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Agroforestry- a sustainable landuse pattern for Kerala

Agroforestry is a system of growing tree crops and forest plants along with agricultural crops, and often animals for human purposes, simultaneously or in rotations on the same unit of land. More broadly, it is the combination of silvicultural, agricultural and other landuse technologies so that their joint application will increase productivity and sustainability or achieve other social goals. Thus, the main objective of agroforestry is to optimise production and economic return per unit area. This type of landuse has been in practice from time immemorial in the State of Kerala. The following factors have contributed to the development of agroforestry in this region:

a) It is located in the humid tropics with mean annual temperature above 25°C and average annual rainfall of 2000 mm.

b) The terrain is undulating and steep with 10% of the geographical area belonging to coastal, 42% to midland and 48% to highland regions.

c) The density of population (747 people/ km^2) being very high, the land holdings are small ranging from 0.02 ha to 1.0 ha in size.

d) The State has a long history of cash crop cultivation involving tree species.

A typical agroforestry system in Kerala can be called a "home garden". A brief description of a home garden (based on a field survey) is as follows: An area of 0.228 ha contains 100 trees belonging to 15 species (Table 1) with an index of diversity of 0.82. The horizontal and vertical profiles of the plot are depicted in Fig. 1(a + b). The upper canopy consists of plantation crops like coconut, arecanut and cashew; multiple-use trees like mango and jack; timber species like teak and aini and matchwood species like matti (Fig. 1a). The ground is more or less covered with different species of trees, annuals and biennials planted in different espacement (Fig 1b). At the ground level, crops like banana and tapioca are cultivated. Pepper vines are grown on arecanut and murukku trees. Animal husbandry in the form of milch cattle and poultry is also present.

Table 1. **A list of tree species grown in a 'typical' home garden in Kerala**

Botanical name	Local/trade name
Acacia auriculiformis	Acacia
Ailanthus triphysa	Matti
Anacardium occidentale	Cashew
Areca catechu	Arecanut
Artocarpus hirsutus	Aini
Artocarpus heterophyllus	Jack
Ceiba pentandra	Elavu
Casuarina equisetifolia	Kattadi
Cocos nucifera	Coconut
Erythrina indica	Murukku
Eugenia calophyllifolia	Grampoo
Garcinia gummi-gutta	Kodampuli
Mangifera indica	Mavu
Tamarindus indicus	Puli
Tectona grandis	Teak

The soil of this homegarden is fertile with a layer of litter on the ground. The light penetration to the floor is low due to canopy coverage. A multi-layer ecostructure like this, prevents land degradation and also permits maximum sustainable returns in the form of cash and multiple-use products.

Thus agroforestry practice not only helps to improve the living standards of the people but reduces the risk of total failure of crops also. It reduces the exposure of soil to rain, wind, sun etc. and consequently leads to the reduction of soil erosion. This system also supplies sufficient fuelwood and fodder to the households.

During the past few decades a shift from multiple cropping to monocropping has been taking place leading to environmental and socio-economic problems. Fluctuation in the international market price for many cash crops (pepper, coffee, cardamom) has added fuel to the fire.

A study conducted by the Division of Agroforestry, KFRI showed that the households are highly dependent on the monsoon for farming. Scarcity of water during dry months, high wages, plant diseases and low market prices are the major problems faced by the farmers. Absence of relevant research and extension support in the field of agroforestry has relegated the system at a medieval level of technology.

The advancement of agroforestry discipline should pay attention to the land resource development of homesteads in the State and to improve management systems. It should combine modern science with ancient practice. The system should adopt new technologies including use of fast-growing species, improved propagation materials, rational planting with optimal spacing, species combination etc. Only such an approach can bring in higher and sustainable output from a limited area of land.

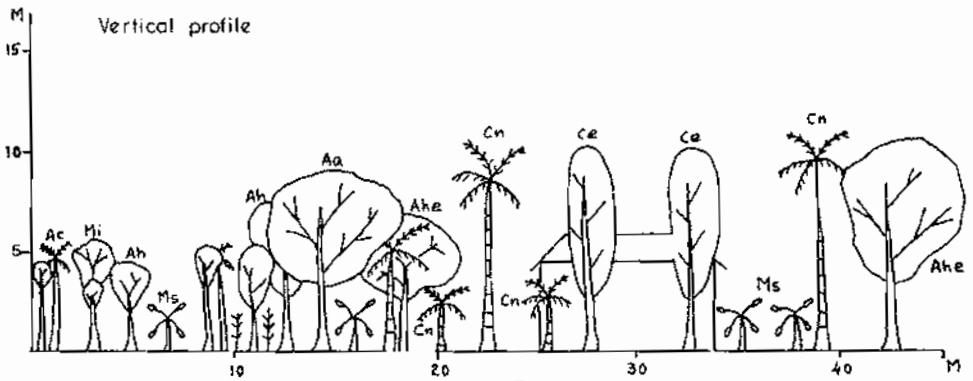


Fig. 1. a.

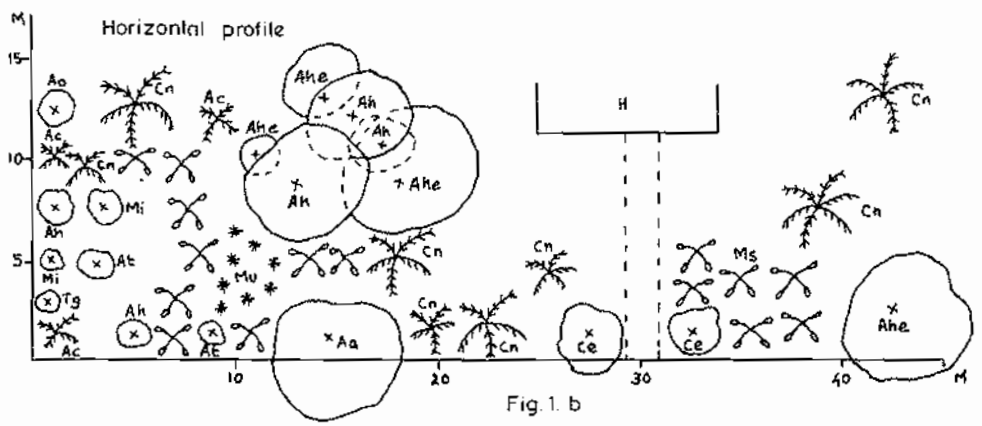


Fig. 1. b

Aa - *Acacia auriculiformis*; **Ac** - *Areca catechu*; Ah - *Artocarpus hirsutus*; Ahe - *Artocarpus heterophyllus*; Ao - *Anacardium occidentale*; At - *Ailanthus triphysa*; Ce - *Casuarina equisetifolia*; Cn - *Cocos nucifera*; H - House; Mi - *Mangifera indica*; Ms - *Musa* sp.; Mu - *Manihot utilissima*; Tg - *Tectona grandis*.

