algebra and area estimation techniques were used for estimation of bamboo growing stock under different category of bamboo areas (Nair, 1991).

RESEARCH FUNDING

KFRI has received substantial funding from the following organisations for bamboo research:

Department of Science and Technology, Delhi and Thiruvananthapuram.

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International Development Research Centre, Canada.

Kerala Forest Department, Thiruvananthapuram.

Natural Resources Institute, U. K.

Flowering, fruiting and seed storage

Of the 34 species of bamboos found in southern India, flowering was observed and herbarium specimens were collected for 21 species. Flowering was reported for the first time for eight species and many others were collected after a long gap of 30 to 90 years (Kumar, 1996; Seethalakshmi, 1997).

Morphologically, bamboo seeds are classified into caryopsis, glans and bacca. In caryopsis, the pericarp is membraneous, thin, soft and adhered to the seed coat. The fruit has an apparent ventral suture, which is nearly as long as the whole fruit. Glans has hard, smooth, crustaceous pericarp separated from seed coat and no ventral suture. In bacca the pericarp is fleshy and thick and separated from seed coat. Seed longevity and storage behaviour are based on the type of seeds. Of the six species observed bamboos produced caryopsis, while reeds produced bacca type fruits. Caryopsis seeds showed orthodox (tolerates desiccation) behaviour and could be stored up to five years by dry storage methods with control of humidity and temperature (Somen and Seethalakshmi 1989, Seethalakshmi, 1991) while bacca type seeds exhibited recalcitrant (sensitive to desiccation) behaviour and conventional storage methods are not effective (Seethalakshmi, 1997). Currently KFRI is trying to develop suitable storage methods to induce desiccation tolerance in recalcitrant seeds.

Genetic improvement

Inheritance pattern in *Bambusa bambos* showed that the characters such as girth at breast height, total number of culms, and number of new culms have low heritability and are positively correlated with one another making the productivity improvement simple. A two way approach is suggested for productivity improvement. Superior clumps can be selected from existing areas and multiplied vegetatively to establish clone banks. From natural forests hybrids within and between species can be subjected to progeny test and superior families can be selected. The superior clones and families can be tested for clone-site interaction and the superior clones can be used for development of

planting stock in future (Indira, 1998).

Observation on breeding system of *O. travancorica* showed dichogamy (maturing of male and female reproductive organs in different periods) with protogyny (female reproductive organ matured first). Time gap between ripening of stigma and anthers is two days. There is no self-incompatibility and pollen grains showed 90 per cent viability in this wind pollinated species (Venkatesh 1984). Genetic variation in the germplasm of *Ochlandra* is being monitored through their growth, and using molecular techniques such as iso-enzymes and DNA finger printing.

Nursery and planting technologies

The major constraint for large scale bamboo planting is non-availability of planting stock. When seeds are available seedlings can be produced easily. Disease-free healthy seedlings can be raised in nurseries by employing the usual cultural measures (Mohanan, 1994). A protocol for large scale vegetative propagation which involves treatment of culm cuttings with growth regulating substances for inducing root formation has been standardised for 23 species (Surendran and Seethalakshmi, 1985; Seethalakshmi, 1991).

Under-planting of *Bambusa bambos* in failed teak plantations or sparsely wooded moist deciduous forests showed that successful establishment can be achieved if protection from biotic interference like fire and grazing are given for initial three to four years (Pandalai, 1991). Observations on growth of bamboo mixed with teak plantations showed that wherever bamboo grew well the performance of teak was poor and vice-versa. The bamboo areas were rich in potassium. For growing bamboo and teak together, only patch planting of bamboo in potassium rich sites or under-planting in failed teak plantations is suitable (Chandrashekara, 1996).

To find out the plantation potential of reed bamboos, pilot scale plantations of two species, *O. travancorica* and *O. ebracteata* were undertaken in collaboration with HNL. Initially 100 per cent survival was observed. The former produced 150 to 200 culms with a height of 6-8 m within four years and the the canopy was completely closed at a spacing of 5x5 m, while performace of the latter was not promising for commercial plantations.

In spite of the great demand for bamboo and significant benefits to farmers and artisans the bamboo wealth of rural Kerala is declining drastically. In order to understand the negative attitude of farmers towards bamboo, and also to assess the possibilities of promoting bamboo cultivation, participatory rural appraisal (PRA) techniques were employed. A wealth of traditional knowledge about bamboo cultivation and management was brought to light through PRA exercises (Chandrasekhara *et al.*, 1997). Financial analysis of planting bamboo in homesteads of Palakkad district showed that bamboo planting is profitable. Bamboo plantations have less labour requirement, relatively easy farm management and marketing. In the context of receding forest areas, homesteads can be taken as a viable option for bamboo cultivation (Jayasankar, 1996)

Bamboo shoot is a delicacy with good potential for export. The first pilot scale plantation using endemic and exotic edible species is being established in KFRI.

Ecology of bamboo

Growth of bamboo (*B. bambos*) in relation to soil properties showed that although it is capable of thriving in all types of soil in the State, factors like soil depth, texture, bulk density and nutrient contents influence the growth (Thomas, 1996). Investigations on reed bamboo (*O. trvancorica*) showed that these required cool, moist climate and well drained fine textured acidic soil (Thomas and Sujatha, 1992).

GIANT BAMBOO

The largest among Indian bamboos is *Dendrocalamus giganteus*. It is distributed in India, Srilanka, Bangladesh, Nepal, Thailand, China and introduced to Indonesia, Malay peninsula and Philippines. The culms are 24 to 60 m tall, 20 to 30 cm in diameter with a wall thickness of 2 to 2.5 cm and internodal length of 35-40 cm. It grows in tropical and sub-tropical moist regions of India and prefers rich loamy soil. Flowering cycle is about 40 years. *D. giganteus* can be propagated by seed or vegetatively using offsets and culm cuttings. It is one of the 12 species recommended for large scale plantation and the annual yield is 20 to 30 t/ha. In addition to the traditional uses like building construction, mast of boats and handicrafts, it is highly suitable for paper-pulp, and young shoots are edible too.

Pests and diseases

Eleven species of pests belonging to *Lepidoptera, Hemiptera, Coleoptera* and *Hymenoptera* have been identified. Of these, the damage caused by shoot borers and sap suckers are comparatively high (Mathew and Varma, 1990). A seed pest viz. *Udonga montana*, observed during gregarious flowering of *B. bambos*, was found to attack developing seeds at the milky stage, converting the seeds to chaff (Mathew and Sudheendrakumar, 1992). Stored reed bamboo was attacked by about 12 species of insects mostly beetles. Of these, *Dinoderus minutes* and *D. ocellaris* were the most serious borers. The borers attack stacked reed bamboo, bamboo and finished products (Mathew and Nair, 1990).

A total of 36 fungal organisms were found associated with diseases of leaf, culm and rhizome of bamboo. Of these, 21 pathogens were recorded for the first time. Large scale mortality of young plants due to rhizome bud rot was the most serious disease in plantations (Mohanan, 1990).

Harvest and Post-harvest Research

A prototype tool for harvesting reed bamboo developed by KFRI is undergoing field trials. A manual on local tools, equipment and technology available in Asia for processing bamboo has been brought out (Gnanaharan and Mosteiro, 1997). Cost effective preservation technique which involves keeping the basal part of culms in 10 per cent copper sulphate solution for one week has been developed. The service life of bamboo poles can be extended to two to three times by this simple treatment (Gnanaharan, 1991) Complete immersion of bamboo thorns used for fencing in copper sulphate or boric acid solutions are also found to prolong their service life (Chandrasekhara *et al.*, 1997).

Wastage reduction of harvested reed bamboo is important for effective use of the raw material. If the culms are converted to slivers, treatment with preservative chemicals is easy (Mohanan and Gnanaharan, 1998). A centralised sliver production unit with semi-automation is on the anvil to provide slivers to the weavers so that they can produce value-added mats (suitable for bamboo board).

Anatomical and physical properties

Investigations on culm structure at different height levels of 21 species of bamboo belonging to seven genera has helped in understanding the utilisation potential of these species (Bhat, 1996). Another study has shown that bamboo starts shrinking soon after harvest, whatever be the moisture level at the time of harvest whereas wood starts shrinking only after reaching the fibre saturation point (Gnanaharan, 1993).

Three different test procedures for evaluating the bending strength of bamboo showed that realistic bending strength data can be generated only by carrying out a 4-point bending test of round bamboo on a long span. However, the study showed that strength properties like modulus of rupture and elasticity could be predicted with high degree of confidence from density and outer diameter of bamboo culm (Gnanaharan, *et al.*, 1994).

BIG BAMBOO FRUITS

The biggest bamboo fruit is reported from *Melocanna baccifera* (syn. *M. bambusoides*). This species is mainly found in Bangladesh and introduced in India. Fruit is bacca (with fleshy pericarp) and weight is highly variable from 8 to 150 g, average being 55g. Of the species endemic to southern India *Ochlandra travancorica* var. *hirsuta* produces the largest fruits (24 to 32 g). The first collection of this has been made by KFRI in 1992 from Shangily (Kulathupuzha Range, Thiruvanathapuram).

Bamboo furniture

Use of locally available bamboo in split form on a treated rubber wood framework for furniture has been found very successful. Problem of taper in the culm and other jointing problems connected with round members can be overcome by using split bamboo. Also, different bamboo species with short internodes and poor form can be used for making furniture (Gnanaharan, 1998).

