Evergreen

Half yearly Newsletter of The KeralaForest Research Institute, Peechi
(An Institution of Kerala State Council for Science, Technology & Environment)

From Director's desk

During the past three decades, KFRI has made significant contributions to tropical forestry research that has made the Institute well known globally. The vision of KFRI is to achieve excellence in forestry research and to use that competence to study and provide information for better management of our forests and for updating our policies to suit the changing local needs and global challenges. The mission of the Institute is to provide research support for the sustainable management of forests and environment, with particular emphasis on conservation of biodiversity, water and soil resources of the State. The research and extension projects undertaken by the Institute have not only been of local relevance but also of national and global significance.

The integration of KFRI with other R&D Institutions of the State under the common umbrella of Kerala State Council of Science, Technology and Environment headed by the Chief Minister in 1993 was a turning point in terms of opportunities for inter-institutional research collaboration as well as access to adequate funds for specific research programmes. The Institute has identified certain priorities of research themes that it wishes to undertake during the next couple of decades. Essentially, these priority areas are identified after examining their relevance to society, our State and also the global environment.

One such important area identified is Biodiversity documentation, conservation and utilisation. The concept has been based on the recognition of the value of different biotic components to sustain human life on earth and that all natural systems are to be viewed in their more complete perspective for their effective conservation. The Institute has already initiated a few projects on documentation of biodiversity in different Panchayaths. Conservation of rare, endangered and threatened plant and animal species is another aspect of research at KFRI. The Institute has also initiated programmes to establish arboreta and live collections of rare and endemic plants including medicinal plants, palms, orchids, bamboos and canes. Research into vegetative propagation and micropropagation of forestry species has yet been another major activity of KFRI in the past decade.

Dr. K.V. Sankaran takes charge as Director

Dr. Sankaran did his M.Sc. (1975) and Ph. D (1983) in Botany at the Department of Botany, University of Calicut. He was awarded the prestigious Darwin Fellowship in Biosystematics by the UK Department of Environment in 1994 to do post-doctoral research in Mycology at the International Mycological Institute, UK. He was also a Visiting Scientist at the CSIRO Forestry and Forest Products Perth, West Australia (1996). Dr. Sankaran was project leader of several major international collaborative research programmes on different aspects of forestry. The KFRI – CSIRO (Australia) Project on 'Improving and maintaining productivity of eucalypt plantations in India and Australia' is a notable example. He is currently the project leader of 3 Indo-British collaborative research programmes.

Dr. Sankaran has authored over 75 research papers in National and International journals/proceedings. He is currently the Co-ordinator of FAO's Asia-Pacific Forest Invasive Species Network (APFSN) - a cooperative alliance of 33 member countries in the Asia-Pacific region.

KFRI looks forward to a dynamic and fruitful period under the leadership of Dr. Sankaran.

A Bio-Resources Nature Park established at the Institute's Sub-centre at Nilambur is already popular with visitors. The Institute has plans to establish several arboreta in different parts of Western Ghats as inter-institutional ventures.

To make research socially relevant, KFRI has initiated several programmes relating to human dimensions of forestry. Women's empowerment through employment generation in forestry sector, nursery raising, supply of seedlings, composting, cultivation of medicinal plants etc. are some of the activities initiated. Establishment of a model watershed and its maintenance, encouraging cluster development of bamboo artisans, establishing community-level charcoal kilns, offering training programmes suitable for the rural population, etc are activities already undertaken. People's participation in pollution abatement is also in the Institute's purview. Similarly, identification and analysis of stakeholders' aspirations from forestry are also envisaged for future study.

KFRI has also started some work on global climate change, its assessment and mitigation measures. More detailed investigations are planned subject to availability of funds and infrastructural facilities.

Besides the research themes mentioned above, the Institute is continuing research activities and training programmes to involve more groups of stakeholders in its programmes and creating awareness among the public. Raising of bio-shields for coastal zone protection as a part of Tsunami Rehabilitation Programme of the Government can be cited as an example of participatory approaches to environmental challenges. The Institute also plans to continue such activities in the future for socially and economically deprived population of the State.

Outbreak Of Pink Disease In Young Teak Plantations

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Fig. 1. Pink disease affected teak plants

Recently, severe incidence of pink disease (stem canker and girdling) in young (1 to 2-year-old) teak plantations raised in high humid tracts of Kerala was noticed. Outbreak of the disease occurred immediately after the south west monsoon (July-August) and plantations raised with both root trainer-grown seedlings as well as conventional stumps were found affected by the disease. The disease occurred in small patches affecting 3 to 5 plants and spread at a very fast rate causing multiple infection (main stem and branch cankers) in a large number of nearby plants; the disease incidence ranged from three to sixty per cent in different teak plantations in the State. Incidence of the disease as well as its severity was noticed more in plantation sites where there was heavy weed growth coupled with high precipitation and relative humidity.

Pink disease is caused by a fungus viz., *Corticium salmonicolor*. The pathogen causes canker on the main stem as well as branches. The cankered areas become depressed with pronounced discoloration of tissues beneath the bark. The initial symptom of the disease is as small 'screw cap" type vertical splits on the bark, which later enlarges into large vertical splits along the diseased areas. Formation of callus tissue around the infected areas takes place as a result of host defence mechanism. Partial to complete girdling of the bark around the cankered area occurs depending on the disease severity. Yellowing and browning of the foliage and gradual die-back of shoot above the cankered area occur. A large number of epicormic shoots usually develop from the area just below the canker. Quick spread of multiple cankers on the main shoot under conducive environment often leads to death of the affected plant. Association of an insect (caterpillar) belonging to Pyralidae was also noticed in wound callus tissues of diseased plants. The insect, though a scavenger type, makes galleries inside the fleshy callus tissues and produces 'frass' (excreta of the insect + wood particles webbed together), and also causes discoloration of the bark and stem tissues.

The causal fungus, *C. salmonicolor* produces its four stages: cobweb, pustule, pink encrustation (basidial stage) and necator (conidial stage) on the cankered area. The pathogen has a wide host range (> 400 host spp.) and affects forest plantation species including eucalypts, acacias, casuarinas, etc. Even though, teak has earlier been reported as a host of pink disease pathogen, the recent outbreak of disease in young plantations has caused great concern.

Management of the disease: Application of Bordeaux paste (10%) is effective in controlling pink canker disease. However, in severely cankered stem, as the Bordeaux paste (contact fungicide) may not reach the crevices of longitudinally split bark, application of systemic fungicide like Calixin (tridemorph 0.1% a.i. with Delaware wet (wetting and spreading agent) is recommended. Since, the insect association was noticed in many affected plants, application of the insecticide Ekalux @ 0.1% along with the fungicide is also recommended.

SOFTWARE FOR INVENTORY ANALYSIS OF NON-TIMBER FOREST PRODUCTS: Invent NTFP 1.0

Forests provide a variety of Non-Timber Forest Products (NTFPs) or Non-Wood Forest Products (NWFPs) besides timber, small wood and firewood. The NTFP species occur in different life forms like herbs, shrubs, climbers and trees. The useful products exploited from these species include bark, exudates, flowers, fruits, seeds, leaves, roots etc. The products are used as food, for manufacturing medicine, toiletries, cosmetics, varnish etc. The NTFP inventory in forests is a sample based survey with an intention to quantify the resource abundance and to identify the rare, endangered and vulnerable species and also to determine the threshold levels for sustainable exploitations at various spatial scales. Some of the problems associated with the inventory of NTFP resources are rarity, clumped distribution and seasonality of the species, high cost, large forest areas and difficult terrain. Due to such complexities, there has not been any formalized methodology available for the inventory of NTFPs. The methodological issues have been discussed by Sivaram et al (2006).

The quantitative analysis of the NTFP inventory involves a number of complex computations. Therefore, software is required to make the computational task easy and get the results quickly. In this regard, the software called 'Invent NTFP' has been developed with the objective to carry out quantitative analysis of data obtained in an inventory of NTFPs in forests conducted by laying fixed area plots like rectangular, square and circular plots. Although the software was originally conceived for the analysis of NTFP inventory, it is found useful in other areas involving fixed area plot based surveys for working out various density and diversity measures. Such application domain include inventory of selected floral and faunal groups (Fig.1.).