T. R. Vinod and S. Sankar
Division of Agroforestry-cum-Publicity

Control of white grubs in teak nurseries

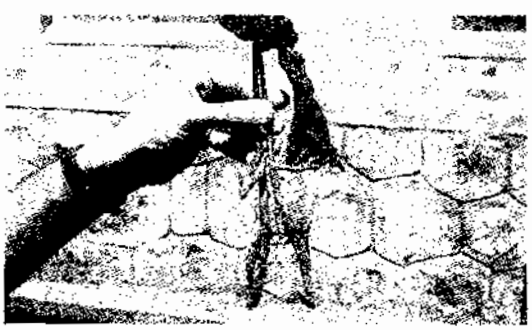
The Insect

The larvae of beetles belonging to the family *Scarabaeidae* are known as white grubs (Cockchafers). The white grubs that attack teak in the nursery stages mostly belong to the genus

Holotrichia and the species recorded from India include *H. consanguinea, H. insularis, H. serrata* and *H. fissa*. The white grub species can vary from place to place depending on the soil types and vegetation.

Nature of attack and intensity of damage

The root portion of the seedlings are eaten up by the grubs and such seedlings show symptoms of wilting and can be easily pulled out. The attack



usually occurs in patches. A recent survey for white grub attack in teak nurseries revealed high mortality of teak seedlings in nurseries located at Nilambur, Kothamangalam and Vazhachal Forest Divisions.

Pest occurrence time and favourable factors

Usually, the white grub damage becomes serious during the dry period. Weed growth in the nursery is found to be favourable for white grub incidence. Application of cow-dung solution to boost up the growth of seedlings also attracts white grubs. Therefore, use of cow-dung in nurseries may be avoided.

Control measures

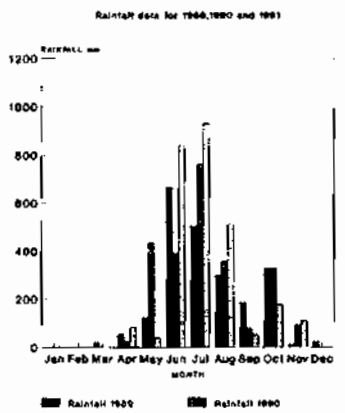
Very often white grub attack becomes noticeable only when much of the damage has already occurred and thus only remedial measures seem to be practical. Based on field trials, two insecticides were found to be effective in controlling the pest - Phorate (Thimet 10 G) and Carbofuran (Furadan 3 G). Any of these insecticides may be used for control. Apply Phorate 30 g per standard bed (12 x

1.2 m) or Carbofuran at the rate of 75 g per bed. Weigh out the required quantity of insecticide, mix with a handful of sand and sprinkle uniformly in the bed. The granules left on the teak leaves may be shaken off to the ground. If the soil is dry, drench the bed with water ensuring that the insecticide granules are not washed away. Usually this treatment will be effective for about a month; repeat the treatment if continued damage is noticed. The insecticides should be handled with care and should not be used in nurseries close to water sources.

R. V. Varma
Division of Entomology

Weather data for Peechi (1991)

Table 1 shows the monthly averages of the weather parameters recorded at the KFRI weather station at Peechi during the year 1991. The monthly rainfall for three consecutive years viz. 1989, 1990 and 1991 is provided in the Figure for comparative study.



Highlights

Day with the highest maximum temperature	27th March (40°C)
Day with the least minimum temperature	16th February (19°C)
Day with the least minimum RH	16th February, 27th and 28th March (37%)
Total rainfall for the year	2745 mm (highest recorded since 1989)
Total number of rainy days	75
Month with the maximum rainy days	June (24 days)
Day with the maximum rainfall	29th July (126 mm)
Month with the maximum wind speed	January (9.7 kmh^{-1})
Day with the maximum wind speed	18th August (25 kmh^{-1})
Month with the maximum sunshine	February (10.3h day^{-1})
Day with the maximum sunshine	13th May (11.7h)

Table 1. Weather data for 1991 at Peechi (Latitude: 10° 32 ' N Longitude: 76° 20'E Altitude: 50 m)

Months	Mean Temp. (°C)		Mean RH (%)		Monthly rainfall (mm)	Daily mean wind velocity (km/h)	Daily mean bright sunshine (h)
	Max.	Min.	Max.	Min.			
Jan.	33.6	21.3	96	57	1 (0)	9.7	9.5
Feb.	36.1	21.1	96	49	0 (0)	8.9	10.3
Mar.	37.3	24.2	91	49	0 (0)	5.3	9.2
Apr.	36.4	24.1	94	57	81.8 (4)	4.4	9.1
May.	39.5	25.0	88	57	39.4 (1)	4.2	8.4
Jun.	29.6	22.9	91	76	838.8 (24)	5.3	2.8
Jul.	28.5	22.1	92	76	931.3 (22)	4.4	2.6
Aug.	28.6	22.0	96	78	513.4 (12)	3.3	3.0
Sep.	33.5	22.7	93	64	52.8 (0)	3.8	7.6
Oct.	32.8	22.0	98	75	174.8 (7)	3.1	4.8
Nov.	33.4	21.8	94	65	110.6 (5)	4.3	7.1
Dec.	34.1	20.3	89	58	0.7 (0)	7.1	7.4

Note: RH: Relative Humidity; The figures in parentheses indicate the number of rainy days when rainfall was > 10 m.

Jose Kallarackal and C.K. Somen
Division of Plant Physiology

A Special feature

Rattan (cane) Seminar, India

Thrissur 29-31 January 1992

A seminar on rattans(canes) was organised by the Kerala Forest Research Institute at Thrissur from 29-31 January 1992. The seminar was sponsored by International Development Research Centre (IDRC), Canada. The specific objectives were:

- to create awareness on the importance of rattans as reasonable non-timber crops.
- to review the current status of resource management and utilization in India in comparison with other rattan producing countries.
- to disseminate the recent research results and to facilitate exchange of information among producers, users and different rattan growing regions.
- to prepare an action plan for greater production, better management and improved utilization.

A total of 75 delegates including five from foreign countries (Malaysia and Sri Lanka) representing forest managers, scientists, industrialists, rural institutions and policy makers participated in a two-day deliberations. A field visit was organised on the third day to cane forests, traditional cottage industry and experimental rattan curing unit.