Sources of supply, demand and trade

Seventy-three per cent of the commercial bamboo in Kerala come from homesteads, and not forests. During 1988-89 the growing stock of bamboo in homesteads was equivalent to 0.4 million tonnes. The major demand for bamboo was from households (59%) and not industry (only 28%). In the household sector, major use of bamboo was for house construction, agricultural implements and banana props. Almost all the reed bamboo supply came from forests. The major share of reed (80%) was used by paper industry while the cottage industry received the major balance

(18.5%). There exists a large number of wholesale depots for trading bamboo from homesteads. Most of these are located in Palakkad district where bamboo supply from homesteads is abundant. Major share of bamboo sold through the depots reach the neighbouring State of Tamilnadu (Krishnankutty, 1990).

About 300,000 workers belonging to the socially and economically backward sections depend on traditional reed based industries like mat-weaving and basket making for their livelihood. To ensure availability of raw-material to them without the interference of intermediaries, rural institutions like the Bamboo Corporation and Co-operative societies were established by the Government. A study was undertaken to evaluate the organisational set up of these institutions and recommendations were given for their better functioning (Nair and Muraleedharan, 1983).

Information and other services

A Bamboo Information Centre (BIC) has been set up at KFRI since 1989. BIC has developed an integrated database comprising of Indian bamboo literature, specialists and current research programmes. Database search supported with document delivery service is offered to customers from India and abroad. Eight half-yearly BIC- India Bulletins containing short articles, abstracts of literature and bamboo research news, and an Annotated Bibliography on Bamboo of South and South East Asia containing more than 1300 abstracts of articles were published (Sarojam, *et al.*, 1996) To popularise the research results of applied value, the BIC published Information Bulletins on vegetative propagation and seed storage (KFRI, 1990, 1992) and to facilitate communication between bamboo specialists, BIC has brought out the Directory of bamboo researchers and research programmes in South and South-East Asia (Sankarapillai *et al.*, 1994). Published information on bamboo was collected, compiled and a Compendium on Indian bamboo was prepared (Seethalakshmi and Kumar, 1998).

KFRI is maintaining a germplasm of bamboo at its Subcentre, Nilambur and at the Field Research Station, Veluppadam. The germplasm has a collection of 47 species including a few varieties of *B. bambos*. Planting materials are supplied to farmers, forest departments, research institutions, universities, private and public sector companies. A bamboo herbarium containing specimens of Indian species has been established.

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Termite-Aided Seed Technology

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For enhancing germination of teak seeds in nurseries, several pre-sowing treatments are recommended: 'weathering' by repeated wetting and drying, charring the mesocarp of the fruits, and pit burial for a few days are some of them. Mechanical removal of mesocarp is also found effective.

Beeson, as early as 1941, had foreseen the potential role of termites in prepar-

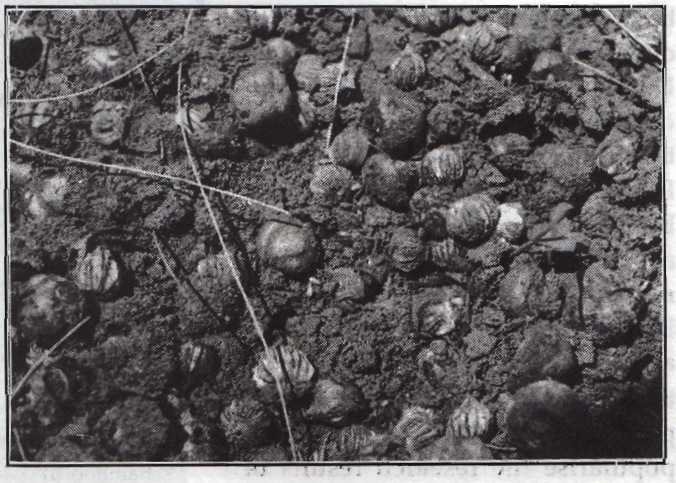

Fig.1. Teak fruits with their mesocarp fully or partially removed by the termites.

ing seeds for nursery use. However, no effort was made to look into the practicality of this method. We have demonstrated the usefulness of termites in preparing teak (*Tectona grandis*) seeds for nursery use. Mature teak seeds, with or without the inflated calyx, may be evenly spread on ground to a height of 3 cm (about 12 kg seeds can be spread over one m^2). The ground may be wetted before spreading the seeds for increased termite activity. The termite infestation starts within two days and most of the mesocarp is eaten up in about two weeks, leaving behind seeds with cream coloured stony endocarp (Fig. 1).

Mesocarp removal by termites reduces seed bulk and weight considerably; after mesocarp removal the seed volume reduces to 33% and the seed weight to 61% (Table 1). Reduction in bulk and weight in turn reduces seed handling costs.

Table 1. Weight, volume and germination of teak fruits after various treatments.

Treatment	Weight		Volume		Germination % at different days after sowing	
	No./kg	Wt. of 1000 fruits (g)	No. per 1000 cm^3	Vol. of 1000 fruits (cm^3)	20 days	45 days
Untreated fruits (with mesocarp)	1328	753 (100%)	366	2732 (100%)	Not available	Not available
Weathered fruits (with mesocarp)	1524	650 (88%)	380	2632 (96%)	3.0	17.3
Termite fed fruits (with mesocarp)	2194	456 (61%)	1109	902 (33%)	10.7	45.0

The figures in parantheses give the percentage of weight or volume, as applicable, over that of untreated fruits.

The termites which feed on the teak seeds are usually subterranean in habit *ie.* not mount building. There are several species of subterranean termites, mainly belonging to the genus *Odontotermes* and any species available in a particular locality will do the same job. The advantages of this method are: (i) cost saving on pre-sowing treatment and transportation (ii) the operations are simple enough to be carried out at the seed collection centre at no extra cost, and above all (iii) the product gives high germination percentage.

A Personal Information Management System

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Traditionally Index Card system could easily cater the need of organizing personal collection of documents and information. However as the volume of information increases exponentially the card system shows inherent inabilities of a manual system: preparation of index cards takes time and effort; there is only one access point to the information per card; space requirement to keep the cards.

Computer database is an effective alternative to card system for organizing personal collection of references. There are many advantages of using computers for Personal Information System (PIS). Most of the information are now coming from computer databases. Importing incoming data to a PIS is really what we need. Time consuming data entry can thus be avoided. Once we build up a PIS in our computer, search and retrieval becomes easy. However, to make the search versatile also, a proper database management system (DBMS) is required. CDS/ISIS can be an effective and friendly software for developing a computerized PIS.

CDS/ISIS is a well tested and widely used text retrieval software package developed by the UNESCO. Thousands of libraries and information centers all over the world use this package for developing bibliographic databases. It is an integrated DBMS and its retrieval process is based on permanent index file. A number of indexing techniques are available so that any term in the text can be

made an access point for the search. Different formats can be developed for displays and printouts. We can define our own databases and most of the database operations can be achieved without any programming. Advanced manipulations of data is possible with Pascal interface.

ISIS Personal, developed by KFRI Library, is a derivative of CDS/ISIS. The package is developed mainly to make CDS/ISIS more handy and user friendly. Database structure is predefined and fixed. About ten ready-made display formats have been created and are available through a menu. Parameters for printing and sorting are also fixed. Thus it is possible to make press-ready references at the end of a manuscript, saving the time of the scientists. Users are made free from most of the difficulties they usually encounter with the original CDS/ ISIS. Even the original messages that give on-the-screen instructions are made more user friendly.

We have successfully converted search results from Tree-CD and Wildlife Review-CD to ISIS Personal. Importing search results from various sources to ISIS Personal presents a great opportunity for scientists to make their own personal databases which are going to be of immense use in the future, particularly the global connectivity and Internet opens entirely a new era for consultancy. Together with these imported information they can add new records of the documents from their personal collection of reprints etc. ISIS Personal is not a tedious program to learn and work with. Once the records have been created, the main task is going to be search and retrieval. Search is based on Boolean operations. Creating Boolean expressions is the only technique a user has to master. Normal operators OR, AND and NOT are used to create search expressions. Facilities for right truncation and term grouping are also available. ISIS Personal lets the user to recall previous queries and to modify and regroup them for a new search. One can construct search expressions by directly taking terms from the Index file. ISIS Personal can accommodate thousands of records. Once the Index file is created/updated retrieval is instantaneous. Retrieval will not be slowed down even when the records amount to millions.

Once the Personal Information System is organized using ISIS Personal it will not be difficult to migrate to a better DBMS in the future. Since Index cards are becoming obsolete ISIS Personal could be an effective tool for personal information management.

More information on the above program is available from the Librarian, KFRI

Can we save the Gul Mohr trees?

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Delonix regia (Boj.) Rafin, commonly known as Gul Mohr is a fairly large deciduous ornamental tree planted in avenues and gardens. The tree has its origin from Madagascar and was introduced to India as early as 150 years ago. The tree has broad spreading umbrella shaped and light feathery crown reaching a height of about 18 m under favourable conditions of growth. Due to its deciduous nature, the tree is almost leafless in hot summer, but flowers in April-May, and as the monsoon starts, new flushes also appear. The entire crown is coverd with dazzling, large, flaming-red flowers presenting a gorgeous appearance.