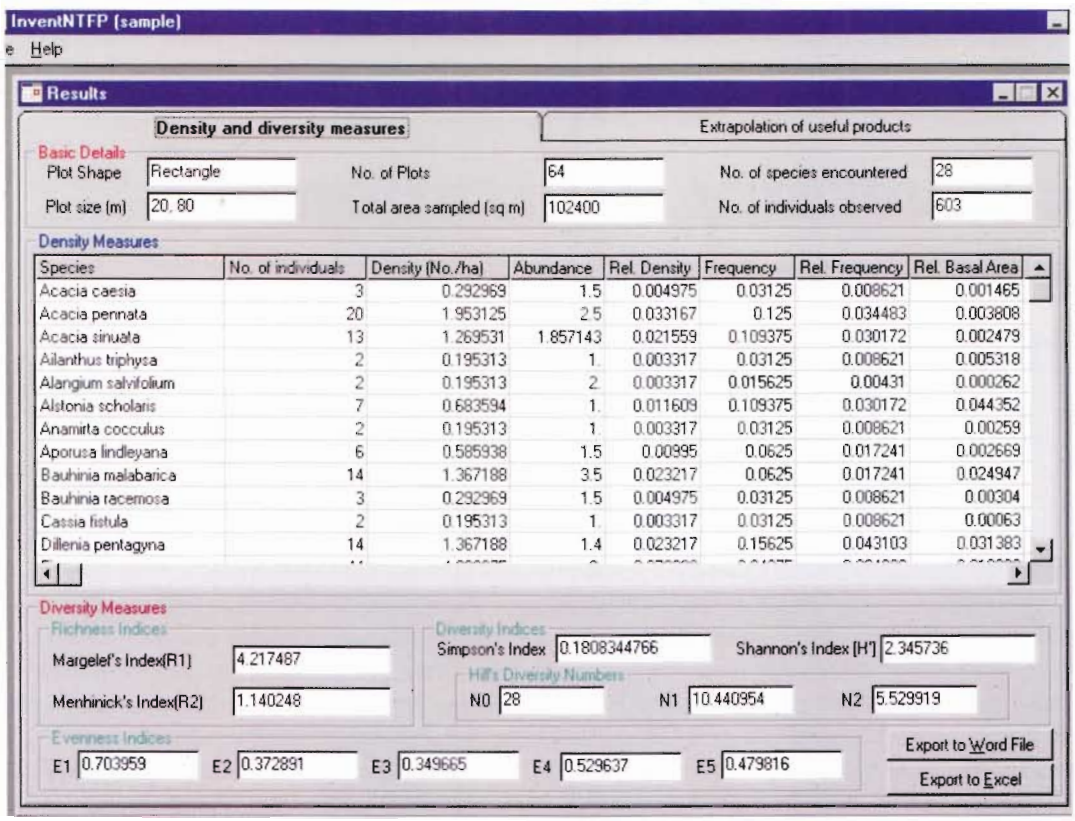

Fig 1. One of the output windows of Invent NTFP 1.0 showing the results of abundance and diversity indices

The software functionally has two major parts. First part is related to the input data obtained by laying down fixed area sample plots in inventory survey. The required input data include plot shape, plot size, number of sample plots, number of individuals of each species and girth at breast height level and height of the individuals as applicable. Using these data, the software quickly produces density and diversity measures, viz., density, abundance, relative density, frequency, relative frequency, importance value index (IVI), Marglef's index, Menhinick's index, Simpson's index Shannon's index, Hill's diversity measures and evenness indices. Second part requires input data from yield studies (or quantification of useful products) such as average weight of the useful part, prediction equation relating the weight of the useful part of the plant with its size measurements (diameter and height) obtained through detailed measurements made on sub-sample of individuals. With this input data, available quantity of range of useful products such as roots, flowers, bark and leaves from different species are extrapolated. It may be noted that the estimates from yield studies (input for second part) have to be worked out outside this software that is, using other statistical software. Instead of using the data entry facility available in the software, user may copy the data from Excel file, provided they are in required format of Invent NTFP. The results of the analysis can also be exported to Microsoft Word/Excel.

Invent NTFP is easy to install. The system requirement is Microsoft Windows 98 or above and 3 MB disk space. The software is best viewed under the screen area 800 by 600 pixels. The software has a help file in Acrobat describing the inventory methodology and the guidance to use the software. The details of the software are also presented in Sivaram et al. (2006) and Sasidharan et al. (2008). This software has been found to be of use by a number of researchers in KFRI particularly for obtaining density and diversity measures. Those who are interested in getting a copy of the software please write to The Director, Kerala Forest Research Institute, Peechi - 680 653, Kerala, India email: director@kfri.org.

Acknowledgements

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Plant Diversity Utilization in Homegardens of Kerala: A changing scenario

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In Kerala, the homestead farming is the most prevalent type of land use system covering about 88% of the total landholding and about 41% of the total cultivable area of the State (KSLUB, 1995). Despite the fact that these homegardens are playing negligible role in conserving wild species diversity outside the protected areas, they are the glorious examples of species diversity in cultivated and managed plant communities and are representing a `genetic backstop', preserving species and varieties that are not economic in field production. For instance, inventorying of randomly selected 228 homegardens in the State led to report over 170 species (Sankar and Chandrashekara, 2002). Similarly, Jose (1991) listed 179 species from 80 homegardens in a village. These include 71 tree species, 6 perennial herbaceous crops, 23 annual crop species, 18 medicinal plant and 61 ornamental plants. Another inventory of plants in the live fences alone of 60 homegardens enabled to register 68 species (Chandrashekara et al., 1997). All these observations support the statement of Ninez (1987) that the homegardeners are perpetual 'experimentors' and are constantly trying and testing new species. It is also argued that the limited space forces people to accommodate many different species with an aim to

optimize the yield and also obtain diverse variety of crops. However, so far no study has been conducted to determine whether the homegardeners are effectively managing and utilizing the species diversity prevailing in their homegardens and whether the changing socio-economic scenario in the society is influencing the plant diversity utilization patterns in the homegarden systems. As a step in this direction, an attempt is made in this article to quantify the species utilization efficiency in homegardens. For the present study 53 homegardens in Vazhikkadavu Panchayat in Malappuram district Kerala were selected. The size of the homegardens in the study area ranged from 0.3 to 1 ha. Elder citizen interviews indicated that of the 53 homegardens, 21 were more than 16 year old (hereafter old homegardens) and the remaining 32 homegardens were less than 16 year old (hereafter new homegardens). Among 32 new homegardens, 26 were derived from paddy fields. This trend of conversion of paddy fields and farmlands into homegardens is common throughout the State.

In the present study, totally 210 species (66 trees, 30 shrubs and 114 herb and climbers) were recorded. The number of species per homegarden ranged from 16 to 57 with the mean value of 34. A wide variation between new and old homegardens in terms of species number was recorded. In the case of old homegardens, 43% of total number of old homegardens were species poor with number of species per homegarden below the mean value (34 species). Where as, majority of the new homegardens (75% of the total numbers of new homegardens) were species poor. While the age of the homegarden is one factor for less number of species in majority of new homegardens, the other factor attributed by the farmers is their preference to maintain less complex and less diverse systems with an intention to maximize the yield from few crops, which will have commercial value than subsistence value.

After preparing a consolidated list of species present in the homegardens studied, about fifty farmers were interviewed at random to understand the uses of each plant species in general and plant parts in particular. Literature search was also done to understand use of each species. Members of the family who owns such homegarden were also interviewed to record the plant species they use and the plant parts of each species being used. Based on this information, actual use of a species in a given homegarden in comparison with all possible uses of that species was ascertained. From the above data, the relative usage of a species in the homegarden was calculated as follows:

$$\text{Relative usage of a species in a homegarden} = \frac{\text{Number of current uses of the species in the homegarden} \times 100}{\text{Number of all possible uses of all species in the homegarden}}$$

The sum of the relative usage of all species in a homegarden gave the real usage of species diversity (RUSD) in that homegarden.

The species present in a homegarden can be classified into three types namely a) cultivated species, b) not cultivated but managed species, and c) not cultivated and unmanaged species. Score 1 to 3 was assigned with score 1 to cultivated species and 3 to not cultivated and unmanaged species. Value obtained for the relative usage of a species in a given homegarden was multiplied with the assigned score value.

The summation of the value obtained for all species in a homegarden was divided by the real usage of species diversity (RUSD) and termed as the species diversity utilization efficiency index (SDUEI) of that homegarden.

$$\text{SDUEI of a homegarden} = \text{Sum of Species Usage efficiency value} / \text{RUSD}$$

An example to illustrate the estimation of RUSD and SDUEI of a homegarden is given in Table 1.