A view of the participants

Inauguration

To quote the famous saying "Rattans are so invaluable to village life that one can speak of rattan civilization of Southeast Asia"; I am sure, India is no exception. I hope, our researchers can improve the living conditions of poor rural people with latest labour-intensive technology for different stages of plantation establishment, resource inventory, harvesting and utilization in order to be competitive in the world market. For better conservation and management of resources, the status of "minor forest products" should be upgraded and the principle of sustained yield adopted.

K.P. Viswanathan
Hon. Minister for Forests, Kerala

We have only 19% of the land with forests now in our country. We have to bring in a green revolution to increase productivity in the area available now. Identification, improvement and popularisation of mutipurpose species like rattans for cultivating in farm lands should be given top priority. There is a need to amend the forest law to take away fear from people in connection with planting and harvesting forest trees in farm lands. There is also a need to evolve appropriate technology for cultivation, harvesting and utilization of forestry species.

C. D. Pandeya
Inspector General of Forests
Government of India

Mr. C.D. Pandeya, IG of Forests, Govt. of India delivers the keynote address

We have to take drastic steps for restocking the fast depleting rattan resources.

M. P. George
Chief Conservator of Forests (Retd.)
Kerala

Kerala Forest Research Institute has the commitment to develop appropriate technology not only for conservation and management of rattan resources but also for their efficient utilization.

S. Chand Basha
Director, KFRI

What the Participants Say

Status reports

While some rattan species are commercially utilised in Malaysia there are still abundant species left unexploited.

Aminuddin Mohamad

After timber, rattan is the most important forest produce in Sri Lanka. The price of cane furniture increased due to the shortage of raw material.

P. A. Swarnamali

The average yield of commercially utilisable canes from the cane bearing forests of Kodagu district in Karnataka may be about 3,400 meters in length per hectare.

A. C. Lakshmana

Commercial plantations of canes have to be established if the cottage industry and rural artisans have to survive.

N. S. Adkoli

The physio-climatic conditions in the forests of North Bengal are quite suitable for the occurrence of various species of canes.

M. A. Sultan

Cane resources are dwindling and are threatened by over- exploitation and destruction of their natural habitats.

A. D. S. Raj

Ecologically, rattans are the indicators of the health of a very fragile and threatened ecosystem called tropical evergreen forests and there is no doubt that this silent contribution of theirs is in no way less than their manifested one in the furniture and handicrafts industry.

Mehar Singh

It will be useful to plant rattans in homesteads and farms under Social Forestry Programms for socio-economic development and environmental conservation as well.

M. P. Shiva

Resource Assessment and Conservation

Until now, four indigenous rattan species have been declared as threatened rattans and enlisted in *Red data book of Indian plants*. Two more *Calamus* species of Peninsular India have been referred to as over-exploited palms in the recent Species Survival Commission's Report on Asian Palms.

Shyamal K. Basu

A recent taxonomical survey in the Western Ghats revealed the occurrence of several new species of rattans. Cultivation of elite species is essential to relieve pressure on wild stocks.

C. Renuka

To arrest the shrinking rattan resource and to ensure adequate supply on a sustainable basis, scientific management is a must. This requires spatial information on the quality and quantity of the resource and also about its silvics which demands a comprehensive resource survey.

U. N. Nandakumar

An attempt was made to delineate cane habitat in North and Central Kerala region, on an experimental basis, using IRS 1A ISS 1 computer compatible tapes.

A. R. R. Menon

A novel solution to the practical problems of controlled breeding and hybridization of rattans could be inducing flowers *in vitro* in large flasks and using these flowers for the purpose.

C. S. Venkatesh

The use of genetically improved seeds appears to be a necessity where plantations are important for rattan production.

E.P. Indira

Canes require adequate but not too much light, poorly drained and strongly acidic soils with rich humus layer. They grow naturally in the humid phase of the moist deciduous or semi-evergreen forest types.

M. Balagopalan

In the virgin humid tropical forests of Nelliampathy (Kerala), *Calamus hookerianus* is observed more in the natural canopy gap regions than in closed canopy regions.

U. M. Chandrasekhara

Production and Management

The large diameter cane - *Calamus thwaitesii* is highly suitable for raising plantations in natural forest areas. It can be tried as an undercrop in man-made plantations of timber species like *Tectona grandis* and *Acacia auriculiformis*.

S. Parameswarappa

Calamus lakshmanae Renuka is one of the most sought after canes in Karnataka. It is attractive, flexible, strong and takes good polishing.

A.C. Lakshmana

The successful method of vegetative propagation involves collection of suckers during monsoon, treatment with growth regulating substance(Napthyl Acetic acid) for root induction and maintenance in polybags in nursery under partial shade for a period of about ten months before outplanting.

K.K. Seethalakshmi

In the genetic improvement of rattans, the use of tissue culture methods appear promising. It can be a useful aid to production of hybrids.

E.M. Muralidharan

In *Calamus rotang* Linn., the sheaths, petiole and pinnae are armed with spines. The transition from eophyllis to adult leaves occur through a stage resembling costapalmate condition.

D. Padmanabhan

In rattan nurseries, a seedling blight caused by *Guignardia calami* and seedling stem infection caused by *Fusarium* sp. are the important diseases.

C. Mohanan

Calamus palustris, a species found in northern part of Peninsular Malaysia, can be an alternative material when *C. manan* is not available sufficiently for the industries.

Aminuddin Mohamad

Utilization (Structure and Properties)

Preparation of Indian standards with suitable classification of rattans according to properties and end-use will be useful for efficient utilization of rattan resources as an industrial material. Establishing an anatomical identification key to Indian rattans is a pre-requisite for the assurance of quality of rattans in the trade.

K.M. Bhat

Like bamboos, rattans possess good structural properties and amenable qualities which if properly utilised in cottage industries, can improve the rural economy on a sustained basis.

S.N. Sanyal

Anatomical structure of five commercial rattan species in Peninsular Malaysia were found to vary from species to species. Mechanical properties were well correlated with the physical and anatomical properties.

Abd. Latif Mohmod

Anatomical characters like shape of epidermal cells, width of hypodermis and cortex, and size of metaxylem vessels are helpful in species identification of rattans.

Luxmi Chauhan

In rattans, the composite action of cortex and central cylinder decides the compressive strength of the stem.

K.S. Jayagopal

Calamus metzianus, a breakable cane of little economic importance is found to possess the lowest lignin and highest silica content among the Kerala rattan species.

T.K. Dhamodaran

Utilization (Processing)

One major constraint in improving the technology for rattan harvesting and processing is the socio-economic condition of the region which does not permit mechanisation.