The tree is a light demander. It does not grow well under shade and develops a lean and lanky stem with sparse crown. The tree is reported to grow well in almost all soil types in fairly dry conditions. It has a shallow root system which makes it susceptible to being blown over by winds. Its superficial spreading roots prevent grasses and other plants to grow in the vicinity and it is unsuitable as a shade tree in the plantations. The roots also compete for nutrition with other flowering plants and shrubs. The tree is sensitive to frost.

Eventhough the tree is attractive with dark flaming red flowers, many of the trees planted as avenue trees in Kerala

face the problem of uprooting, causing serious damage to the property. This prevents many tree lovers from choosing this as an avenue tree. Casual observation of some of the uprooted trees show that the butresses and snaky roots of *Delonix regia* do not go deep into the soil and the soil binding capacity is very poor. The tap root usually rots away as the tree matures along with the development of butress roots. With the onset of South West Monsoon, the wet and heavy canopy is not able to withstand the strong winds, leading to the uprooting of the tree. It has also been reported that roots and collar region of the tree are often attacked by fungi (root-rot caused by *Clitocybe tabescens* and *Ganoderma lucidum*), termites, mushrooms etc. Casual observation of billeted trees shows a hollow core in the basal region of the trunk. Research is warranted to see if this beautiful tree can be saved from the above problems so that it can continue to beautify our avenues.

Figure shows an uprooted Delonix tree on the roadside that caused damage to a private property.

Vegetative propagation of Asokam

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Saraca asoca known as "Asokam" in Malayalam and "Gathasoka" in Sanskrit belongs to subfamily Caesalpineacea of the family Fabaceae. This is a small tree reaching 8-10 m in height with brown bark and pinnately compound leaves, bearing attractive orange red flowers in dense racemes, and produces oblong compressed fruits. The distribution of the tree is in the west coast tropical evergreen forests of India and quite often grown in homesteads too.

The tree grows well in a variety of soils with good drainage. Natural propagation is through seeds, but insufficient production of fruits and pest problems to seeds, does not favour natural regeneration.

As this is a species in great demand, vegetative propagation was tried and found successfull, the details of which are given below.

- Collect juvenile (current year) branch cuttings from young (6-7 years old) trees.
- Prepare shoot cuttings having a length 10-15 cm and 1-2 pairs of leaves intact. Apical bud can be removed, and the leaf area can be reduced considerably by trimming away leaflets of the compound leaves.
- Treat the prepared cuttings with aqueous solution of Bavistin (0.05% a.i.) to prevent any possible fungal attack during the propagation.
- Treat the cuttings with indole butyric acid (IBA) (4000 ppm concentration) by dipping the lower cut end in powder preparation of the hormone in talc.
- Insert the cuttings immediately in Vermiculite taken in root trainers and keep them in mist chamber.
- Regular misting should be provided for 15-20 days, while sprouting and rooting occurs. Within a period of about 30-35 days the rooting will be completed.
- After good rooting has occurred they could be transferred to polythene bags filled with sand and soil in equal proportions (1:1) and kept in the hardening room for about 15 days.
- The properly hardened cuttings could be taken out for planting.

Figure shows a rooted cutting of Saraca asoka ready for outplanting.

SOIL ORGANIC MATTER AND ITS ROLE IN SOIL FERTILITY

Smitha Sreedharan and M. Balagopalan
Division of Soil Science

Soil organic matter (OM) includes both plant and animal residues, cells and tissues of microbes and substances synthesised by them at different stages of decomposition. As any other soil component, OM is also affected by various environmental conditions, plant community, human interference etc.

Vegetation and OM

Plants vary greatly in relative and absolute absorption of nutrients from soil, as a result of which the chemical composition of the leaves of the various species also differ greatly. Consequently the humified materials produced due to microbial decomposition and transformation of organic residues by processes like hydrolysis and oxidation even within the habitat vary. Hence vegetation exerts a major influence on the properties of soil. Soil organic matter, organic carbon (C):N ratio and nitrification depend on vegetation type. Different types of vegetation contributes differently to OM status. OM content under moist deciduous forests was found to be higher compared to tropical evergreen forests. Also OM content in plantations is observed to be lesser compared to natural forests.

Variation in OM with elevation and rainfall

Due to variation in elevation and associated climatic changes, quite contrasting flora grow at different elevation which in turn affect the OM status of the soil. Slow and lethargic activity of microbes in the acidic soil at high elevation increases the accumulation of OM content in the soil.

Rainfall, which is an important component of weather, imprints its effect on soil. The water that penetrates into the soil is used for the hydration and hydrolysis of OM or otherwise it is evaporated or percolated. It is also noted that OC and N increased with rainfall and the C:N ratio has a logarithmic increase with rainfall.

OM and soil properties

Decomposition of OM under anaerobic conditions results in the production of numerous organic acids, CO2, NH3 and nitrates which affect the pH of the soil. The increased acidity slows down further decomposition of OM.

A major part of the carbon fixed by the plants is subsequently returned to the soil in the form of dead organic debris. The products resulting from the interaction of OM with inorganic soil components affect the physical, chemical and biological properties of soils. Increased OM gives higher water holding capacity and decreased compaction, breaking strength and bulk density. A positive relationship betweeen OM and soil structure is also noted. Incorporation of OM increases the retention of soil moisture.

OM plays an important role in the maintenance of soil fertility and productivity. Organic matter is found to increase the cation exchange capacity (CEC) of soils. The relationship of OM with the ecosystem productivity reveals its biological significance. The rate of OM decomposition by a variety of micro organisms determines the rate at which nutrients become available for renewed uptake by plants.

OM and plant nutrients

Since early human history OM has been used as a manure . It is a primary natural resource of plant nutrients. The presence of OM is necessary to ensure a reasonable CEC and release of soil nutrients. OM stimulates the speed of uptake of nutrients and productive capacity of soils. In other words as OM builds up, the nutrient status improves.

OM and crop yield

OM exerts considerable influence on crop yield. Addition of OM in nursery soil improves the growth of seedlings.

In order to understand the dynamics of forest ecosystems it is necessary to ascertain the magnitude of litter accumulated on the forest floor. Nutrient as well as energy transfer in forest ecosystems are stabilised by the litter fall. The litter accumulation is varied with climatic zones, type of forests, plantations and grassland. Hence the clearing of natural forests exerts significant changes in OM content. Biomass production depends on the nutrients available to the plants. Denudation results in the destruction of OM. Various studies conducted in Kerala underline the fact that both OM and N get leached down to greater depths in deforested areas compared to forest lands. Though initial nutrient losses occur due to clearfelling, the ensuing nutrient cycle patterns depend on the species planted. The loss can be compensated by the addition of fertilizers, but it is more difficult to retain the soil characterstics such as humic content, retention, mobilisation and fixation of N and the hydrological properties.

Effect of burning on OM content

Burning disturbs natural ecology of the soil and initiates a new cycle of soil formation. Burning of OM brings about many physico-chemical changes in the soil-some of which are conducive to the growth and development of plants while others are detrimental. Removal of forest canopy and burning results in erosion and removal of fertile surface soils. This results in decreased acidity and quick oxidation of OM.

Effect of plantation activities on OM

Cropping can cause large losses of OM and N. Obviously natural forest soils are practically always richer in OM compared to man-made ones. It was also found that there is a significant drop in OC and different forms of N in plantations compared to natural forests.

Thus, it could be seen that organic matter is a major influencing factor of soil fertility. With reference to the various studies carried out, it is quite clear that OM concentration in natural forests is far greater compared to the plantations. This reveals that fertility of the soil is maintaned and improved in the natural forest areas. In plantations with unscientific operations, there is the possibility of the rich top soil being removed. To preserve the rich top soil and to maintain the fertility of the land, it is highly necessary that sound soil management measures promoting OM retention are adopted in plantations. ●

How deep do the eucalypt roots go?

N. Rajesh, C.K. Somen and Jose Kallarackal
Plant Physiology Division

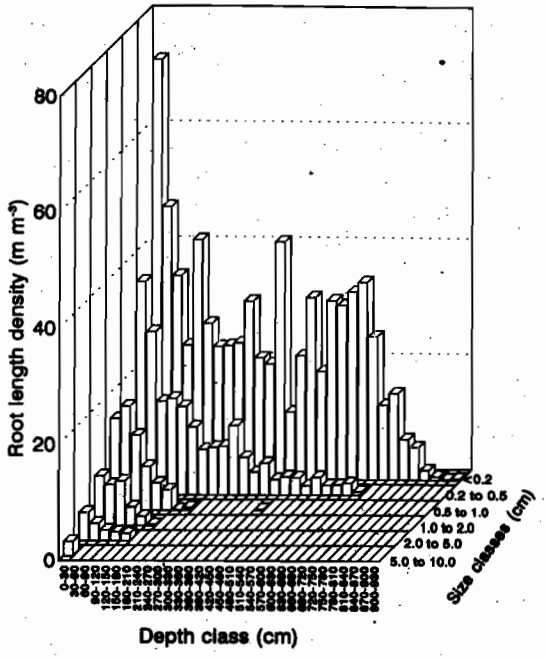


Figure shows the root length density in E. tereticornis according to different depth classes and size classes (cm).