The value obtained for the Real Usage of Species Diversity (RUSD) ranged from 38 to 46% which showed that the species diversity in the homegardens is under-utilized (Table 2). However, in species rich homegardens, the SDUEI value was between 1.6 to 1.7 indicating that about 50-70% of total numbers of species are uncultivated but being managed and utilized by the farmers. On the other hand, the SDUEI value in species poor homegardens was closer to 1 (Table 2). This reflected the fact that the majority of the species in these homegardens are cultivated and very few uncultivated species are being managed and used by the farmers. The major reasons for less importance given to management and utilization of uncultivated species include the use of external source for biomass such as green manure, firewood, fodder etc. and use of inorganic fertilizers and pesticides. Since farming is only a subsidiary activity for several homegardeners adequate emphasis is not being given to species diversity management and utilization. The study also showed that in none of the homegardens the SDUEI value is near 3. Thus it may be concluded that the farmers of both species rich and species poor homegardens are utilizing only a few uncultivated and unmanaged species though several of them are useful to improve the overall productivity and soil fertility of homegardens. Since majority of the new homegardens are species poor and showing low SDUEI value, it can also be concluded that the enrichment and utilization of species diversity for ecologically sound cropping system is being neglected.

Table 1. Estimation of the Real usage of species diversity (RUSD) and the species diversity utilization efficiency index (SDUEI)[c] of a homegarden.

Species	Total number of uses	Total number of current uses in the home-garden	Relative usage of the species in the home-garden	Score assigned	Species Usage efficiency value
Adhatoda vasica	4	1	0.79	1	0.79
Aerva lanata	9	3	2.38	2	4.76
Aloe vera	2	1	0.79	1	0.79
Amarantus sp.	2	1	0.79	1	0.79
Anacardium occidentale	7	5	3.97	1	3.97
Ananas comosus	1	1	0.79	1	0.79
Areca catechu	5	5	3.97	1	3.97
Aristolochia indica	2	1	0.79	1	0.79
Artocarpus heterophyllus	6	4	3.17	1	3.17
Calycopteris floribunda	3	2	1.59	2	3.17
Capsicum annuum	2	2	1.59	1	1.59
Cardiospermum halicacabum	5	1	0.79	1	0.79
Carica papaya	3	2	1.59	1	1.59
Cocos nucifera	9	9	7.14	1	7.14
Coleus aromaticus	1	1	0.79	1	0.79
Cyclea peltata	1	1	0.79	2	1.59
Cyperus rotundus	1	1	0.79	2	1.59
Eclipta alba	5	1	0.79	1	0.79
Emblica officinalis	4	2	1.59	1	1.59
Ficus asperima	1	1	0.79	2	1.59
Garcinia gummi-gutta	2	1	0.79	1	0.79
Hemidesmus indicus	3	1	0.79	1	0.79
Isachne sp.	1	1	0.79	3	2.38
Ischaemum sp.	1	1	0.79	3	2.38
Ixora coccinea	4	1	0.79	1	0.79
Leucas aspera	4	2	1.59	2	3.17
Mangifera indica	4	4	3.17	1	3.17
Moringa tinctoria	8	7	5.56	1	5.56
Murraya konigii	2	1	0.79	1	0.79
Musa paradisiaca	8	1	0.79	1	0.79
Musa sapientum	8	1	0.79	1	0.79
Paspalum sp.	1	1	0.79	3	2.38
Pseudarthria viscida	1	1	0.79	1	0.79
Psidium guajava	3	3	2.38	1	2.38
	126[a]	.	56.35[b]		69.05[d]

a, Total number of possible uses of all species; b, Real usage of species diversity (RUSD) in the homegarden;
c, Score: 1 for cultivated species, 2 for not cultivated but managed species,
and 3 for not cultivated and unmanaged species;
d, Sum of species usage efficiency value.

The SDUEI of the homegarden = Sum of species usage efficiency value/ RUSD
= 1.23.

Table 2. Real usage of species diversity (RUSD) and species diversity utilization efficiency index (SDUEI) values in homegardens in Vazhikkadavu Panchayat, Kerala. Values are mean with SE. Values in a row with same alphabets in the Superscript are not significantly different (P<0.05)

	Real usage of species diversity (RUSD) value	Species diversity utilization efficiency index (SDUEI) value
Old Homegardens		
Species rich (N=12)	41.04 ± 1.31[a]	1.721±0.004[a]
Species poor (N=9)	46.21 ± 2.75[ab]	1.226±0.002[b]
New Homegardens		
Species rich (N=8)	39.21 ± 2.27[a]	1.599±0.009[a]
Species poor (N=24)	38.31 ±1.27[ac]	1.193±0.002[b]

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Modelling the growth of teak in relation to soil conditions in the Kerala part of the Western Ghats.

KFRI Research Report No.284 (Rugmini, P., Balagopalan, M. and Jayaraman, K. 2007).

The overall objective of this study was to evaluate alternative model structures useful for characterising the interrelation between soil, foliar nutrient status and growth of plantation teak and select the most suitable model. Two major modelling approaches viz., empirical and process-based were tried to characterize the interrelation of tree growth vs soil properties and tree growth vs nutrient status of leaves observed in the sample plots. The relationship between the leaf and soil attributes was studied through canonical correlation analysis. The study was conducted in 52 permanent sample plots, established in teak plantations in Kerala. The sample plots belonged to different age, site quality and stocking classes, and were distributed in different parts of Kerala State. The plots size ranged from 20 m x 20 m to 50 m x 50 m. The plots were established during 2000-2001 and re-measured during 2004. Girth at breast-height (1.37 m above ground) was recorded on all the trees in the plots. Height was measured on a sub-sample of less than ten trees covering the range of diameters in each plot. Diameter increment was computed for all the 52 plots. From each plot, soil samples were taken from pits at three depth layers viz., 0-20, 20-40, 40-60 cm and leaf samples were also collected. The soils were subjected to analysis for determination of particle size separates, bulk density (BD), particle density (PD), water holding capacity (WHC), soil pH, organic carbon (OC), exchange bases (EB), exchange acidity (EA), cation exchange capacity(CEC), base saturation (BS), Total N, available P, K, Na, Ca and Mg. Leaf samples were also analyzed for N, P, K, Ca and Mg contents.

Under the empirical approach, it was observed that the relationship between tree growth and soil characteristics varied with the soil depth levels. Almost 33 per cent of the variation in tree diameter growth was explained by the soil attributes viz., soil bulk density and pH in the 20-40 cm depth level. Under process-based approach, WHC, in the 20-40 cm depth level, turned out as the foremost soil variable significantly influencing tree growth. The process-based approach is preferable over empirical approach to study soil-tree growth relationship on account of its biological validity.

Study on the relation between leaf nutrient status and tree growth indicated that the growth is influenced by multifarious factors and nutrient composition of leaves alone cannot be considered as a good indicator in this regard.

The overall result that comes out through the above two modelling approaches is that soil compaction (bulk density) and soil reaction (pH) have much to do with tree growth. Equally important is the soil depth level (20-40 cm), which exerts maximum influence on the growth of trees occupying the site. On the whole, canonical correlation analyses revealed inter- correlation exists between leaf and soil characters.

Ethnozoological Studies on the Tribals of Palghat and Malappuram Districts of Kerala, South India

KFRI Research Report No: 292. (Padmanabhan, P. 2007)

Forests provide multiple benefits and services to mankind, which are essential for the survival and livelihood of forest dependent indigenous people. Destruction and degradation of forest resources over the last few decades in India have threatened the livelihood of forest dwellers and other poor people living in the vicinity of the forests. There are about 36 tribal communities in Kerala, with a population of about three lakhs forming about one percent of the total population of the State. Among the 36 tribal communities in Kerala, five are primitive communities with pre agricultural stage of development, stagnant population and with very low literacy. Cholanaikans, Kattunaikkans, Kadars, Kurumbas and Korugas are the primitive tribes of Kerala and they constitute nearly 4.8 percent of the total tribal population of the state. Cholanaikkans, the cave dwellers of the dense forests of Nilambur and Manchery mountain ranges are the most primitive humans known in the sub-continent. Ethnically they are quite different from all other tribals of Kerala. Kattunaikkans are another primitive type of tribals who are seminomadic tribe. Ethnozoological studies from the tribal groups of Malappuram and Palakkad districts have revealed some interesting findings hitherto unrecorded. Data from six tribes, such as Arandan, Cholanaikan, Kuruman, Kattunaikan, Muthuvan, and Paniyan have been documented from Malappuram district and 32.18 per cent of tribal groups have been surveyed in detail. Ten tribes, such as Eravalan, Irular, Kadar, Kurumbar, Kattunaikar, Malasar, Mudugar, Malamalassar, Malayarayan and Paniyar from Palakkad

district were documented and 34.35 per cent of tribal groups have been surveyed in detail.