K. M. Bhat

Since mechanisation increases reliability and provides greater accuracy and accountability, manufacturers should consider the move for mechanisation in rattan industry. The selection of rattan for utilization relies on its characteristics and processing method. The disregard of these two major criteria often leads to inferior quality of final products.

Abd. Latif Mohmod

Often kerosene alone is sufficient as the cooking oil medium in rattan curing for better skin colour and appearance.

T.K. Dhamodaran

Moisture content and nutrient status of the post-harvest rattans and climatic conditions are the important factors which influence the development of fungal staining in rattans. In laboratory evaluation, fungicide such as carbendazim, sodium pentachlorophenoxide, sodium azide and copper sulphate were found to be effective against *Botryodiplodia theobromae*, the causal organism of fungal staining in rattans.

C. Mohanan

There is a need for further research on the diffusion treatment of full lengths of canes with varying treatment periods and concentrations of treating solutions. The major factors influencing treatability are void volume, gross features of control cylinder like periphery and centre, permeability and moisture control.

T. K. Dhamodaran

Experiments conducted in U.P., indicated that rattan can be easily treated by diffusion process involving minimum cost and equipment.

Satish Kumar

The best method for polishing cane furniture is the application of lacquer. Prior to polishing, hand sanding is to be done and after that sander sealer to be applied. After removing the sander sealer lacquer glossy is to be sprayed. This will give a royal look to the furniture.

Ashok Kumar

Socio-economics and Trade

Preliminary planting trials with seedlings of *Calamus thwaitesii, C. hookerianus, C. rotang* and *C. pseudotenuis* showed that under-planting of rattan in natural forests is a success. If proper care is given during the first two years, rattan plantations can be established without much disturbance to the existing vegetation.

P. K. Muraleedharan

It is estimated that the rattan cottage industry in Karnataka gets only around 20% of its effective demand for raw materials from the Karnataka Forest Department.

N. Narasimha

Sustained supply of rattans can be achieved by planned conservation, propagation and distribution systems. Genetically significant and economically viable species should be identified and conserved *in situ* and *ex situ*.

K. K. Lakshmanan

Kerala Forest Research Institute and State Forest Departments must help the training centers run by the Development Commissioner (Handicrafts) with technical knowhow and supply of canes.

H. B. Varadarajan

The future of rattan industry in Malaysia is bright provided sustained supply of the raw materials is secured by the protection of the resource base and modernization of its processing and manufacturing technology.

Abd. Latif Mohmod

In grading and determining the end-uses of rattans, not only the species but also the stem position is an important criterion.

K.M. Bhat

The cane industry in Varkala (Kerala) can be traced back to the olden days when devotees from different parts of the country used to bring flowers for offering in cane baskets to the famous Janardana Swamy Temple.

P. Ramesan

Valedictory function

Recommendations of the Rattan (cane) Seminar, India

The rattan (cane)seminar, India in its closing session made the following recommendations with regard to future course of action in terms of research and development.

1. A Rattan Information Centre be established in India to serve the South Asian countries such as India, Bangladesh, Nepal and Sri Lanka to carry out detailed studies on the ecological, environmental, edaphic, propagation and utilization aspects and exchange of information. To meet this purpose, a resource group be formed.

2. Forest Corporation of each rattan growing State in India be entrusted with the work of extraction and also develop machinery for harvesting, primary processing of rattans for supply to manufacturers for better productivity and utilization of rattans.

3. Standardization be developed for proper diversification and utilization of waste materials in the rattan manufacturing industries with reference to India.

4. Suitable organizations be identified to develop simple manuals for the utilization of machinery used in rattan industries.

5. An inventory of the rattans occurring in India be made by the BSI, KFRI, Universities and other institutions dealing with taxonomical research on rattans along with efforts for enrichment of national and other herbaria in the country, with new rattan collection for facilitating revisionary studies of Indian rattans.

6. Primary processing centers be established under the Small Scale Industries Directorate of different States who will draw up the technical knowhow that is developed by these research institutes who will also develop suitable machineries from time to time and make it available to the end users for better utilization.

7. Germplasm banks be established for future conservation strategies and

8. Study of existing resource potential of canes be initiated by survey in terms of quality and quantity in each state and an economic analysis be done and such survey be carried out by a standard method to be suggested by KFRI,which will also be the coordinating agency between the different States in India.

Papers presented in Rattan (cane) seminar by participants from Kerala Forest Research Institute

Balagopalan, M. and Sankar, S. Ecological conditions of rattan (cane) growing areas with special reference to soil properties.

Bhat, K.M. Rattans as an industrial material of the future.

Bhat, K.M. Changing scenario of rattan trade.

Bhat, K.M. and Dhamodaran, T.K. Rattan harvesting and processing technology: present and future.

Bhat, K.M. and Thulasidas, P.K. Why some canes are rejected in rattan trade?

Bhat, K.M. and Thulasidas, P.K. Anatomical identification key to south Indian rattans (canes)

Chandrasekhara, U.M. Forest canopy gaps and cane distribution in a humid tropical forest of Kerala, India.

Dhamodaran, T.K. Lignin and silica contents of some Kerala grown rattans.

Dhamodaran, T.K. and Bhat, K.M. Diffusion treatment of rattans.

Dhamodaran, T.K. and Bhat, K.M. Preservative treatment of rattans by vacuum-pressure process.

Dhamodaran, T.K. and Bhat, K.M. Kerosene curing of rattans.

Indira, E.P. Prospects of cane improvement for higher productivity.

Jayagopal, L.S., Ramasamy, J.V., Raghupathi, R., Dhamodaran, T.K. and Bhat, K.M. Behaviour of rattan (cane) specimens under compression.

Menon, A.R.R. Cane resource mapping using remote sensing data.

Mohanan, C. Diseases of rattans in Kerala, India and their possible control.

Mohanan, C. Biodeterioration of post-harvest rattans: present status and future prospects.

Mohanan, C. Protective measures against fungal staining in rattans.

Muraleedharan, P.K. and Seethalakshmi, K.K. Rattan plantation and its profitability - an appraisal.

Muralidharan, E.M. Prospects for tissue culture of rattans in India.

Nandakumar, U.N. and Menon, A.R.R. Resource survey of rattans - problems and prospects.

Renuka, C. Taxonomy of South Indian rattans.

Renuka, C. Rattans-their diversity in habit and habitat.

Seethalakshmi, K.K. Propagation of clustering canes using suckers.