The rooting depth of eucalypts reported from studies in Australia have indicated that they may go as deep as 60 m. Theses reports have led to the fear that eucalypts extract the water table. Water loss estimation by transpiration measurements, isotope method, core sampling etc. can give an indication as to the depth of the root system to some degree of accuracy; the actual depth could be confirmed only by excavation. From studies on transpiration we had previously estimated the rooting depth of Eucalyptus tereticornis as 7 m. To confirm the estimate we did an excavation.

Excavation was done using hand tools and the roots were collected carefully by sieving out the loose soil. Roots were then classified into different classes, oven dried for biomass estimation after measuring the length.

The root length density obtained from the study is given in figure. The roots were traced up to 9.3 m. Roots of larger size classes (>1.0 cm dia) were found till a depth of about 2.0 m from ground level. Maximum density of roots with diameter <2.0 mm was found in upper 30 cm of the soil. Roots of lower size classes were found in all the soil layers. At depths deeper than 2.0 m roots with a diameter of <5.0 mm only were seen and hence they could be absorbing roots of the tree mainly water. The examination of summer water table in the domestic wells in the adjacent locations showed that the phreatic aquifers existed at about this depth. This indicated that the eucalypt roots are penetrating down in search of water.

A survey of literature has shown that eucalypt species are probably the deepest rooting trees. Studies in Australia have shown that the root systems were deeper and denser at higher tree densities. This gives the indication that the trees in eucalypt plantations should be spaced wider if water conservation is also intended. A spacing of 3x3 m has been already recommended from KFRI in previous studies. It has been also found that the yield of usable biomass is not affected even when the spacing is increased from 2x2 m to 3x3 m. Thus the present study reaffirms the need of wider spacing in eucalypts. ●

Research Highlights

Epicentres of Teak Defoliator Outbreak

A team of KFRI scientists (Dr K.S.S. Nair, Dr V.V. Sudheendrakumar, Dr R.V. Varma and Dr K. Mohanadas) have observed that the teak defoliator (*Hyblaea puera*) outbreaks begin in comparatively small epicentres soon after the pre-monsoon showers. These epicentres are sites where a group of defoliator moths assemble and lay eggs gregariously. The mechanism by which the moths come together all of a sudden is not yet understood. Critical analysis of the spatial and temporal pattern of outbreaks in about 10,000 ha of teak plantations at Nilambur suggest that many of the large scale outbreaks can be prevented by controlling the small epicentre populations, although some outbreaks were attributable to moths immigrating from outside Nilambur. The results of this study have been reported (KFRI Research Report No. 147) to the Kerala Forest Department who sponsored this work.

An auger digger for forestry plantations

With the increase in tempo of tree planting in India, the need for a mechanized digger for planting tree saplings has been felt to eliminate the human health hazard and for ensuring timeliness of planting immediately after the receipt of rainfall. The digger unit is a standard equipment which can be front mounted on any power tiller as shown in the figure. It consists of a spiral auger of 225 mm diameter and 100 mm pitch actuated by a rack and pinion arrangement. By this arrangement the auger can be moved up and down with the help of a simple rotating hand wheel. The drive for the circular motion of the auger is effected through belt pulley and bevel gear transmission from the engine pulley of the power tiller directly without affecting the transmission for the forward movement of the power tiller. The entire assembly is mounted on a rectangular frame with necessary bearings and fixtures. The hand wheel provided at the side of the unit can be effectively used for the depth control. For increased size of holes replaceable type larger diameter auger bits of 250, 275 and 300 mm can be used. This device has been designed by three scientists, Dr K. Kathirvel, Dr T.V. Job and Dr R. Manian from the College of Agricultural Engineering, Tamilnadu Agricultural University, Coimbatore.

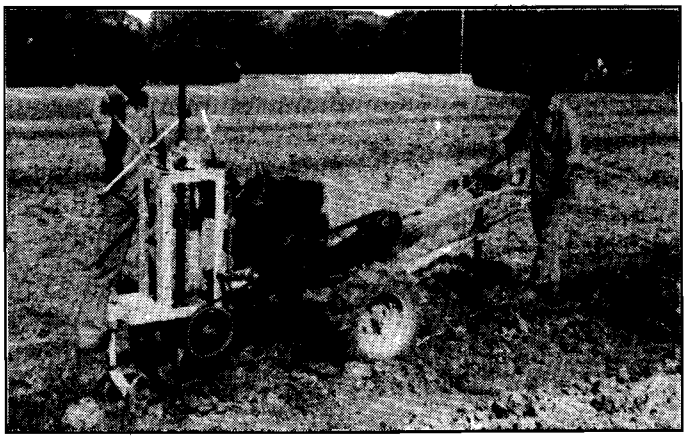


Figure shows the working of the auger digger mounted on a power tiller.

Baculovirus for Teak Defoliator Control

A naturally occurring baculovirus that infects the teak defoliator (known as *Hyblaea puera* Nuclear Polyhedrosis Virus or HpNPV in short) has been produced on a large scale by a team of entomologists, Dr K.S.S. Nair, DrV.V. Sudheendrakumar, Dr R.V. Varma and Dr K. Mohanadas from KFRI. They used the large number of the insect larvae that become available during natural outbreaks, and hence the method is relatively inexpensive. The larvae can also be reared on an artificial diet in the laboratory, and the viral pesticide isolated from them. The HpNPV which is a DNA virus (family Baculoviridae) is highly specific to its host and safe for field application. This virus has very little environmental persistence and does not persist even for a week when applied onto teak foliage. Under field conditions, 70-76% of the foliage loss caused by the pest was prevented by application of a high volume spray of 0.75 to 1.75 litres of the spray fluid per tree, containing $1X10^5$ PIB/ml. This study was funded by Department of Biotechnology, to whom a report (KFRI Research Report No. 151) has been given. Work is now in progress to standardise ultra low volume spray application.

Nilambur Richest in Herpetofauna

A study conducted to document the reptiles and amphibians in Kerala part of Nilgiri Biosphere Reserve recorded 33 species of amphibians and 62 species of reptiles. Nilambur area was the richest in both reptiles and amphibians.

Mabuya allapallensis and *Aspideretes leithi* were recorded for the first time from Kerala. The amphibians, *Anosonia rubigina*, *Micrixalus thampii* and the reptile *Uraeoptyphlus menonii* were documented from new areas. *Anosonia rubigina* was recorded from Wayanad and the other two from Nilambur. Species diversity was high in deciduous forests. Amphibians were most abundant in plantations surrounded by natural forests and reptiles in deciduous forests. Leaf litter was found to be the most preferred microhabitat of amphibians, and tree trunk for reptiles. A detailed report (KFRI Research Report No. 147) on this study carried out by Dr. P.S. Easa from the Wildlife Biology Division has been submitted to the Ministry of Environment & Forests.

PTR has Half of Kerala's Flowering Plants

The Periyar Tiger Reserve (PTR), which has an area of 777 km² is located in the Western Ghats of Kerala. Dr. N. Sasidharan recorded 1965 taxa from the PTR in a floristic study. Among the 1272 species that are considered endemic to the Southern Western Ghats, 515 species were collected from the PTR. It is heartening to note that, 150 species that have been placed under various threat categories could be collected. They include 17 species categorised as 'possibly extinct'. The occurrence of 1965 species in an area of 777 km² indicates the richness and diversity of the flora of PTR. Nowhere in the subcontinent has such a large number of taxa been reported from an area comparable to that of PTR. The highest estimated number of species is 2000 for the Agasthymala region of Western Ghats, but it has an area of 2000 km². The 1965 species in the PTR is more than 50 per cent of the estimated flowering plants of Kerala! The study report (KFRI Research Report No. 150) has been submitted to the Kerala Forest Department (Wildlife Wing), who funded the project.

New Thinning Schedule for Teak Mooted

Mensuration combined with computer simulation has suggested a re-examination of the present thinning schedule followed for teak plantations in the State. The results of the simulation study conducted by Dr K. Jayaraman (Statistics Division) indicated that out of the four silvicultural thinning practiced after 10 years currently, there was no need for the first and second. Even when the two thinnings were avoided, diameter growth remained unaffected. The larger sized trees when harvested in later stages, resulted in increased overall volume. The results of the simulation studies will need to be tested in the field. A detailed project report (KFRI Research Report No. 141) has been submitted to the Kerala Forest Department who funded this project.

More Accuracy in Wildlife Census

The relative efficiency of some of the feasible methods of estimating the abundance of herbivores in the forests of Kerala has been subjected to statistical evaluation by a team of scientists, Dr K. Jayaraman, Dr P.S. Easa and Dr E.A. Jayson. This study has shown that total count is unsuitable for estimation of animal abundance as it leads to heavy undercounting. Line transect sampling has a firm theoretical footing but suffers from low number of sightings arising from low density of animals or poor detection percentage. Calibration of detection functions using random parameter models shall go a long way in making localized prediction of animal density and hence future works should attempt to develop generalized prediction models based on random parameter models. The methods based on indirect evidences also hold promise for the future and works can be undertaken to convert indirect evidences to animal numbers. Indices of abundance based on indirect evidences would serve most of the practical purposes in wildlife management. A report (KFRI Research Report No. 142) has been submitted to the Kerala Forest Department (Wildlife Wing) who sponsored this work.