One hundred and seven organisms such as, ten species of insects, two annelids, one mollusc, one arthropod, two arachnids, nine fishes, five reptiles, five amphibians, twenty eight birds and forty four mammals are be used by the tribals in ethnomedicine for the treatment of more than thirty two diseases. The organisms are used either as a whole or parts of the body. The body parts include tissues, exoskeletons, flesh, blood, fat, bones, gastrointestinal tracts, etc. Besides their uses as food, medicine and in trade, parts or the whole animal are also used for non-edible purposes like ornaments, clothing, tools and in religious rituals. The tribals use various methods for killing/capturing animals and most of them are non sustainable. They include pit poaching, poisoning, arrowing, trap an snare, stick and glue, net harpooning, etc. The methods of fishing used by the tribal people include both destructive and non-destructive methods. Possibilities and practises for captive breeding by the integration of traditional and modern methods need to be explored and appropriate policy/s formulated for the conservation of animal biodiversity and preservation of the cultural heritage of the tribals of Western Ghats. Scientific investigations to testify the efficacy of some of the crude drugs derived from animal sources/from ethnic groups need to be undertaken and large-scale sustainable product development is recommended.

Comparison of prediction models developed by statistical and neural network techniques in applied forestry research.

KFRI Research Report No. 299 (Sivaram M. 2007)

Neural network or Artificial Neural Network (ANN) is a powerful data modelling tool that is able to capture and represent complex input/output relationships whether it be linear or non-linear. The motivation for the development of neural network technology stemmed from the desire to develop an artificial system that could perform "intelligent" tasks similar to those performed by the human brain. ANN acquires knowledge through learning and knowledge is stored within inter-neuron connection strengths known as synaptic weights.

The most common ANN model is the multilayer perceptron (MLP). This type of ANN is known as a supervised network because it requires a desired output in order to learn. In MLP with one hidden layer the inputs are fed into the input layer and get multiplied by interconnection weights (synaptic weights) as they are passed from the input layer to the hidden layer. Within the hidden layer, they get summed, and then processed by a nonlinear function (usually the sigmoid/hyperbolic tangent). The processed data leaves the hidden layer and finally again processed one last time within the output layer to produce the neural network output. The MLP and many other ANNs learn using an algorithm called backpropagation. With backpropagation, the input data is repeatedly presented to the neural network. With each presentation the output of the neural network is compared to the desired output and an error is computed. This error is then fed back to the neural network and used to adjust the weights such that the error decreases with each iteration and the neural model gets closer and closer to producing the desired output. This process is known as "training". The trained neural network is tested and validated for applications.

In this study, the performance of ANN model is compared with traditional statistical models for certain datasets emerged out in applied forestry research. The nature of statistical problems that could be considered for the investigation is of regression type (functional approximation) and time series prediction using Auto regressive integrated moving average (ARIMA) model. For regression problem, three data sets are used. First two data sets are related to the prediction of bark thickness using diameter measurements of two species Lagerstroemia reginae and Acacia caesia. The third dataset is related to the prediction of the ratio of germination percentage to the viability percentage at different days of germination of teak (Tectona grandis) seeds.

With regard to time series prediction problem, the prices of teakwood belonging to different girth classes are considered. The architecture of ANN used is MLP with one hidden layer for all the problems. The activation function used in the hidden neuron is sigmoid. The error minimization algorithm used is Levenberg-Marquardit algorithm. While the performance of ANN with regression is assessed by the Root mean square error, the performance of ANN with ARIMA is assessed by mean absolute percentage error. The performance statistics suggest that the performance of ANN is comparable with that of regression model and ARIMA model.

Estimation of moisture content in bamboo for deriving the weight and price conversion factors.

KFRI Research Report No. 300 (Krishnankutty, C. N. 2007)

Bamboo (Bambusa bambos) from the forests in Kerala is allotted by the State Government to the Hindustan Newsprint Limited, a public sector newsprint factory in the State, for harvesting. Selling price of bamboo, known as notified price, is fixed annually by the government per metric tonne of standing weight of bamboo in the forests. Weight of the utilizable portion of the standing green mature bamboo culms in the forests is referred to as the standing weight, whereas the weight of the harvested bamboo when weighed at the factory gate is known as the net weight. Conversion factors are required to determine the equivalent standing weight from the weight of harvested bamboo and to derive the selling price of bamboo at 50% moisture content from the notified price.

For deriving the weight and price conversion factors, an estimate of the average moisture content in bamboo in the forests was necessary. To estimate the average moisture content, 312 sample culms were felled from 52 bamboo coupes during the harvesting period from October to May through a sample survey in the forest bamboo coupes in Kerala. As soon as the sample culms were felled from the sub-sample of two bamboo clumps in each of the selected coupes, sample discs of 5 cm length were prepared by cutting at different height levels of each culm without any change in the moisture content in the standing condition of the culm and the disc. Immediately after cutting, green weight of each disc was measured at the felling site with an electronic balance. Altogether 858 discs from nodes and 1,157 discs from mid-internodes were prepared and the oven-dry weight of each disc was determined in the laboratory. Based on the green and oven-dry weights of the sample discs, the average moisture content in bamboo in the forests was developed through ratio estimator.

Using the estimated average moisture content of 45.23%, the weight and price conversion factors were derived. The weight conversion factors for various values of the moisture content in harvested bamboo are calculated and presented. For converting the net weight of harvested bamboo with known moisture content to the equivalent standing weight of bamboo as in the forests, the weight figure has to be multiplied with the respective weight conversion factor. The derived price conversion factor is 0.9129. The selling price in a financial year per metric tonne of bamboo at 50% moisture content can be found out by simply multiplying the notified price in the same year with the price conversion factor of 0.9129. The price payable by the factory to the government for the net weight of harvested bamboo in a financial year can directly be arrived at by calculating its equivalent standing weight using the weight conversion factor and multiplying it with the notified price in the same year.

Growth enhancement of *Dalbergia latifolia* through soil management techniques

KFRI Research Report No. 303 (Sujatha, M. P., Thomas P. Thomas and Maria Florance. E. J. 2008)

Considering the drastic depletion, slow growing nature and long gestation period of *Dalbergia latifolia*, a nitrogen fixing as well as high valued timber yielding forest species, this study was conducted during 2001-2004 with the view of increasing its growth through various soil management practices using different types of planting materials such as root suckers, seedlings and rooted cuttings. The study also aimed at finding out the association and variability of isolate of rhizobium and the clonal propagation in this species. Growth response to various treatments such as lime, vermi compost, cow dung, chemical fertilizer, rhizobium and combinations of organic manures with chemical fertilizer were studied by conducting pot trial at Field Research Centre of KFRI in Velupadam and field trial at Sub Centre of KFRI in Nilambur. Changes in soil properties due to the application of various treatments were also studied. Results indicated that organic manures such as cow dung (1kg/plant) or compost (1kg/plant) either alone or in combination with chemical fertiliser (½ kg cow dung or ½ kg compost + potash-15g + amophos-50g) were effective in achieving a substantial increase in the growth of *Dalbergia latifolia* coupled with improvement in soil quality. All the three types of planting materials used in the study responded very well to the above treatments and the maximum growth responses were observed in root suckers followed by seedlings and cuttings. The best strain of rhizobia was isolated from those collected from Nilambur and all the cultures were capable of forming nodulation on Dalbergia seedlings. But the application of these rhizobia had no significant impact on the growth of *Dalbergia latifolia*. In order to produce rooted cuttings from suckers the best concentration of IBA was 5000 ppm.

A Handbook of Lesser Known Timbers

KFRI Research Report No 304. (Bhat, K. M., Thulasidas, P. K. and Hussain, K. H. 2008)

The Handbook of Lesser Known Timbers will serve as a source of ready reference in the trade and user-sectors to get acquainted with the lesser known timbers of domestic market particularly in Kerala. The information presented on various properties of timbers and their standard trade and botanical names will facilitate selection process of right timber for application in different end-uses with greater confidence. In addition to individuals, larger organisations like State Forest Departments, Central Public Works Department, and various public-sector units/ Corporations, who commonly handle timbers, are expected to derive direct benefits of this handbook.

This user-friendly handbook with illustrations of wood figure (colour, grain and texture) and appearance will point to right choices of timbers especially to substitute the well known commercial timbers which are increasingly becoming scarce in the market. The market price of timber (in the year 2006) and the substitutes for some of the well-known timbers are also highlighted for the benefit of common man.

This handbook was prepared based on both collation of published technical information and newly investigated properties and uses of timbers supplied from wood farm/agroforestry sectors and imported sources of Kerala State, including those are supplied from other states of India. In this treatise, readers may come across a few timbers, whose technical properties are already known but external appearance is not familiar to common dealers. Besides the hardcopy, computer CD is also provided for the benefit of those who seek images of surface appearance of different wood species along with technical properties.