Recent publications

Scientific papers

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Sharma, J.K. and *Sankaran, K.V.* 1991. **Epidemiological studies on *Rhizoctonia* web blight of *Albizia falcataria***. Indian Phytopathology, 44: 201-205.

Research reports

Maria Florence, E.J. 1991. **Sapstain fungi of some commercially important timbers and their chemical control**. KFRI Research Report No. 80. Final Report of Project Pathol F04/86. Division of Pathology.

Abstract: Sapstain caused by fungi results in considerable qualitative loss of wood products. Due to favourable environmental conditions such as high rainfall and humidity, sapstain is a serious problem in Kerala. A preliminary survey conducted in various wood based industries in different districts of Kerala State revealed that sapstain and mould growth were caused by a number of fungi. Eight commercially important timber species were selected for the study and *Botryodiplodia theobromae* was found to be the dominant fungus causing sapstain on all the timbers through out the year. Studies revealed that in rubber wood infected by *B. theobromae* there was a weight loss of 8.0% in the first month which increased to 12.2% by the end of fourth month. In *Ailanthus triphysa* the weight loss increased from 4.3% in the first month to 10.1% in the fourth month. But in *Alstonia scholaris* only 4% weight loss was recorded by the end of the fourth month.

The results clearly showed that rubber wood was easily susceptible to sapstain by *B. theob-romae*. Effect of wood moisture content and microclimatic

factors on growth of *B. theobromae* was studied and it was found that the growth of the fungus was influenced by high relative humidity (90 and 100%). When the moisture content of timber was reduced to < 24%, the fungal growth on timber was very much restricted. Among the various fungicides/chemicals tested, sodium azide proved to be the best to control both sapstain and mould fungi in the laboratory. The chemical was effective even at lower concentrations viz. 250 and 500 ppm. A bacterium viz. *Bacillus subtilis*, isolated from rubber wood, showed antagonism against several stain and mould fungi. The efficacy of this isolate was tested in laboratory and proved to be effective in controlling the growth of several stain fungi. In field tests also, the bacterium was effective in preventing the fungal growth on rubber wood up to 80%.

Jayaraman, K and Rajan, A.R. 1991. **Yield from *Acacia auriculiformis* plantations in Kerala.** KFRI Research Report No. 81. Final Report of Project KFRI 133/90. Division of Statistics.

Abstract: The growing stock of *Acacia auriculiformis* plantations raised under the Social Forestry Scheme in Kerala till the year 1986 has been estimated through a stratified two- stage sampling procedure. The first-stage units were plantations whereas rectangular plots formed the second-stage units. Strata were formed based on age (4 to 8 years), species planted (pure and mixture plantations of *Acacia auriculiformis)* and type of plantation (block, strip and avenue). About 10 percent of the existing plantations were covered with proportional allocation of the sampling units among the strata.

Commercial volume (wood > 10cm girth over bark) of plantations above 4 years of age was estimated to be 0.284 million m^3. Fresh weight of the commercial volume worked out to be 0.296 million t. Air-dry weight of the material which will come to nearly 60 percent of this amount works out to 0.178 million t. Age-class distribution of the growing stock was found uneven.

Provisional volume table and variable density yield table have been prepared for the species. The mean annual volume increment has been found to be maximum at 7 years for all site quality levels within the range of data suggesting a 7 year rotation of maximum volume production. Diameter-height relationship at the tree level has also been established. Stacked wood of 2 m^3 has been found to have a fresh weight of 1.2663 t and an air-dry weight of 0.7598 t after 120 days.

Regional differences in productivity could not be detected due to large within region variation. However, Central Region including Ernakulam, Trichur and Palghat Districts has relatively lesser stocking in terms of volume per unit area.

KFRI Information bulletins

Quality improvement of cane (rattan) products (In English and Malayalam). KFRI Information Bulletin 11. Division of Wood Science, January 1992.

Storage of bamboo seeds. KFRI Information Bulletin 12 (BIC Series 2), March 1992.

Copies of the information bulletins are available free of cost on request.

Timber training course organised

The Division of Wood Science organised a Timber Training Course in collaboration with the National Building Organisation, New Delhi during 7-12 October 1991 at the Institute. Practising Civil Engineers from various State/Central Government organisations participated. Dr. R. Gnanaharan, Dr. K. M. Bhat, Dr. K.V. Bhat, Mr. T.K. Dhamodaran (Wood Science), Dr. G. Mathew (Entomology), Mr. M. Balasundaran and Mrs.E.J.M. Florence (Pathology) gave lectures on various aspects of timber.

New research projects

KFRI 137/ '91

Studies on the existing flora and specialised ecological niche of the Malayattoor Forest Division, Kerala.

Project leader : Director, KFRI

Investigators: K.K.N. Nair, M.S. Muktesh Kumar, K.V. Sankaran, E.J.M. Florence, P.V.K. Nair, E.A. Jayson, George Mathew, A.R.R. Menon and M. Balagopalan.

Objectives: 1) Collection of plant specimens from the study area 2) Establishment of a herbarium of demonstrative value in the study centre 3) Preparation of a checklist of the flora 4) Detailed studies on the floristic composition and ecological associations in the specialised ecological niche, if any 5) To gather information on the macrofungal flora and to prepare a checklist of plant diseases. 6) Recording the status of arboreal animals, herbivores, carnivores, birds and other animals 7) To gather information on the insect fauna 8) To prepare a grid mapping covering different vegetation and 9) Preparation of a general soil map of the area.

Sponsored by Social Forestry Wing of Kerala Forest Department.

KFRI 138/ '91

Agroforestry models in Kerala.

Investigator: S. Sankar (Soil Science)

Objectives: 1) To identify the existing agroforestry systems 2) To understand the structure and functioning of the systems and 3) To prepare models.

Sponsored by Social Forestry Wing of Kerala Forest Department.

KFRI 139/ '91

Evaluation of Social Forestry plantations raised under the World Bank scheme in Kerala.

Investigators: K. Jayaraman (Statistics), P.K. Muraleedharan (Economics) and R. Gnanaharan (Wood Science).

Objectives: 1) Assessment of survival and productivity of the plantations 2) Socio-economic evaluation of the planting programme 3) Generating information on the utilization aspects.

Sponsored by the Social Forestry Wing of Kerala Forest Department.

KFRI 140/ '92

Management of the teak defoliator (*Hyblaea puera*) using nuclear polyhedrosis virus (NPV).

Investigators: K. S. S. Nair, R. V. Varma, V. V. Sudheendrakumar, M.I. Mohamed Ali and K. Mohanadas (KFRI), S.P. Singh and K. Narayanan (National centre for IPM, Bangalore)

Objectives: Evaluation of NPV for management of teak defoliator including 1) Characterisation of the *Hyblaea* NPV, 2) Study of epizootiology 3) Evaluation of NPV safety to non-target organisms 4) Pilot-scale field testing and 5) Integration of NPV use with other pest management techniques.