Choosing a Data Analysis Method

Data arising from repeated measurements of experimental units occur on many occasions in forestry and related fields. Very often such data are analyzed without considering their several peculiarities, like correlation between successive measurements and heterogeneity of variances, which may lead to erroneous conclusions. Three different methods of analysing repeated measures *viz.*, two way analysis of variance, univariate mixed model analysis of variance and multivariate analysis of variance were evaluated with respect to their suitability in different contexts such as soil properties observed from multiple core samples and another study on annual yield of latex from rubber trees in three years. The study revealed that multivariate analysis

of variance is the most appropriate method of analysis for majority of the soil properties and analysing data on annual yield of latex from rubber trees as well. This study undertaken by Mrs. P. Rugmini and Dr K. Jayaraman was reported (KFRI Research Report No. 149) to KFRI who sponsored this work.

Butterfly Farming

Captive breeding of butterflies depends on the knowledge of their habitat preferences. Dr George Mathew from the Entomology Division has completed a study on the habitat preferences of butterfly species visiting the KFRI campus. It is expected that this study, now submitted as a report (KFRI Research Report No. 146) will be useful for establishing a butterfly house in the campus. *Evergreen* (No. 40) had reported the establishment of a butterfly house in KFRI.

Economics of Teak Plantations

With the growing interest in teak planting, KFRI has been flooded with enquiries regarding the profitability of teak plantations. Dr Mammen Chundamannil from the Economics Division has made a detailed analysis on teak plantations using yield data from 12,500 ha in Nilambur. The Kerala Forest Department permitted access to their plantation journals and files for undertaking this work. The highlights of the findings are presented in the table. A report (KFRI Research Report No. 144) has been submitted to the Kerala Forest Department, which sponsored this study.

Table highlighting the teak plantation economics.

Item	Value
Mean yield in 53 years	151 cu.m/ha
Mean Annual Increment	2.85 cu.m/ha
Net benefit in 53 years	Rs. 23 lakhs/ha
Net present value (NPV)	Rs. 40,000/ha
Benefit-cost ratio	3.2
Internal rate of return (IRR)	31.3%

Note: All the calculations are based on the assumption that no land rent is payable.

Sacred Groves - Mini Evergreen Forests

When parameters like stand density, basal area and species diversity of trees are compared, a sacred grove is similar to an evergreen forest. This was revealed in a report (KFRI Research Report No. 152) submitted to UNESCO (who funded the study) by Dr U.M. Chandrashekara and Dr S. Sankar from the Agroforestry Division. The study also extended to species composition, vegetation structure, biomass production and nutrient cycling pattern in sacred groves.

Vegetation map of Eravikulam National Park

Vegetation mapping of Eravikulam National Park has been done using remote sensing techniques. Maps have been prepared in 1:25,000 scale using black and white aerial photographs and in 1:50,000 scale using IRS 1B geocoded satellite imagery. A set of supplementary maps which includes physical, digital, drainage and slope maps are also available. These maps are available in a report (KFRI Research Report No. 130) submitted to the Kerala Forest Department (Wildlife Wing) by Dr A.K.R. Menon from Ecology Division.

Wide Choice of Food for Monkeys

Is it not interesting to know that when the number of plants that contribute to the dining table of an average man can be counted on our fingers, the monkeys have a very wide choice of food in the forests. The lion-tailed macaque (LTM) and the Nilgiri langur in Silent Valley National Park consume food from nearly 90 plant species. The favorite food of the LTM is the flowers and seeds of an evergreen tree, *Cullenia exarillata*. This is a dominant species in the Silent Valley NP. Dr K.K. Ramachandran (Wildlife Division) who made this study has submitted a report (KFRI Research Report No. 143) to the Kerala Forest Department (Wildlife Wing).

Evaluation of some teak defoliator parasitoids

The biology, behaviour and mass multiplication of two species of indigenous parasitoids of the teak defoliator, *Hyblaea puera* namely, *Sympiesis hyblaeae* Surekha (Hymenoptera: Eulophidae) and *Palexorista solennis* (Walker) (Diptera:Tachinidae) were studied and the usefulness of these parasitoids as candidates for the biological control programme was evaluated by Dr. V.V. Sudheendrakumar of Entomology Division of KFRI. He found that the eulophid, *S. hyblaeae* entered diapause in the pupal stage during the months February-May, the early phase of pest build-up, and therefore was not able to numerically respond to the increasing pest population. It was not possible to rear the parasite in the laboratory. The tachinid, *P. solennis* could be reared

continuously in the laboratory on host larvae.

The general egg parasitoids *Trichogramma dendrolimi* and *Trichogramma embryophagum* parasitised *H. puera* eggs. Both the species preferred fresh eggs for parasitisation and the percentage parasitism on one-day old eggs was significantly lower. This indicated that successful parasitisation is dependant on timely release of parasitoids. The report (KFRI Research Report No. 129) submitted to the Kerala Forest Department concludes that practical biological control programme depends on our ability to predict the pest incidence so that inundative release of parasitoids in the field can be suitably timed.

A promising eucalypt

Eucalypts have always been criticised by environmentalists for high water consumption. However, the water consumption need not be very alarming if *Eucalyptus urophylla* is used in plantations. This is the finding of Dr. Jose Kallarackal and Dr. C.K. Somen, scientists from the Plant Physiology Division (KFRI) in a report (KFRI Research Report No.136) submitted to the Ministry of Environment and Forests, Govt. of India who sponsored a study on the water relations and rooting depth of selected eucalypt species. Out of the six eucalypt species, namely *E. tereticornis, E. urophylla, E. camaldulensis, E. deglupta, E. brassiana* and *E. pellita, E. urophylla* showed good ecophysiological features which help to conserve water by reducing excessive transpiration.

It may be noted that *E. urophylla* is one of the two eucalypt species reported to be a native outside Australia. This species is a native of Timor. The above study also revealed that *E. tereticornis*, presently planted in Kerala can have a rooting depth of 9.3 metres, which was the water table depth of the locality. This need not cause alarm, as wider spacing is reported to result in a reduced water consumption and in shallow rooting.

Juvenile wood is not inferior

Compared to mature wood, the juvenile wood in teak is characterized by wide growth rings, short fibres, high percentage of cell wall, wide microfibrillar angle, small diameter and low percentage of vessels and low or similar mechanical properties. Because all mechanical properties did not differ consistently between juvenile and mature wood, the former is not always inferior in timber strength to mature wood. This will be a good news for planters who manage short-rotation plantations of teak. The above finding was made by Dr. K.M. Bhat, scientist in the Wood Science Division while studying the cambial activity and juvenile wood formation in teak. The above results were submitted as a report (KFRI Research Report No.137) to the Department of Science and Technology, Government of India who sponsored this study.

A Sanctuary for Ferns

The Kerala Forest Department has implemented the Sylvan Valley Fern Sanctuary scheme with the help of KFRI. Dr Muktesh Kumar from the Botany Division collected and identified 159 species of ferns from different parts of Kerala. All these specimens are maintained in a fern house set up at Sylvan Valley. It is reported that there are 236 species of ferns and fern allies in the Western Ghats. This means that the collection in Sylvan Valley Fern Sanctuary is a good representation of the entire

Figure shows the ferns growing in the fern house at Sylvan Valley

Ghats. A detailed report (KFRI Research Report No. 145) on the work done by KFRI in this project has been submitted to the Kerala Forest Department who funded this. It is hoped that the nature lovers visiting Munnar will have another beautiful spot to visit in Sylvan Valley, which is located 12 km east of Munnar town in Idukki district of Kerala.

Wild Boars damage Crops most

A survey(KFRI Research Report No. 140) in the peripheral human settlements of the Peppara Wildlife Sanctuary has shown that wild boar causes the maximum damage to crops, compared to all other wild animals including elephants. Of the 30 species of larger mammals recorded from the sanctuary, five species were destructive to 17 crop species. Dr E.A. Jayson from the Wildlife Division who undertook this survey, in his report to the Kerala Forest Department (Wildlife Wing) has recommended the control of wild boar population also among other recommendations. He observed that solar powered electric fence can protect crops from elephants, sambar and gaur.

NEWS AND VIEWS

World Environment Day Celebrated

KFRI celebrated the World Environment Day by organising programmes for students of selected local schools in the Pananchery Panchayath. For seven days during June 15 -22, 1998 everyday 60 students each were brought to KFRI. They were given lectures on environmental conservation with the help of audiovisual aids. The students accompanied by their teachers also visited various Divisions of the Institute. Feed-back indicates that the students and teachers immensely enjoyed and benefitted from the programme. Dr P.S.Easa, Dr N. Sasidharan and Dr George Mathew led the programme with the help of the research fellows.

Training for PCKL Staff

KFRI organized a training programme on "Nursery and Plantation Practices of Forestry Species" for officials of the Plantation Corporation of Kerala Ltd. on 10-11 June 1998 and 11-13 August 1998 respectively. Mr. K.C. Chacko (Silviculture Division) co-ordinated both the training programmes. Additionally, another three-months training was organised for the JRFs of the PCKL on "Questionnaire-cum-field study on home gardens". This was co-ordinated by Dr P.K. Muraleedharan (Economics Division).