Quantitative Inventory of Non-Wood Forest Products in Northern Kerala

KFRI Research Report No. 306. (Sasidharan, N., Sivaram, M. and Muraleedharan, P. K. 2008).

The quantitative inventory study of the NWFPs was carried out in the 15 Forest Divisions (11 Territorial and four Wildlife Divisions) of the seven northern districts of Kerala covering an area of 4,220 km2.

The NWFPs consist of different forms like herbs, shrubs, climbers and tree yielding useful products such as bark, flowers, fruits, seeds, leaves and roots. Most of the NWFPs have clumped distribution, seasonal availability, rarity and occur in a varied terrain conditions. Therefore, there has not been any methodology available for the quantitative inventories of NWFPs. A pilot study was constructed to determine the sample size and the number of plots to be established for the estimation of NWFPs in different forest types by species area curve method.

For the quantification of useful products of NWFPs software called Invent NTFP has been developed. The software has two major parts. The first part deals with input data. Using the data, the software quickly analyse density, abundance, relative density, relative frequency, important value index, Shannon's index and evenness index. The second part deal with yield studies such as available quantity of useful products like root, flower, bark and leaves from different species.

For quantification of NWFPs, a total of 11,548 sample plots were laid out in the natural forests and plantations of 15 forest divisions. Among the 137 NWFPs listed for quantification, 123 were enumerated from the sample plots. Others did not appear mostly because of their habitat specificity and restricted distribution. Among the 123 NWFPs recorded, the species with enough sampling intensity alone were quantified. However, structural data such as density, frequency and abundance of the species were worked out. The highest and lowest density and availability of useful part (kg/ha) were worked out for each forest division, range and vegetation types.

Though, it was envisaged to standardize the collection of important NWFPs, the study was restricted to 30 herbaceous and shrubby species.

The sustainable harvest per cent was studied through regeneration index method and the appropriate collection season is also worked out. For want of permission, the sustainable extraction of bark and root of tree species could not been undertaken.

Among the 123 NWFPs studied 25 species belong to the Red Listed Categories such as Vulnerable (12 spp.); Low risk near threatened (4 spp.); Endangered (6 spp.) and one species (Coscinium fennestratum) as critically endangered.

Among these Kingiodendrum pinnatum, Strobilanthes ciliatus and Hydnocarpus pentandra are Peninsular Indian endemics.

There are two stages in the marketing of NWFPs in Kerala, sale of collected products by the tribes to Federation through society and marketing of the collected products by the Federation. There exists different market situation in both the stages. In the first stage, the market structure is more or less similar to that of monopoly. In the second stage, the market structure of NWFPs in the product market is oligopolistic in Kerala with few firms or sellers in the market.

With no increase in the real income and standard of living, the gatherers are compelled to collect more and more of highly demanded items which will affect their availability in coming years. For conservation and better management of NWFPs, economic upliftment of the collectors, value addition of NWFPs through post harvest processing are suggested.

Identification of *Santalum album* and *Osyris lanceolata* through morphological and biochemical characteristics and molecular markers to check adulteration

KFRI Research Report No. 307 (Bhat, K.V., Balasundaran, M. and Balagopalan, M. 2007).

The study undertaken to elucidate the means and criteria to differentiate the woods of *Santalum album* and *Osyris lanceolata* showed the possibility of distinguishing the woods reliably on the basis of anatomical structure, colour of the hot water extract, chemical constituents and their proportion in the oil, and DNA fingerprinting.

Wood anatomical characteristics useful for distinguishing *Santalum album* from *Osyris lanceolata* were seriation of rays, type of crystalliferous cells and abundance of extractives. Wood of *Santalum album* had 1 to 2 seriate rays, crystals in axial parenchyma cells and scanty extractives; whereas, *Osyris lanceolata* had 1- to 3-seriate rays, crystals in ray cells and relatively abundant extractives. The hot water extract of *S. album* was pale yellowish without traces of red colour while that of *Osyris lanceolata* was reddish. Similarly, the oil extracted from *Osyris lanceolata* had a faint reddish hue as compared to *S. album* which was yellowish. The wood of *S. album* yielded thrice as much oil as that of *Osyris lanceolata*. Oil from *S. album* contained 46 to 57% and 0.42 to 1.56% α-Santalol and cis Lanceol respectively, while that from *Osyris lanceolata* contained 24 to 25% α-Santalol and 28% cis Lanceol. Chemical constituents such as α-Bergamotene, (Z)-β-Farnesene, β–Bisabolene, α-Bisabolol, Z-α-trans-Bergamotol were present only in *Osyris lanceolata*, while 2-Carene, α-Curcumene, Teresantalol and trans-β-santalol were found only in *S. album*. As DNA was unavailable from the dry specimens of *Osyris lanceolata*, DNA extracted from samples of locally found *Osyris wightiana*, reported as synonym of *Osyris lanceolata*, was used for the study. The genomic DNA extracted from the wood and leaf samples of *S. album* and *Osyris wightiana* was PCR-amplified using specific primers designed to amplify the 18S and 26S rDNA units. The variations in restriction patterns (RFLP) of these amplified products when digested with restriction endonuclease Bam HI served as tools to distinguish the two species. The 18S rDNA of *S. album* and *Osyris wightiana* contained 1695 and 1668 nucleotides and 26S rDNA

contained 3204 and 3264 nucleotides respectively. Nucleotide sequence dissimilarities between the rRNA genes of the two species were also sufficient to distinguish S. album from Osyris species.

Post- harvest protection of bamboo from insect borers by a technique enhancing starch hydrolysis

KFRI Research Report No. 308 (Bhat, K. V. and Kallarackal, J. 2007)

The reduction of storage starch in harvested bamboo culms during post-harvest period was investigated in two common species of bambos, namely, Bambusa bambos and Dendrocalamus strictus. The extent of starch storage in culm tissues varied between the different height levels of the culms and between seasons. Also, there was no definite pattern of seasonal variation in starch content and the extent of starch stored. On an average, approximately 60% reduction in starch content occurred in a fortnight following harvesting. Starch depletion trend was identical in samples stored at room temperature (30° C) and at lower temperatures (20° C) but was more pronounced in the former. Maximum starch depletion occurred during May- August. The starch depletion was attributable to the activity of β-amylase enzyme which showed high activity during the first week after harvesting. The enzyme activity rose from a low value recorded on day-2 and attained a peak, usually on day-6, and then declined gradually. However, in samples where the enzyme activity was high right from the day-2 (or probably, right from the time of harvesting), the activity reduced gradually without a subsequent rise. The declining trend in enzyme activity, evident during the second week was more gradual as compared to its initial increase which was more rapid. It was also found that lower temperature was not as favourable as room temperature for amylolytic depletion of storage starch. In general, the enzyme activity was high from July to December as compared to the rest of the period. The sugars released due to the amylolytic hydrolysis of starch were probably utilised for the respiratory activity in the culm tissues since there was an obvious increase in respiratory activity in harvested culms during the first week of post-harvest storage. Application of end coats of cashewnut shell oil or a wall paint called black japan on cut en ends and other exposed parts of the culm segments decreased the rate of moisture loss from the culms. However, the effect of the treatment on starch depletion was not very encouraging. Thus it is concluded that end coating may serve only as a barrier to the entry of borer beetles into the culms during the post-harvest period. Steeping the culms with amylase solution during harvesting did not result in appreciable increase in subsequent starch depletion as probably the solution taken up by the transpiration stream was not distributed laterally. The stomatal conductance and transpiration rates were high during summer months in both the species. The Fv/Fm values obtained from chlorophyll fluorescence measurements which are indicative of photosynthetic efficiency showed a reduction as the dry period progressed.

Water and light use characteristics of the vegetation in the different strata of a moist deciduous forest

KFRI Report No.310 (Kallarackal, J. and Chandrashekara, U.M. 2008)

Kerala State, at present holds a total of 4100 km2 of natural MDFs. These forests hold a complex association of different kinds of habitats like reservoirs, man-made forests and natural forests. The present study was conducted in a moist deciduous forest located at Pattakarimbu, Nilambur North Forest Division, Kerala, India . The climate is typically monsoonal with mean annual rainfall in the study area being 2312mm. This forest area forms part of the Western Ghats range of hills, which is one of the hotspots of biodiversity.

The tree community structure, composition, distribution pattern and diversity were studied in the forest site by laying hundred quadrats, each of 10m x 10 m in size. In the study plot, out of the 33 tree species encountered, *Xylia xylocarpa*, *Terminalia paniculata* and *Grewia tiliifolia* are the most dominant ones. The total tree density in the plot is 415 individuals ha-1 with a total tree basal area of 23.2 m2 ha-1. The crown to land ratio (CLR) was 112.1 ± 6.5 and leaf area index (LAI) was 3.60 ± 0.22. Estimated species diversity index value was 3.49, which suggests that over-dominance of any single or a set of species is absent in this forest.