Sponsored by the Department of Biotechnology, Ministry of Science and Technology, Government of India.

KFRI 141/'92

Evaluation of Forest schemes under Western Ghat Development Programme.

Investigators: R. C. Pandalai (Silviculture), S. Sankar (Soil Science) and P. K. Muraleedharan (Economics).

Objectives: 1) How far the forestry programmes implemented so far under the WGDP have been effective in augmenting the forest resources 2)How far the ongoing/completed programmes implemented by the Forest Department under WGDP satisfy the objectives of ecorestoration and ecodevelopment and if not how the existing programmes have to be re-oriented to fulfill these objectives.

Sponsored by the Planning and Economic Affairs Department, Government of Kerala.

KFRI 142/ '92

Use of alternative materials as containers for raising seedlings.

Investigator: U.N. Nandakumar (Silviculture)

Objectives: 1) To identify various materials that could be used as containers for raising planting stock in nurseries 2) To study in depth the advantages and disadvantages of these materials and 3) To design containers of optimal size to meet varying requirements-species, site and duration.

Sponsored by Forest and Wildlife Department, Government of Kerala.

KFRI 143/ '92

Enhancement of productivity in *Eucalyptus grandis* through fertilizer inputs and other cost effective treatments.

Project leader: S. Chand Basha (Director)

Investigators: M. Balagopalan (Soil Science) and P. Rugmini (Statistics)

Objectives: 1) To study the effect of different planting techniques and fertilisers on the growth and biomass of *E. grandis* in different years 2) To evaluate the nutrient uptake and partitioning in different parts of the plant by destructive sampling and 3) To assay the fate of fertilisers in the soil.

Sponsored by Forest and Wildlife Department, Government of Kerala.

KFRI 144/ '92

Studies on the growth performance of teak nursery stock from genetically better sources for developing improved plantation technology.

Project leader: S. Chand Basha

Investigators: E.P. Indira (Genetics), K.C. Chacko (Silviculture) and C.N. Krishnankutty (Statistics).

Objectives: 1) To study the growth performance of nursery stock using genetically better seed sources 2) To study the effect of grading on seedling growth and 3) To develop appropriate improved plantation technology.

Sponsored by Forest and Wildlife Department, Government of Kerala.

KFRI 145/ '92

Ecological studies in disturbed forest ecosystem with special reference to Moist Deciduous Forests (Collaborative project with French Institute, Pondicherry).

Co-ordinator: S. Chand Basha

Investigators: S. Sankar (Soil Science) Mr. Obein (French Institute, Pondicherry).

Objectives: 1) To determine the typology of moist deciduous forests 2) To determine what is a degraded forest 3) To understand the reasons for degradation 4) To investigate into the structure, floristics and ecosystem functioning of degraded forests and 5) To identify the factors that can contribute to ecosystem recovery processes and evolve a management plan for degraded moist deciduous forests.

KFRI 146/ '92

Macrofungal flora of Peechi-Vazhani Wildlife Sanctuary

Investigator: J.K. Sharma (Pathology)

Objectives: 1) To prepare a substratum-wise checklist of saprophytic and parasitic macrofungi occurring in the sanctuary 2) To identify edible fungi for commercial exploitation and 3) To prepare herbarium/museum specimens for display in the Peechi- Vazhani Wildlife Information Centre and Divisional museum.

KFRI 147/ '92

Structural dynamics of teak stands in Kerala.

Investigator: K. Jayaraman (Statistics)

Objectives: 1)To obtain information on the age, structure, stocking and productivity of teak plantations in Kerala 2) To develop models for prediction of yield under varying age classes, stocking and site quality levels and 3) To work out the consequences of the present structure of teak plantations on future out-turn using the yield models to be developed.

Sponsored by Forest and Wildlife Department, Government of Kerala.

Participation in seminars, symposia and workshops

Smt. E. J .M. Florence (Pathology) participated in the zonal meeting of the Indian Phytopathological Society held at the Centre for Advanced Studies in Botany, University of Madras on 9 October 1991. She presented a paper entitled "Laboratory evaluation of sodium azide against sapstain and mould fungi affecting rubberwood".

Dr. M.S. Mukteshkumar (Botany) participated in a National Seminar on 'Biology, Improvement, Propagation and Commercialization of Indian Orchids' held at Bangalore during 15- 16 November 1991. He presented a paper entitled "Studies on the orchid anatomy with special reference to floral morphology".

Dr. K. Swarupanandan (Ecology) and *Dr. Jose Kallarackal* (Plant Physiology) attended the DOEN project monitoring workshop held at TBGRI, Trivandrum during 15-16 November 1991.

Mr. M. Balasundaran, Smt. E.J.M. Florence and *Mr. C. Mohanan* (Pathology) participated in the International Workshop on Biodeterioration, Culture Collections and Aspects of Applied Mycology organised by the Department of Applied Botany, University of Mysore, Manasagangotri, Mysore, during 18-29 Novemebr, 1991. Mr. Mohanan presented a paper entitled "Biodeterioration of rattans in India".

Dr. E.M. Muralidharan (Genetics) participated in the IUFRO workshop on 'Trends in the Biotechnology of Woody Plants' held at Dehra Dun during 25-29 November 1991 and presented a poster entitled "Somatic embryogenesis in *Acacia nilotica*".

Dr. S. Chand Basha (Director) *Dr. R. Gnanaharan* (Wood Science) *Dr. P. Vijayakumaran Nair* (Wildlife), *Dr. A.R.R. Menon* (Ecology) and *Mr. K. Sankara Pillai* (Library) attended the "Fourth International Bamboo Workshop" held at Chiangmai, Thailand during 27-30 November 1991. The following papers were presented.

1. *Ochlandra* (bamboo reed)- a vanishing asset of forests in Kerala, South India (*S. Chand Basha*).
2. Physical and strength properties of *Dendrocalamus strictus* grown in Kerala, India (*R. Gnanaharan*).
3. Field evaluation of preservative treated bamboo (*R. Gnanaharan*).
4. G.I.S. on bamboo distribution in Kerala (*P. Vijayakumaran Nair*).
5. Remote sensing application in bamboo resource evaluation - a case study in Kerala (*A.R.R. Menon*).
6. Information for bamboo research: Activities of the Bamboo Information Centre, India (*K. Sankara Pillai*).