Costa Rican Team visits KFRI

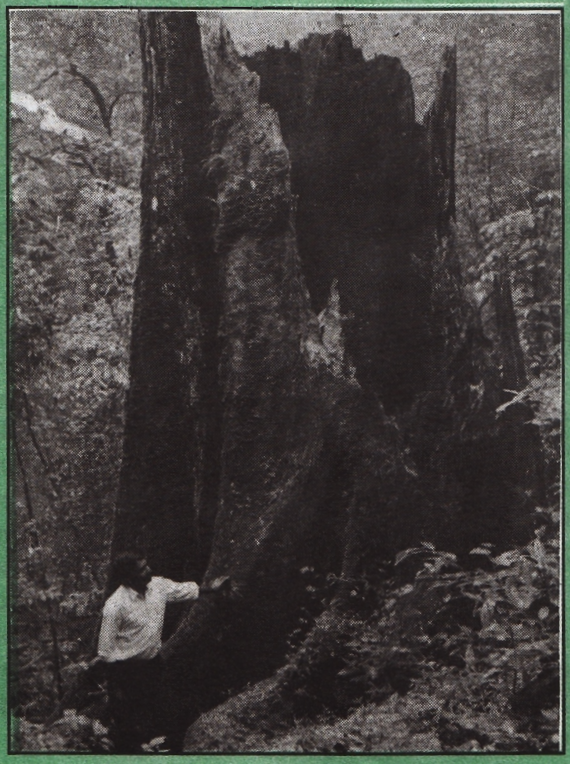
A team of forestry professionals interested in teak planting from Costa Rica visited KFRI during 11-12 August 1998. A training programme on the cultivation, management and protection of teak plantations was arranged for them at KFRI. The programme was coordinated by Dr K.M. Bhat (Wood Science Dn).

Low-cost Micropropagation

The State Committee on Science, Technology and Environment has sponsored a training course in "Low-cost micropropagation techniques" in KFRI as part of an ongoing research project. The training was held from March 16-21, 1998 in the Genetics Division. Farmers and housewives attended the training programme. The training was coordinated by Dr E.M. Muraleedharan (Genetics Division) and Dr U.M. Chandrashekara (Agroforestry Division).

The fall of a giant tree

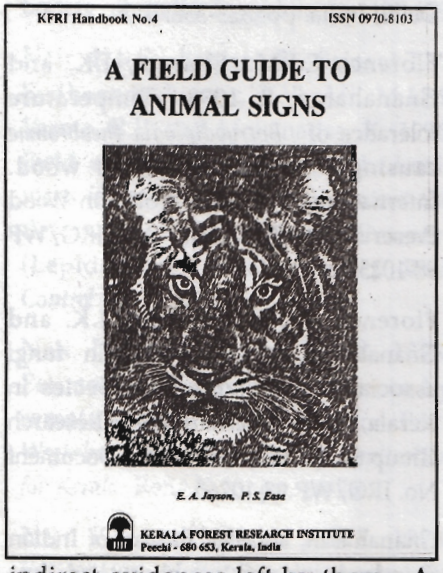
The giant hollow tree of the Silent Valley National Park that attracted the attention of many visitors is no more. Its giant size (height 40 m and GBH 13 m) and the hollow bole from base to top had attracted many visitors. The identity of the tree was a matter of dispute till Dr N. Sasidharan (NWFP Division) collected flowering twigs of this tree in 1989. Further studies by him and Dr K. Swarupanandan (Ecology Division) proved it to be an undescribed species. Later, this species was located at Punnamala, Sairanthry, Arvambara and a few other spots in the National Park. The species was named as *Cassine kedarnathii* Sasi & Swarup. (Fam: Celastraceae) (Reinwardtia, 11(1): 29-32) in honour of Dr S. Kedarnath, geneticist and former Director of KFRI who took keen interest in determining the taxonomic identity of this giant hollow tree. This species has not yet been reported outside the Silent Valley NP. Conservationists would be pleased to know that there is a good population of this species in the National Park.



Broken stump of Cassine kedarnathii photographed a week after its fall.

A Field Guide to Animal Signs

Most of the wild mammals are nocturnal and their direct sighting is difficult. But many of them declare their presence by way of indirect evidences or signs. Such evidences are used for many scientific studies on wild animals. Several census methods are also based on indirect evidences. A field guide published by KFRI describes twenty seven species of mammals based on



indirect evidences left by them. A key is also provided for identification of species based on indirect signs. Indirect evidences examined for this work include tracks, foot prints, droppings, gnawings on the bark of the trees, scratches on trees, rubbings and burrows. The field guide is illustrated with drawings and colour plates. It is hoped that this field guide will be useful to researchers, wildlife enthusiasts, foresters and volunteers who help in wildlife census. This guide is authored by Dr E.A. Jayson and Dr P.S. Easa, both from Wildlife Biology Division.

Familiarization Workshop on Bamboo

To acquaint the officers of Indo-German Reservoir Development Project, Malampuzha with the species diversity, cultivation and management of bamboo, a one day workshop was organized on 4 August 1998. Twenty five officials benefitted from this training. Dr S. Sankar (Agroforestry Division) coordinated the training.

Environment Awareness Campaign

A one-day National Environment Awareness Campaign Workshop was organized on 27 June 1998. KFRI conducetd this workshop at Gandhi Smarak Nidhi School, Vadakkanchery, Palakkad District. Dr S. Sankar (Agroforestry Division) organised the workshop.

An Initiation Workshop

A project initiation workshop on "Improving and maintaining productivity of eucalypt plantations in India and Australia" reviewed the researches on eucalypts done in India and Australia. The Australian group was represented by Dr. A.M. O'Connell, Prof. R.J. Gilkes and Dr. T.S. Grove. The KFRI team was led by Dr K. V. Sankaran (Plant Pathology Dn.). The interaction helped scientists from both sides to get a clear understanding of the productivity problems in both countries and to proceed with the right kind of research methodology.

Volunteer training for biodiversity register

Mr. E. M. Sreedharan, Member, Planning Board inaugurated the training of volunteers for the preparation of a Biodiversity Register for the Panacherry Panchayat on 9 May 1998. This is in connection with a project sponsored by the STEC and implemented by KFRI with peoples participation. The Panchayat President Mr. C. M. Damodaran, Professor T. P. Sreedharan and Professor M. K. Prasad served as Resource Persons for the training, in addition to several scientists from KFRI.

Forest Secretary visits KFRI

Mrs. Lissy Jacob IAS, Secretary of Forests to the Government of Kerala visited KFRI on 28 September 1998. She showed keen interest in the ongoing research work at KFRI and visited all Divisions and held discussion with scientists. Later, she visited Kottappara, near Kothamangalam accompanied by Dr. K.S.S. Nair, Director, Dr. J.K. Sharma, Research Coordinator and scientists of the Plan Pathology Division to see the tree improvement work on Eucalypts in progress. As a follow-up measure, she convened a meeting of the senior officials of the Kerala Forest Department and KFRI in Thiruvananthapuram to discuss ways to better utilise the services of KFRI and facilitate greater interaction with the Department.

Photograph shows Mrs. Lissy Jacob IAS along with the director Dr. K.S.S. Nair, Dr. J.K. Sharma and Mr. K.C. Chacko visiting the field experiments at Kottappara.

Recent Publications

Books/Chapters in Books

Balasundaran, M. and Gnanaharan, R. 1997. Timber defects of plantation grown teak and their implication on wood quality. In: *Teak* (Eds. S. Chand Basha, C. Mohanan & S. Sankar) Kerala Forest Department and Kerala Forest Research Institute. pp. 129-134.

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No. 130. A.R.R. Menon 1998. Vegetation mapping and analysis of Eravikulam National Park using remote sensing techniques.

No. 140. E.A. Jayson 1998. Studies on the man-wildlife conflict in Peppara Wildlife Sanctuary and adjacent areas.

No. 141. K. Jayaraman 1998. Structural dynamics of teak stands in Kerala.

No. 142. K. Jayaraman, P.S. Easa & E.A. Jayson 1998. Evaluation of methods for estimating the abundance of herbivores in the forests of Kerala

No. 143. K.K. Ramachandran 1998. Ecology and population dynamics of the endangered primates in Silent Valley National Park.

No. 144. Mammen Chundamannil 1998. Teak Plantations in Nilambur : An economic review.

No. 145. M.S. Muktesh Kumar 1998. Studies on the fern flora of Kerala with special reference to Sylvan Valley, Munnar.

No. 146. George Mathew 1998. Mass rearing of selected butterflies for possible reintroduction in the conservation programme.

No. 147. K.S.S. Nair, V.V. Sudheendrakumar, R.V.Varma & K. Mohanadas 1998. Tracing the epicentres of teak defoliator outbreaks in Kerala.

No. 148. P.S. Easa 1998. A survey of reptiles and amphibians in Kerala part of Nilgiri Biosphere Reserve.

No. 149. P. Rugmini and K. Jayaraman 1998. Analysis of data from long term trials.

No. 150. N. Sasidharan 1998. Studies on the Flora of Periyar Tiger Reserve.

No. 151. K.S.S. Nair, R.V.Varma, V.V. Sudheendrakumar & K. Mohanadas 1998. Management of the teak defoliator (*Hyblaea puera*) using Nuclear Polyhedrosis Virus (NPV).

No. 152. U.M. Chandrashekara and S. Sankar 1998. Ecological and social importance of conservation of sacred groves in Kerala.