Phenological studies have shown that duration of the mature leaf phase in the species studied varied from 187 days to 256 days, while yellowing before the abscission takes 12 to 32 days. It was also recorded that the duration between complete leaf-yellowing and leaf abscission ranged from 6 to 16 days.

Leaf expansion rates of a few dominant species in the MDF have been also studied. Several deciduous species studied, produced new foliages during early part of the summer season (January-February). The leaf colour variations and the changes in specific leaf area (SLA) have been followed in several species.

The variations in LAI during different months (2004-2005) showed that it started from a higher value (3.60) in June and gradually decreased thereafter up to March (1.57), except a rise (2.89) during December and another rise was noticed during April. The plot-wise production of leaf litter in the nine sample plots analysed is presented.

Similarly the month-wise production of leaf litter in each of the plot is also given. Wide variations in leaf litter production can be found between plots. Species associations and their interactions are probably responsible for such behaviour. The variations in SLA of three-age classes, viz., very young, young and mature leaves of seven MDF species are presented using ANOVA.

Transpiration in 12 different tree species was measured using the sapflow method. The species are – *Wrightia tinctoria*, *Gmelina arborea*, *Stereospermum colais*, *Xylia xylocarpa*, *Dalbergia latifolia*, *Tectona grandis*, *Cleistanthus collinus*, *Sterculia guttata*, *Terminalia*

paniculata, Dillenia pentagyna, Terminalia crenulata, and *Bauhinia malabarica*. The measurements were done during the dry period (premonsoon period), the monsoon period and the post monsoon period. The hourly rate of sap flow shows that leaf area is the most important determinant regulating the water loss due to transpiration. The VPD measurements done simultaneously with the sap flow measurements show that all the species have a marked reduction in sap flux during midday when the VPD reaches values greater than 1.0 kPa. This is a very important water conserving mechanism, which prevent excessive water loss from the forest. *Terminalia paniculata, Tectona grandis* and *Gmelina arborea* were the species that consumed the maximum amount of water on a daily basis. The species to species variation and the seasonal variation were so enormous that it is difficult to model the water use of the entire stand in a meaningful way when we have 33 species altogether.

Predawn water potentials measured in seven tree species in the MDF showed values in the range of -0.45 to -0.60 MPa (Megapascals). In almost all the species, there is partial closure of the stomata from midday. The maximum stomatal conductance values are shown before noon. This is an adaptation for most of the native species to prevent water loss from the plant during the warm sunny days in the tropics.

The light availability above and below the canopy of the MDF was measured continuously using the line quantum sensor. It was found that during the dry season the light availability at the ground level was two-third of the light available above. However, during the post monsoon period, when the canopy was relatively denser, it was only one-third of that available above the canopy. Chlorophyll fluorescence measurements on the seedling-leaves have helped us to assess the stress undergone by them for growth and regeneration. The Fv/Fm values and the PI values recorded show that some of the seedlings are under severe water stress during the dry season. This could be the reason for the absence of several tree species in the adult stage, but present in seedling stage.

It is the interactive controls such as resources, modulators, disturbance regime, human activities and biotic communities that directly regulate ecosystem processes. Species that alter these controls generally have strong effects on ecosystems. This point has been discussed at length based on the phenological and ecophysiological studies carried out in this project.

Information compendium on Kerala Forestry Sector

KFRI Research Report No. 313 (Jayaraman, K., Krishnankutty, C.N., Menon, A. R. R, Anitha, V., Vijayakumaran Nair, P., Sivaram, M., Jayson, E.A. and Rugmini, P. 2008)

Forests have important ecological, environmental and economic roles to play and are essential for survival of human species at the *current level of technological development and hence its preservation is of utmost importance.*

Forests in Kerala, mostly confined to upland occupy about 29 per cent (as officially declared) of the land area of Kerala.

Because of the large population, the per capita forest land in the State is 0.04 ha which is much low compared to the national (0.08 ha) or global figures (0.62 ha). However, the total forest cover as defined by the Forest Survey of India extends over 40 per cent in the State including trees outside forests.

According to the remote sensing based stratification, moist deciduous type covers the maximum area of forests (43.8%) followed by evergreen and semi-evergreen (35%). Dry deciduous type shows least coverage under the phenological classes (1%).

During the last three and a half decades, the percentage area under evergreen forests came down to 35 per cent from 49 per cent that was in 1973. Moist deciduous forests which constituted 31 per cent of the total area in 1973 now make up 43.8 percent. Subsequently, there were changes in species composition with dominance of light demanding species.

The State forests have a rich diversity of flora and fauna comprising as many as 11,840 plant species and 8,452 animal species. Biodiversity must be protected not only for purely ecological reasons but also because it sustains livelihoods.

Wildlife is an integral part of forests in Kerala, as elsewhere. A total area of 2630.49 km^2 has been brought under Protected Category in Kerala which is 23.3 per cent of the total forest area. Crop damage by wild animals in agricultural fields adjoining the forest areas is very heavy. Against certain animals, deep trenches seem to be more practical compared to electric fences, which are presently being promoted under various government schemes.

Kerala has about 2000 sacred groves, which are distinct and unique in biological diversity. Sacred groves which were once part of the culture are fast disappearing due to anthropogenic pressure. Sacred groves are important not only with respect to biodiversity conservation but also by the many beneficial effects they provide to the local environment.

Myristica swamps are a special case of swampy vegetation largely confined to certain pockets in southern Kerala occupying not more than 0.014 per cent of the total forest area of Kerala.

The enormous biodiversity of the Myristica swamp forests is noteworthy. Conservation of these small and scattered swamp patches needs immediate attention.

Mangroves are salt-tolerant forest ecosystems found mainly in inter-tidal regions. Presently, the extent of undisturbed mangroves in Kerala is reduced to just 150 ha mostly distributed in Ernakulam, Kannur and Kozhikode Districts but the potential area comes to around 1670 ha. Destruction of mangroves increases the vulnerability to the calamities and disasters arising out of losing a natural barrier to the fury of the seas.

Forest plantations occupy about 14 per cent of the area under forests in Kerala. Teak and eucalypts have been the principal forest

plantation species. Enhancement of productivity of the plantations has been a major issue in the past, which calls for much research effort.

Home gardens in Kerala carry a significant stock of trees which also contribute towards the environmental benefits accrued through tree vegetation and can be taken as a form of agroforestry.

Social forestry is the practice of growing trees in non-conventional forest areas for the benefit of the society. Under the World Bank aided Social Forestry Programme implemented in 1980's in Kerala, around 20,000 ha were brought to plantations of *Acacia auriculiformis*, *Eucalyptus tereticornis* and *Casuarina equisetifolia*.

Non-wood Forest Products (NWFPs) play an important role in the rural economy of Kerala. There are about 550 species utilized as NWFP which includes medicine and narcotic, gum and resin, tan and dye, oil and fat, spices and condiments, food and fodder, fibre and floss, bamboo and cane, insecticides and leaves. One of the major problems for management of NWFP is the absence of suitable marketing channels for these products. However, overexploitation has led to rarity of certain species.

Of the many bamboo species available, 22 species and two varieties belonging to six genera are recorded as native to Kerala. Natural forests and home gardens are the sources of bamboo in Kerala. *Bambusa bambos* is the most common commercially important bamboo species in the home gardens. Palakkad is a major outlet for export of bamboo to the neighboring States but the quantity traded has been coming down over years due to depletion of growing stock in home gardens.

Kerala State Bamboo Corporation is the only agency concerned with collection of reeds from forests, distribution to registered mat weavers and sale to other traditional workers.

Around 14 species of cane are found growing in Kerala. The range of indigenous uses of rattan is vast, from bridges to baskets, from fish trap to furniture, from crossbow strings to handicraft items. The resource depletion of cane in natural forests has led to large scale import of the same to Kerala from north eastern states particularly Assam and Arunachal Pradesh.

Eco-tourism has taken off in a big way in Kerala resulting in phenomenal increase in both the tourist arrivals and earnings from tourism. With increasing urbanization and focus on wildlife and natural ecosystems, Sanctuaries and National Parks are favourite destinations for tourists. Though this eagerness is encouraging, unrestricted tourism in the protected areas may pose a serious threat to the wildlife and their habitats.

Kerala Forest Department has a well developed marketing system including a network of sales depots. Timber mainly from plantations is sold through forest depots. Bamboos, reeds and eucalyptus are being allotted yearly to the industries like HNL. NWFP collected from forests through tribals are marketed by the Federation of SC/ST Societies. Over the years, prices of all timbers have been on the increase, import has been going up and export coming down except in the case of rubber wood.