Dr. S. Chand Basha (Director), Dr. K.S.S. Nair, Dr. R.V. Varma, Dr. George Mathew (Entomology) *Dr. J.K. Sharma, Mr. C. Mohanan, Smt. E.J. Maria Florence, Mr. M. Balasundaran, Dr. K.V. Sankaran, Mr. M.I. Mohamed Ali* (Plant Pathology), *Smt. E.P. Indira* (Genetics), *Dr. Jose Kallarackal* (Plant Physiology), *Dr. K.M. Bhat* (Wood Science), *Dr. S. Sankar* and *Dr. M. Balagopalan* (Soil Science) attended the International Symposium on Teak organised by the Kerala Forest Department at Trivandrum during 2-4 December 1991. The following papers were presented.

1. The future of teak in Kerala (*S. Chand Basha and S. Sankar*).
2. Control of teak defoliator -past attempts and the new promise (*K. S. S. Nair, V. V. Sudheendrakumar, K. Mohanadas and R.V. Varma*).
3. Distribution, infestation, progression rate and host range of the teak carpenter worm *Alcterogystia cadambae* (Moore) (Lepidoptera: Cossidae) in Kerala, India. (*George Mathew*).
4. White grub damage and its control in teak nurseries (*R.V. Varma*).
5. Seed microflora of *Tectona grandis* and their effect on seed germination and seedling growth (*J.K. Sharma and C. Mohanan*).

6. Nursery diseases of teak in India (*C. Mohanan, J.K. Sharma and E.J. Maria Florence*).
7. Current status of diseases in teak plantations in India and future research needs (*J. K. Sharma, E.J.M. Florence and C. Mohanan*).
8. Mistletoe problem of teak and its control measures (*M. Balasundaran and M.I. Mohamed Ali*).
9. Effect of mistletoe attack on teak wood (*R. Gnanaharan and M. Balasundaran*).
10. Timber defects of plantation grown teak and their implication on Wood quality (*M. Balasundaran and R. Gnanaharan*).
11. Decomposition of teak leaf litter (*K.V. Sankaran*).
12. Possible use of microbial pathogens against teak pests (*M. I. Mohamed Ali and V. V. Sudheendrakumar*).
13. Genetic improvement of teak in Kerala-present status and future strategy (*E. P. Indira*).
14. Water blister problem of teak in Kerala (*Jose Kallarackal, K. V. Bhat and K. K. Seethalakshmi*).
15. Managing teak plantations for super quality timber (*K.M. Bhat*).
16. Effect of tree species on soil properties along a transect through teak, eucalypt and rubber in Kerala, (*M. Balagopalan and A.I. Jose*).

Dr. Jose Kallarackal and Mr. C.K. Somen (Physio-logy) participated in the 'National Symposium on Recent Advances in Drought Research' held at the Rubber Research Institute of India, Kottayam during 10-13 December 1991 and presented a paper entitled "Microclimate and transpiration in relation to growth in eucalypts". Mr. Somen also attended the orientation programme associated with the symposium.

Mr. N. Sasidharan (Botany) attended the National Seminar on 'Angiosperm Taxonomy in India and the 30th anniversary of van Rheede' held at the University of Calicut during 13-15 December 1991 and presented a paper entitled "Field identification of forest trees".

Dr. R.V. Varma (Entomology) participated in the workshop on 'Biotechnological Approaches in Biological Control of Insects' held at Entomology Research Institute, Madras during 20-27 January 1992.

Dr. K.M. Bhat (Wood Science) attended the 'Brain Storming Session on Tree Biology' held at Shillong during 18-20 February 1992 and presented a project proposal on "Effect of air pollution on structure and quality of wood".

Mr. U.N. Nandakumar (Silviculture) attended the 'International Space Year Conference on Remote Sensing and GIS' held at the Jawaharlal Nehru Technological University, Hyderabad during 24-28 February 1992 and presented a paper entitled "Application of remote sensing in rattan resource survey - a case study from Kerala" (*U. N. Nandakumar and A.R.R. Menon*).

Dr. P.K. Muraleedharan (Economics) participated in the Fourth Kerala Science Congress held at Thrissur during 27-29 February 1992 and presented a paper entitled "Sustainability of traditional agriculture: a study of short fallow shifting cultivation in Attappady". (*P. K. Muraleedharan and S. Sankar*).

Training programme

Mr. M.I. Mohamed Ali (Pathology) attended a training programme on 'Molecular Biology of Plant Viruses' held at Department of Virology, S.V. University, Tirupathi from 3-30 January 1992.

Guest lecture

Dr. K.K. Seethalakshmi (Physiology) gave a lecture on "Seed storage and seed pretreatments for breaking dormancy" in the 'Training on Seed Technology to Range Officers' held at Trivandrum on 20 February 1992.

Study visits and meetings

Dr. R. Gnanaharan visited different bamboo furniture manufacturing sites in Malaysia, Indonesia and Philippines during 1-13 December 1991.

Dr. Gnanaharan attended a technical subcommittee meeting convened by the Central Pollution Control Board, Delhi on 13 February 1992, for preparation of draft criteria for labelling wood substitute as 'Environment friendly products'.

Forthcoming events

20 -24 July 1992

First World Congress on Medicinal and Aromatic Plants for Human Welfare, Maastricht, The Netherlands.

Contact: IUBS, 51 Boulevard de Montmorency, F 75016, Paris, France.

2-8 August 1992

Global Climate Change and the Tropical Rain Forests, Ibadan, Nigeria.

Contact: Dr. M. Ellatifi, Forest Service, P.O. Box 12507, Casablanca 01, Morocco.

23-28 August 1992

Better Products Through Wood Science, Nancy, France

Contact: Secretary, IUFRO Div. 5, Nancy 1992, Bureau de la Conference, ENGREF, 14, rue Girardet, F-54042, Nancy, Cedex, France.

24-28 August 1992

Conference on Tropical Trees: Potential for Domestication, Edinburgh, Scotland, U.K.

Contact: The Institute of Terrestrial Ecology, Bush Estate, Penicuik, Midlothian EH26 0QB, Scotland, U.K.

31 August-6 September 1992

IUFRO Centennial Meeting, Berlin, Germany.

Contact: Organising Committee (IUFRO), Alfred-Moller-Strasse, D- 0-1300, Eberswalde-Finow, Germany.

2-7 September 1992

International Symposium on Rehabilitation of Tropical Rainforest Ecosystems: Research and Development Priorities, Sarawak, Malaysia.

Contact: The Secretariat, Symposium on Rehabilitation of TRF Ecosystems, Centre of Applied Sciences, UPM Bintulu Campus, P.O. Box 396, 97008 Bintulu, Sarawak, Malaysia.