Campus News

New Research Projects

KFRI 295/98 : Raising planting stock of *Eucalyptus* clones for the Kerala Forest Department.

Investigators: Dr J.K. Sharma, Dr M. Balasundaran and Dr E.J. Maria Florence (Plant Pathology Division)

Objectives: 1) To raise planting stock of selected clones of *Eucalyptus* identified by KFRI and 2) to supply the clonal planting stock for establishing Clonal Multiplication Areas at Palode and Nilambur.

Funding source: KFD Forest Development Fund

Duartion: 6 months (Jan.-Jun.1998)

KFRI 296/98 : Fungal pathogens as a potential threat to tropical acacias - Phase II.

Investigators: Dr J.K. Sharma and Dr E.J. Maria Florence (Plant Pathology Division)

Objectives: 1) Identification of newly recorded pathogens of acacias in India, and further assessment of their potential for damage, 2) taxonomic investigations of existing collections and 3) preparation of manual of diseases of tropical acacias aimed at plantation managers and forest health officers.

Funding source: Centre for International Forestry Research (CIFOR), Indonesia

Duration: One year (Jan. 1998 - Dec. 1998)

KFRI 297/98 : Insect fauna of the shola forests of Munnar and Wayanad.

Investigators: Dr George Mathew and Dr K. Mohanadas (Entomology Division)

Objectives: 1) To determine the insect fauna (major groups) in the grassland-shola forests of Eravikulam and 2) to study the diversity and distribution of major groups in different biocoenoses in the grassland-shola forests.

Funding source: KFD Forest Development Fund

Duration: 2 years (Apr. 1998 - Mar. 2000)

KFRI 298/98 : Inventory of macro-invertebrate fauna of the shola forests of Kerala.

Investigator: Dr K.K.Ramachandran (Wildlife Biology Division)

Objectives: 1)To document the macro invertebrate fauna of the shola forests based on field collections. 2) To document the abundance of the major organisms within the shola forests. 3) To derive elevational specificity of the organisms based on the collections.

Funding source: KFD Forest Development Fund

Duration: 2 years (Apr. 1998 - Mar. 2000)

KFRI 299/98: Generation of basic data on variability of rubber wood in Kerala and formulation of grading rules.

Investigator : Dr R. Gnanaharan (Wood Science Division)

Objectives : 1) To generate data which are missing but are essential for effective utilization of rubber wood. 2) To formulate grading rules.

Funding source: Science, Technology & Environment Committee (STEC), Kerala.

Duration : 2 years (Apr. 1998 - Mar. 2000)

KFRI 300/98: Preparation of Biodiversity Register - A model study in Pananchery Panchayat, Thrissur District, Kerala.

Investigators: Dr K.S.S. Nair (Director)and Dr P.S. Easa (Wildlife Biology Division)

Objectives: To carry out a model study for documenting the people's knowledge about biodiversity conservation through people's Biodiversity Register at Pananchery Panchayat.

Funding source: State Committee on Science, Technology and Environment

Duration: 3 years (Apr. 1998 - Mar. 2000).

KFRI 301/98 : Floristic studies in Parambikulam Wildlife Sanctuary.

Investigator: Dr N. Sasidharan (NWFP Division)

Objectives: 1) To prepare an inventory of the plants of the Sanctuary. 2) To carry out floristic analysis with emphasis on dominant plant groups, endemic, rare and threatened species. 3) To find out areas with respect to species richness.

Funding source : KFD Wildlife Wing

Duration: 3 years (May 1998 - Apr. 2001)

KFRI 302/98 : Survey on the commercial exploitation of medicinal plants in the drug industry of northern Kerala.

Investigators: Dr N. Sasidharan

(NWFP Division) and Dr P.K. Muraleedharan (Economics Division)

Objectives : 1) To find out the source of supply of the medicinal plants. 2) To estimate the extent of medicinal plants from the forests. 3) To enlist the medicinal plants extracted from the forests and recommend species which needed urgent protection and conservation.

Funding source: KFD Wildlife Wing

Duration : 1 year and 6 months (May 1998 - Oct. 1999)

KFRI 303/98: Ecology of wetland birds in the kole lands of Kerala.

Investigator: Dr E.A. Jayson (Wildlife Biology Division)

Objectives: 1) To determine the status and distribution of wetland birds in Thrissur kole region, 2) to assess the seasonal fluctuation of wetland bird population, 3) food and feeding habits with special reference to cultivation damage and 4) identify and rate the conservation problems.

Funding source: KFD Wildlife Wing

Duration: 3 years (May 1998 - Apr. 2001)

KFRI 304/98: Documentation of vertebrate fauna in Mangalavanam Mangrove area.

Investigators: Dr E.A. Jayson and Dr P.S. Easa (Wildlife Biology Division)

Objectives: To document the fauna of the Mangalavanam mangrove, threat to the mangrove ecosystem and to suggest possible management strategies.

Funding source: KFD (Social Forestry Wing)

Duration: 1 year (May 1998 - Apr. 1999)

KFRI 305/98: Transfer of some wood processing technologies developed by ICFRE to wood using industries in Kerala.

Investigators : Dr R. Gnanaharan and Dr T.K. Dhamodaran (Wood Science Division)

Objectives : 1) To set up a solar kiln as a demonstration unit. 2) To demonstrate the techniques of plasticization of wood and bending. 3) To demonstrate colouring and ammonia fumigation of wood. 4) To promote simple preservative treatments in rural areas.

Funding source: ICFRE, Dehra Dun

Duration : Aug. 1998 - Dec. 1999

KFRI 306/98: Mass multiplication of selected bamboos by macro-propagation.

Investigator: Dr K.K. Seethalakshmi (Plant Physiology Division)

Objectives: 1)Testing simple techniques of macro-proliferation for *B. bambos* and *D. strictus* 2) production of planting stock in bulk and distribution, 3)preparation of brochure on simple techniques for bamboo propagation, 4) organization of a training on bamboo propagation.

Funding source: ICFRE

Duration: Aug. 1998 - Oct. 1999.

Participation in Seminars, Symposia and Workshops

Dr. K.M. Bhat (Wood Science) participated in the National Conference on teak during 25-26 May 1998 in Jabalpur and presented an invited paper on "Tree breeding for improved wood quality of teak." He also participated in National Seminar on processing and utilisation of plantation grown timbers and bamboo during 23-24 July 1998 in Bangalore and presented paper on " Properties and utilisation of small timber resource of teak plantations". Also he attended the INBAR meeting held on 25 July 1998 at IPIRTI, Bangalore.

Mr. K.C. Chacko (Silviculture) and **Dr U.M. Chandrashekara** (Agroforestry) attended the Workshop on "Setting Research Priorities for ICFRE in Forestry Research in Kerala" from 4-6 May 1998 at Thiruvananthapuram. Mr. Chacko attended the Seminar on "Role of Forest Education in Conservation of Natural Resources" on 22 May 1998 in Coimbatore. He also participated in the Launch Workshop of Kerala Forestry Project at Thiruvananthapuram during August 1998.

Dr P.S. Easa (Wildlife Biology) attended the Annual Symposium of International Society for Conservation Biology held at Macquarie University, Sydney, Australia during 13-16 July, 1998. Presented a paper on Man-Wildlife conflict in Wayanad Wildlife Sanctuary". He also attended the National seminar on Wildlife Conservation, Research and Managment from 10-13 August, 1998 organized by Wildlife Institute of India, Dehra Dun.

Dr E.J.M. Florence (Plant Pathology) participated in the 29th International Research Group on Wood Preservation Annual Meeting in the Netherlands during 14-19 June 1998 and presented two papers entitled "Sapstain fungi associated with softwood species in Kerala, India" by E.J.M. Florence, J.K. Sharma and R. Gnanaharan and "Temperature tolerance of *Botryodiplodia theobromae* causing sapstain in rubber wood" by E.J. Maria Florence, J.K. Sharma and

R. Gnanaharan. She also participated in the National Seminar on Processing and Utilisation of Plantation Timbers and Bamboo at IPIRTI, Bangalore during 23-24 July 1998 and presented a paper on "Strength properties of rubber wood affected by sapstain" by E.J. Maria Florence and J.K. Sharma.

Dr R. Gnanaharan (Wood Science) attended the Timber Sub-committee meetings CED 9:3 and CED 9:9 of the Bureau of Indian Standards held at FRI, Dehra Dun on 19 May 1998. Also, he attended the Timber Sectional Committee meeting CED 9 of the Bureau of Indian Standards held at Bangalore on 22 July 1998. He also attended the National Seminar on Processing & Utilisation of Plantation Timbers and Bamboo organized by IPIRTI, Bangalore during 23-24 July 1998.

Dr K.S.S. Nair (Director) and **Dr A.R.R. Menon** (Ecology) participated in the National Workshop for user Interaction on the Application of Remote Sensing Technology for the Management of Natural resources - RESEREON- KERALA-98 held at Thiruvananthapuram on 16 September 1998. Dr Menon contributed a paper on "Bamboo Resource Estimation Using Remote Sensing".

Dr K.K.N. Nair (Botany) attended a workshop of National Wasteland Development Board at Chennai during April 19-21, 1998. He also participated in another workshop on setting up Forestry Research Priorities organized by ICFRE and KFD in Thiruvananthapuram during 4-5 May 1998.