Comparison of demand for wood in 1987-88 and 2000-01 shows that there has been an overall decline. The decline was primarily due to the use of substitutes for timber in construction and due to increased use of LPG. Trees in areas outside forests particularly home gardens are extremely important not only for producing timber and fuelwood, but also for social and environmental benefits. Fuel-wood, non-wood biomass, LPG and kerosene are the cooking media used in the household sector, which is the largest fuel-wood using sector (73%) in Kerala. To reduce the dependence on fuel-wood, which is a cause of environmental degradation, it is important to make LPG available throughout the rural areas in the State, particularly in areas adjoining forests.

The major wood-based industries in Kerala are sawmilling, manufacturing of packing cases, match splints and veneers, plywood, pulp and paper, wooden furniture and fixtures. The raw material demand by these industries is met more from homesteads and imports rather than from forests.

In spite of many governmental programmes, tribal populations in forests are under deprived conditions. Some of the major problems associated with tribals are their acute poverty, malnutrition, consumption of intoxicants and exploitation by way of land grabbing by non-tribals which have led to unrest in various tribal pockets. Fire, grazing, illicit felling, poaching, encroachment, sand mining and to some extent, ecotourism pose threats to forests in Kerala although the strict regulations have brought down the number of forest offences committed.

Forests in the State are managed in consonance with the National Forest Policy which lays stress on environmental stability and joint forest management. Over the years, the State has introduced several rules and regulations aimed at the protection of forest resources. Certain restrictions made on felling of trees from areas outside forests have also been effective in preserving the growing stock of trees outside forests. Analysis based on available data, criteria and indicators shows that management of forests in Kerala is moving towards achieving sustainability.

Research on forestry and related aspects in the State has brought out much valuable information useful for scientific management of forests. Kerala Forest Research Institute over the last three decades could make significant contributions in this respect.

Mapping the Biodiversity of the Myristica Swamps in Southern Kerala.

KFRI Research Report 452. (Nair, P. V., Ramachandran, K.K., Swarupanandan, K. and Thomas P. Thomas, November 2007.)

Myristica swamps were first described from Kulathupuzha in Kerala State in 1960. In Kerala, these swamps are present in Anchal and Kulathupuzha Forest Ranges and Shendurney Wildlife Sanctuary (between 77. 27° and 77. 58° E and 8.74°N and 9.03°, below 200m MSL (so far wrongly reported as 300m). This study is the first to map 60 individual swamp patches which constitute 1.5 km^2

which hardly make up 0.004% of the total land area of Kerala and 0.014% of the total forest area of Kerala.

Mapping was done using a combination of GPS in relatively open areas and conventional survey under dense canopy.

The swamps have been accurately plotted over 1:50,000 SOI toposheets enabling accurate relocation, spatial analysis and 3D visualization.

Each swamp has a central stream, which causes inundation of the swamps. Each swamp has different inundation characteristics- such as time period of inundation, depth of inundation and area under inundation. Many of the swamps dry up during the months of December to March. Water table beneath the ground recedes below 50 cm during summer. The soils of these swamps vary in texture from sandy soils to sandy loams to silt loams and rarely clay loams depending on locational factors including geology and physiography of the land; gradational variations within the swamps being not uncommon. There is remarkable variation in other properties also, but in general, most of the swamp soils are acidic (pH 4.5-6.0, exchange acidity < 2 cmol kg-1, exchangeable bases < 5 cmol kg-1) non-saline (electrical conductivity <70 µs cm-1) and with low organic carbon content of 0.3 to 1.3%. But highly acidic peaty soil with pH values of 3 - 4 and organic carbon content of < 20% is also encountered. Gleying is common down the profile in most swamps except those that are very coarse textured.

The vegetation inside and outside the swamps have been enumerated using a total of 33 sample plots of 0.33 ha area each. Shrubs have been enumerated in subplots of 4x4m and herbs in subplots of 1x1m. All the plants have been digitally photographed with close up views. Eighty two trees and ninety four species of herbs/shrubs constitute the vegetation. Forty nine lianas have been recorded. Twelve of these plants have been redlisted and up to 28 plants are endemic to Western Ghats. Out of the 19 sample plots, *Gymnacranthera farquhariana* was dominant in 10 plots. *Myristica fatua* var. *magnifica* was the dominant tree in 6 swamps. In the remaining plots, *Vateria indica* was the dominant tree in one plot, *Holigarna arnottiana* in one plot and *Lophopetalum whightianum* in another plot. Phenological studies were carried out for two years on five tree species. Individuals of the same species at different swamps showed similar phenological phases across seasons. Germination studies were carried out on various species of Myristicacea and upto 80% of germination success was obtained. Seedlings raised in plantation trials were planted in forest areas.

The Myristica swamps are famed for its charismatic and archaic vegetation but studies documenting the animal wealth of these swamps are almost nonexistent. This study is the first effort to document and quantify animals of the Myristica swamps in Southern Kerala. Faunal biodiversity of the Myristica swamps consisted of Platyhelminthes- (Bipalium-2, tapeworm-1) 3 species, Nemathelminthes-1 species, Annelida (Oligochaeta-2and Hirudinea-2) 4 species, Mollusca-10 species, Unidentified Crustacean-1 species, Insecta- 281 species belonging to 83 identified families, Myriapoda- 6 species and Arachnidae 54 species, Pisces 14 species, Amphibia 56 species, Reptilia 55 species, Aves 129 species and Mammalia 27 species. Quantitative analysis of herpetofauna revealed that the differences in the environmental characteristics inside the swamp and outside the swamp play an important role in regulating the species diversity and abundances of both amphibians and reptiles. Amphibians were more susceptible to environmental changes. Patterns of diversity and abundance during day and night, across swamps and months changed. There was no significant difference in patterns of diversity and abundance recorded during the two years. Many of the animals documented belong to the redlisted and endemic categories.

This report contains more than 200 pages, with 60 pages of maps and photographs of swamps, plants and animals. The report is also brought out in the form of an interactive CD which can be searched by location, plant or animal name. CD contains additional illustrated data sheets on individual swamps, plants and animals.

Requirement of Important raw drugs for Ayurvedic Medicines and estimation of planting materials for cultivation of medicinal plants in Kerala

KFRI Extension Report No. 25 & 26 (Sasidharan, N. and Pandalai, R.C. 2008.)

The annual consumption of the 50 selected medicinal raw drugs in Kerala is about 11,830 tonnes. Consumption of raw drugs is highest in the Thrissur and Malappuram districts as some of the larger units are located in these districts. The source of the raw drugs is mostly from the forests. Only six items are obtained from cultivated sources and seven items from sources outside Kerala. The requirements of the Pachamarunnu items are met through collection from the wild during the wet seasons. But there is scarcity for these items during the dry seasons. Considering the present requirement of raw drugs and the growth of the Ayurvedic Drug Industry, cultivation of the much-needed raw drug is essential. Though wide coverage on the proposed programme of distribution of the planting materials of medicinal plants was given in the leading Malayalam Dailies in Kerala, only farmers responded. Many farmers are of the opinion that at present cultivation of many medicinal plants are not profitable when compared with the cash crops. A major problem faced by the farmers is in selling the medicinal plants, especially when they cultivate a few items. The Medicine Manufacturing units prefer to buy the raw drugs through a contract system so that they will get the required quantity of raw drugs at the specified time. We received several enquiries regarding the cost of the planting materials and the marketing of the medicinal plants. We explained that the distribution of the planting materials would be on a no loss no profit basis produced by the Kerala Forest Department. Among the requests for planting materials, Kattarvazha (*Aloe vera*) and Chappangam (*Caesalpinia sappan*) are the most demanded ones.

Development of protocols for collection, grading and storage of medicinal plants is a time-consuming process as the seeds/root-shoot cuttings/rhizomes are available only at certain periods of the year and some of the species are not even cultivated in any part of the State. Details of seed biological aspects of most of the short listed plants have been assembled.

The difficulty in obtaining live medicinal plants either from the homesteads or from the wild is yet another major impediment for data collection. Lack of standard procedures for obtaining the planting materials especially for species cultivated through root-shoot cuttings and rhizome is another hurdle for developing appropriate protocols. In addition, there is dearth of information on aspects like propagation and cultivation methods in the case of a large number of medicinal plants.

Hence the thrust of the project, due to the typical crop pattern of Kerala, should be to promote cultivation of selected medicinal plants not only in the farmlands but even in forest areas through mixed/miscellaneous species afforestation programmes, being taken up by the Forest department. This way, constant depletion of these medicinal plants from the forest areas can be partially compensated. Species worth mentioning in this regard is *Coscinium fenestratum* in the list of species selected for the present study. This species is alarmingly diminishing from the natural forests of the state. Therefore a concentrated effort for planting the species through the projects already mentioned, as well as through allied schemes of the forest department is actually the need of the hour.