14-18 September 1992

Stand Inventory Technologies, Oregon, USA.

Contact: Gyde Lund, USDA Forest Service, P.O. Box 96090, Washington DC 20090-6090, USA.

14-18 September 1992

Mass Production Technology for Genetically Improved Forest Tree Species, Bordeaux, France.

Contact: Ms. Marylise Leroy, Symposium Secretariat, AFOCEL, 164 Boulevard Haussmann, F 75008, Paris, France.

28 September - 2 October 1992

International Symposium on Management of Mycorrhizas in Agriculture, Horticulture and Forestry, Perth, Australia.

Contact: Inez Tommerup, CSIRO, Division of Forestry, Private Bag, P.O. Wembley, Western Australia, Australia.

11-13 November 1992

Third International Bamboo Congress, Kumamoto, Japan.

Contact: The Office of the International Bamboo Congress, C/o. Minamata Promotion Office, Planning and Development Dept., 6-18-1 Suizenji Kumamoto City, Kumamoto Perfecture, Japan 862.

23-27 November 1992

IUFRO Symposium on Tree Seeds, Ouagadougou, Burkina Faso.

Contact: Director, du centre National de Semences Forrestieres, 01BP 2682, Ougadougou 01, Burkina Faso.

6-9 December 1992

International Conference on Current Progress in Medicinal and Aromatic Plants Research, Calcutta, India.

Contact: Dr. Santwana Mukherjee, Secretary General, 131/A SP Mukherjee Road, Calcutta 700 026, India.

7-11 December 1992

International Symposium on Industrial Use of Bamboo, Beijing, China.

Contact: Prof. Zhu Shilin, Bamboo Information Centre, Chinese Academy of Forestry, Wan Shou Shan 100 091, Beijing, China.

Campus news

Young scientist award

Dr. U.M. Chandrasekhara, Post-doctoral Fellow, Division of Silviculture won the Young Scientist Award (1991) of the State Committee on Science, Technology and Environment, Government of Kerala for the best paper presented on the theme 'Ecology and Environment' at the Fourth Kerala Science Congress held at Thrissur during 27-29 February 1992.

Nominated

Dr. P.S. Easa (Wildlife Biology) has been nominated as a member of the Asian Elephant Specialist Group of IUCN Species Survival Commission.

Ph. D awarded

Mr. M. Balagopalan (Division of Soil Science) was awarded Ph.D. degree in Chemistry by the University of Calicut for his thesis entitled 'Studies on soil organic matter'.

Exhibition

The Division of Agroforestry and Publicity took part in the Science Exhibition organised by Kerala Sastra Sahitya Parishad at Kodungalloor in January 1992.

Book released

A book entitled 'Bee keeping and Social Forestry' (Malayalam)authored by *Mr. P. Padmanabhan* (Division of Entomology) and published by the Kerala Language Institute was released by Shri. T.M. Jacob, Hon. Minister for Irrigation, Government of Kerala in Ernakulam on 7 March 1992.

Fourth Kerala Science Congress

The Institute extended active support to the State Committee on Science, Technology and Environment, Government of Kerala in organising the Fourth Kerala Science Congress at Thrissur during 27-29 February 1992.

KFRI Seminars

5 October 1991
Plant tissue culture

Dr. E.M. Muraleedharan, Division of Genetics, Kerala Forest Research Institute.

30 October 1991
Forest ecology

Prof. I.S. Zonneveldli, University of Wageningen, The Netherlands.

14 November 1991
Butterflies of Western Ghat region

Dr. Harish Gaonkar, University of Copenhagen, Denmark.

30 December 1991
Animal migrations

Prof. J.C. George, University of Guelph, Canada.

27 January 1992
Natural resources economics

Dr. Fred Hithzhusen, Ohio State University, USA.

1 February 1992
Impact of industrial pollution on the ecosystem

Dr. G. Oblisami, Tamil Nadu Agricultural University, Coimbatore.

19 February 1992
Canadian forests, wildlife and effect of pesticide application on the ecosystem.

Prof. James Bendell, University of Toronto, Canada.

Distinguished visitors

Shri. B. Rachaiah
Hon. Governor of Kerala
12 October 1991

Prof. I.S. Zonneveldli
University of Wageningen, The Netherlands.
30 October 1991

Dr. Harish Gaonkar
University of Copenhagen, Denmark
14 November 1991

Mr. Norman Jones
World Bank, Washington
7 December 1991

Prof. Savithri Lakshmanan
Member of Parliament
27 December 1991

Prof. J.C. George
University of Guelph, Canada
30 December 1991

Prof. C.G. Ramachandran Nair
Chairman, State Committee on Science, Technology and Environment, Government of Kerala.
9 January 1992

Dr. Fred Hithzhusen
Professor, Department of Agricultural Economics and Rural Sociology, Ohio State University, USA.
27 January 1992

Mr. Van Levieren
World Bank, Washington
5 February 1992

Mr. T. Madhava Menon
International School of Dravidian Linguistics, St. Xavier's College, Thiruvananthapuram.
17 February 1992

Prof. James Bendell
University of Toronto, Canada
19 February 1992

KFRI Publications

ECODEVELOPMENT OF WESTERN GHATS

Proceedings of the National Seminar on Ecodevelopment of Western Ghats held at Peechi, India, 17-18 October, 1984. (Eds.) K.S.S. Nair, R. Gnanaharan and S. Kedharnath. 315 p. ISBN 81-85041-03-2. Price Rs. 200 (India) US$ 18 (other countries).

Explains the concept of ecodevelopment and contains 62 papers covering overview of developmental activities and programmes in the Western Ghat Region by planners and Government officials, and scientific papers on flora and fauna, forestry and agriculture, landuse, water and energy, impact of development on environment, and future options and the proceedings of the plenary session including recommendations.

TROPICAL FOREST ECOSYSTEM CONSERVATION AND DEVELOPMENT IN SOUTH AND SOUTH-EAST ASIA

Proceedings of the MAB Regional Training Workshop held at Peechi, India, 1-13 May 1989. (Eds.) K.K.N. Nair, K.V. Bhat, J.K. Sharma and K. Swarupanandan. 297 p. ISBN 81-85041-05-9. Price Rs. 200 (India) US$ 18 (other countries).

A comprehensive publication comprising 55 papers including lectures by experts and case study presentations by trainee participants on conservation and development of tropical forest ecosystems in South and Southeast Asia.

For copies contact:

The Librarian, Kerala Forest Research Institute, Peechi- 680 653, Thrissur, Kerala, India