Dr S. Sankar (Agroforestry) participated in the International Project Advisory Panel meeting of CIFOR held on 24-26 March 1998 in Rome. He presented a paper on Criteria and Indicators for Sustainable Management of Teak Plantations in Kerala. He also participated in the Launching Workshop of the Kerala Forestry Project on 20-21 August 1998.

Dr J.K Sharma (RME) presented a paper entitled "Tree improvement of eucalypts for high productivity and disease resistance to *Cylindrocladium* leaf blight and pink disease in Kerala" by J.K Sharma, M. Balasundaran and E.J.M Florence in the International Symposium on Plant Pathology held at Indian Agricultural Research Institute, New Delhi during November 1997. He also attended the IUFRO International Symposium on micropropagation and spread of superior genetic material held at WWF Auditorium, New Delhi during 10-12 April 1998 and presented a paper entitled "Clonal propagation in tree improvement of eucalypts for high productivity and disease resistance" by J.K Sharma, M. Balasundaran and E.J.M. Florence.

Dr V.V. Sudheendrakumar (Entomology) attended the IUFRO workshop on "Pest management in Tropical forest plantations" organized by the IUFRO working group S7.03.09 at Bangkok, Thailand during 25-29 May 1998, and presented a paper entitled "Feasibility of using indigenous parasitoids for biological control of the teak defoliator".

Guest Lectures

Dr K.M. Bhat, as guest faculty, gave lectures and conducted wood anatomy practical for the ACF trainees at SFS College, Coimbatore during 16-21 March 1998. Dr Bhat also gave lectures on " Utilisation of wood and non-wood forest resources" and "Application of wood anatomy in tree breeding for wood quality" on 20 June 1998 to the participants of UGC refresher course in the Department of Applied Botany of Mangalore University, Mangalagangotri.

Mr. K.C. Chacko, took a class on General Silviculture on 19 May 1998 for the III Semester Master of Environment Management students from the School of Environmental Studies, Mahatma Gandhi University, Kottayam.

Drs R. Gnanaharan, K.K.N. Nair, R.C. Pandalai and T.K. Dhamodaran gave invited talks to the participants of the seminar on "Wood Industry - Problems & Prospects" organized by the Thrissur District Panchayat at Ollur on 25 July 1998.

Dr R.C. Pandalai, took a class on "Our neglected trees and how to grow and manage them" in connection with a one-day Environmental Awareness Camp under the auspices of the National Environment Awareness Campaign 1998 on 27 June 1998 at The Gandhi Smarak Sevakendram, Anjumoorthimangalam.

Research Visits

Dr K. Jayaraman spent 3 months at the Finnish Forest Research Institute, Suonenjoki, Finland during the months of March - June 1998.

Dr J.K. Sharma attended a two-week training programme on "Forestry Research Strategy Formulation, Planning and Management" during 10-22 April 1998 at Universiti Putra, Malaysia. The participation was sponsored by FORSPA, Bangkok. He also attended a five week hands-on

training in the use of biochemical and molecular markers in eucalypts at the CSIRO Division of Forestry and Forest Products, Canberra, Australia during June-July 1998.

Exhibitions

KFRI participated in the *Rajakad Fest-1998* conducted from 2nd to 6th April 1998 by providing an information stall on forestry.

KFRI Seminars

The following seminars were given in KFRI:

Mr. K.H. Hussain, KFRI Library - ISIS Personal: application of CDS/ISIS for the management of personal information system - 17 March 1998.

Dr Prem Masand, Global Hospital and Research Centre, Mt. Abu, Rajasthan - Self Management qualities - 28 April 1998.

Dr Radhika, Management Centre, Hyderabad - Leadership attitude - 28 April 1998.

Dr R. J. (Bob) Gilkes, Professor and Head, Department of Soil Science and Plant Nutrition, University of Western Australia - Properties of Lateritic Soils from South Western Australia - 30 April 1998.

Dr V. V Sreenivasan, Former Director, Institute of Wood Science and Technology, Bangalore - Wood preservation -14 July 1998.

Mr. Abdul Kareem, Puliyamkulam village, Kodon Bailur, Kanhangad led a discussion based on his experience of raising 32 acre forest - 24 July 1998.

Dr C.T.S. Nair, Senior Programme Advisor, FORSPA, FAO, Bangkok - Activities of FORSPA and funding opportunities - 7 August 1998.

Dr Mark Wilkinson, School of Biological Sciences, University of Bristol and British Natural History Museum, London, U.K. - Naked Snakes - 11 August 1998.

Dr A. P. Gore, Professor and Head, Department of Statistics, University of Pune - Forecasting weather for pests management - 18 August 1998.

Distinguished Visitors

Mr. Lionel Jayanetti and **Mr. Paul Follett** of TRADA Technology Limited, High Wycombe, U.K. visited the Institute on 27 July 1998.

Ms. Tuyen Pham, Chemical Analyst, CSIRO, Division of Forestry and Forest Products was a visitor at the Soil Science Division for two weeks in March 1998.

Mr. K. N. Kurup, Secretary Planning visited the Institute on 22 May 1998.

Dr Harsh Gupta, Director, National Geophysical Institute, Hyderabad visited KFRI on 23 June 1998.

Professor K.R. Shivanna, Professor of Botany, University of Delhi visited KFRI on 18 August 1998.

Professor R.J. Gilkes, Professor of Soil Science, University of Western Australia was in KFRI during 18-30 April 1998.

Ph.D. Awarded

Mr. Mammen Chundamannil has been awarded Ph.D. degree in Social Sciences by the Cochin University of Science and Technology for his thesis entitled "Teak plantations in Kerala: An analysis of productivity and profitability". He was guided by Prof. K.K. George, Director, School of Management Studies, CUSAT.

Mr. T.K. Dhamodaran has been awarded the Ph.D. degree by the Cochin University of Science and Technology for his thesis, "Preservative treatment and chemical modification of rubber wood". He was guided by Dr R. Gnanaharan, Wood Science Division.

Mr. B. Jayasankar has been awarded Ph.D. degree by the FRI Deemed University, Dehradun for his thesis entitled "Economic analysis of Forest Resource Management: A study of Bamboos in Kerala". He was guided by Dr P.K. Muraleedharan, Economics Division.

Mr. P. Jeyakumar was awarded Ph.D. degree in Forestry by the FRI Deemed University, Dehradun for his thesis entitled "Physiological investigations on the performance of oil palm (*Elaeis guineensis* Jacq.) introduced into India from different sources". He was guided by Dr Jose Kallarackal, Plant Physiology Division.

Mr. A.O. Varghese was awarded Ph.D. Degree in Botany from FRI Deemed University Dehradun for his thesis entitled "Ecological studies of the forests of Peppara Wildlife Sanctuary using remote sensing techniques". He was guided by Dr A.R.R. Menon, Ecology Division.

Nominated

Dr. K.M. Bhat has been nominated as a member of the Technical Foundation Committee of TEAK 2000, operated from Ireland.

Dr. C. Renuka and **Dr. M.S. Muktesh Kumar** were nominated as members of the organising committee for the National Seminar on Biodiversity Conservation at Kozhikkode.

Evergreen

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KFRI Publications (priced)

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1.	Ecodevelopment of Western Ghats	30.00	200.00
2.	Rattans of Western Ghats	10.00	100.00
3.	Structure and Properties of South Indian Rattans	08.00	75.00
4.	Tropical Forest Ecosystem Conservation and Development in South-East Asia	30.00	200.00
5.	Rattan Management and Utilization	35.00	300.00
6.	Litter Dynamics, Microbial association and Soil Studies in *Acacia auriculiformis* Plantations in Kerala	08.00	75.00
7.	Socio-economic Research in Forestry	40.00	350.00
8.	History of Forest management in Kerala	15.00	150.00
9.	Teak (Information Bulletin)	05.00	15.00
10.	Upgradation of rubber wood	08.00	75.00
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12.	Bamboo Researchers and Projects of South and South-East Asia	15.00	125.00
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15.	Teak (Seminar Proceedings)	20.00	200.00
16.	Forest Trees of Kerala	10.00	30.00
17.	A Field Guide to Animal Signs	10.00	40.00
	Educational Videos (VHS)		
1.	The Teak Defoliator	50.00	500.00
2.	Bamboo - A Crop	50.00	500.00

Prices are inclusive of inland and surface-mail postal charges. Those who wish to receive by air-mail may please ask for an invoice.

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FOREST TREE SEEDLINGS AVAILABLE FOR DISTRIBUTION.

KFRI has in stock seedlings of a number of tree species meant for distribution. They include:

1. *Tamarindus indica* (Puli)
2. *Syzygium cuminii* (Njaval)
3. *Ficus religiosa* (Arayal)
4. *Vateria indica* (Vellapayin)
5. *Thespesia populnea* (Poovarasu)
6. *Aegle marmelos* (Koovalam)
7. *Castanospermum australe*
8. *Cassia fistula* (Kani konna)
9. *Artocarpus hirsuta* (Anjili)
10. *Santalum album* (Chandanam)
11. *Wrightia tinctoria* (Danda pala)
12. *Bambusa vulgaris* (Yellow bamboo)

Advance order can be placed for seedlings of species not mentioned above. Details of supply are available from the Silviculturist, KFRI, Peechi 680 653, Kerala. Ph: (0487) 782037.