Population estimation of wild elephants in the Elephant Reserves of Kerala

KFRI Extension Report No. 27. (Sivaram, M., Ramachandran, K. K., Nair, P.V. and Jayson, E. A. 2007).

Population estimation of wild elephants was undertaken in all the four Elephant Reserves of Kerala State, using Block Count Method on 7th May 2007 and Line Transect Sampling of Dung on 9th May 2007. The forest was divided into a number of small blocks utilizing the maps of the Survey of India. A random sample of blocks was chosen in each Forest Division for the survey. In the Block Count Method, elephants were counted in the sample blocks and the elephant density was estimated (number of elephants per km^2). The total number of elephants was calculated by multiplying the elephant density with the actual extent of elephant habitat. The direct sighting of elephants further provided information on the population structure.

In the estimation of elephant population based on the Line Transect Sampling of Dung, there were three components involved viz., dung density from Line Transect Sampling, dung decay rate from dung decay experiments and the defecation rate. The elephant density was obtained by multiplying decay rate with the ratio of dung density to defecation rate.

A total of 1679 elephants were sighted in the selected blocks. The estimated wild elephant population for the State by the Block Count method was 3002 elephants with 95 per cent confidence interval, ranging from 2543 to 3461. The highest elephant density (No./km^2) was found in Wayanad Elephant Reserve (0.5250), followed by Anamudi Elephant Reserve (0.4574), Periyar Elephant Reserve (0.3754) and Nilambur Elephant Reserve (0.0758). In terms of total number, Anamudi Elephant Reserve ranked first with 1289 elephants followed by Periyar (1136 elephants), Wayanad (490 elephants) and Nilambur Elephant Reserve (87 elephants). The age-sex ratio of the elephants sighted is as follows. Bull to Cow 1: 3; Sub-Adult Male to Sub-Adult Female 1: 2 and Adult Cow to Calf 3.8:1. The percentage tusker in adult and sub-adult population was 21.9. The estimated elephant population in the State, based on the Dung Survey, was 6068 elephants with 95 per cent confidence interval, ranging from 4950 to 7481. This figure is considerably higher than the population estimated from the Block Count Method.

The estimated elephant population could not be directly compared with the past results due to differences in census methods, coverage and the methods of analysis. However, an attempt made on the analysis of trends in elephant density and dung density revealed that, in general, there is an increasing trend in the wild elephant population in the State.

Research Report KFRI

New Research Projects Initiated

KFRI Plan fund projects

KFRI 525/2007: Establishment of a soil museum at KFRI (M. P. Sujatha 2007 April-2010 March).

KFRI 526/2007: Early selection and mass multiplication of Eucalyptus interspecific hybrid clones (M. Balasundaran, 2007 April-2010 March).

KFRI 527/2007: Rust fungi of Kerala: Biodiversity and biosystematics (C. Mohanan, 2007- April-2009 March).

KFRI 528/2007: Macro fungi of Kerala: Biodiversity and biosystematics (C. Mohan 2007 April-2010 March).

KFRI 529/2007: Establishment of a tree protection helpline for the state of Kerala (V. V. Sudheendrakumar, 2007 April-2009 March)

KFRI 530/2007: Digital Library in Forestry (K. Sankara Pillai, 2007 April-2010 March).

KFRI 531/2007: Flowering Plants of Kerala- CD Version 2.0 (N. Sasidharan, 2007 April-2008 December).

KFRI 532/2007: Strengthening and rehabilitating the Bioresource Nature Park in the KFRI Sub Centre Campus (U.M. Chandrashekara, 2007 April-2010 March).

KFRI 533/2007: Establishment of a Taxonomic Garden in the KFRI Sub Centre Campus (U.M. Chandrashekara, 2007 April-2010 March).

KFRI 546/2008: Software development for forestry applications, (K. Jayaraman, 2008 June-2009 March).

KFRI 547/2008: Optimizing management of bamboo stands using growth simulation models (K. Jayaraman, 2008 June-2011 March).

KFRI 548/2008: Quality improvement of organic manures for reducing soil health hazards (M. P. Sujatha, 2008 June-2011 March).

KFRI 549/2008: Development and maintenance of the Medicinal Plants Garden in the Peechi Campus (N. Sasidharan, 2008 June-2011 March).

KFRI 550/2008: Vegetative propagation of selected medicinal plants for enrichment of resources –Phase II (Surendran T, 2008 June -2011 March).

KFRI 551/2008: Ecophysiological responses of tree species to elevation gradient in the shola forests of Kerala (Chandrashekara, U.M. 2008 June-2011 March).

KFRI 552/2008: Assessment of crop damage by wild animals in Trichur District Kerala (Jayson, E. A., 2008 June-2011 March).

KFRI 556/2008: Land use and its change in forests of Kerala, (Vijayakumaran Nair P.V, 2008- June 2011 March).

KFRI 557/2008: Evaluation of the effectiveness of water submersion method for protection of bamboo from borer damage, (Bhat K.V. 2008 June-2010 March).

Sponsored Projects

KFRI 523/2007: Conservation and sustainable management of Non Timber Forest Products through participatory approach in the Western Ghats of Kerala, (Muraleedharan, P.K. 2007 April-2009 December) UNFDP-GEF, URAVU, Wayanad, Kerala.

KFRI 534/2007: Biodiversity of Terrestrial and Lignicolous Macrofungi in the Kerala part of the Western Ghats (C. Mohanan, 2007 July-2010 June) Ministry of Environment & Forests, GOI, New Delhi.

KFRI 535/2007: Identification of Satyrine butterflies of Peninsular India through DNA barcodes (George Mathew, 2007 August - 2010 July, Department of Biotechnology, GOI, New Delhi.

KFRI 536/2007: Establishment of a Bamboo Technical Support Group for South Zone, (K.K. Seethalakshmi, 2007 September-2008

March) National Bamboo Mission, Department of Agriculture and Cooperation, GOI, New Delhi.

KFRI 537/2007: Protection of Tsunami affected coastal areas by establishing bioshields through people's participation, (M. Balagopalan 2007 September-February 2009) Tsunami Rehabilitation Programme, Govt. of Kerala.

KFRI 538/2007: Carbon storage in different age teak plantations in Kerala (M. Balagopalan, 2007 September-2010 August) KFDC, Thiruvananthapuram.

KFRI 539/2007: DNA barcoding of Dalbergia species (K.K.N. Nair, 2007 October-2010 September.) Department of Biotechnology, GOI, New Delhi.

KFRI 540/2007: Field trial of tree infusion technique to manage mistletoe infestation in Teak plantations (Sajeev, T.V., 2007 November-2008 October) Kerala Forest Department, Govt. of Kerala.

KFRI 541/2008: Conservation of microfungi: a voice for unprotected and vulnerable organisms (K.V. Sankaran, 2008 January-2010 March) Darvin Initiative, UK.

KFRI 542/2008: Symbiotic nitrogen bacteria supported INM for rosewood plantations in degraded acid soils of Western Ghats (Balasundaran M., 2008 March-2011 February) Department of Biotechnology, GOI, New Delhi.

KFRI 543/2008: A field study to evaluate the efficacy of lemon grass in controlling runoff and soil erosion (Thomas P. Thomas, 2008 March.-2011 February) Planning and Economic Affairs (E) Department, Govt. of Kerala.

KFRI 544/2008: Forestry sector analysis for the state of Kerala –Phase II (Jayaraman K, 2008 May-2009 April) Ministry of Statistics and Programme Implementation, GOI, New Delhi.

KFRI 545/2008: Evaluation of Saraca asoca, Kaempferia rotunda, their substitutes and medicinal preparations with respect to phytochemical and biological properties (N. Sasidharan, 2008 June-2011 May) National Medicinal Plant Board, New Delhi.

KFRI 553/2008: Phylogeny and generic classification of the woody bamboos (Poacea: Bambusoideae: Bambuseae) International Collaborative Project with Dr. Clark Lynn G, IOWA, State Univ, USA, (Muktesh Kumar, 2008 June-2009 December) National Science Foundation, Washington, USA.

KFRI 554/2008: Natural enemies of the weeds Impatiens glandulifera and Hedichium sp. native to the Himalayas, (K.V. Sankaran, 2008 June-2009 March) DFID, UK.

KFRI 555/2008: Directory of wetland (P.V. Vijayakumaran Nair, 2008 June-2009 March) Kerala State Biodiversity Board, Thiruvananthapuram.

Extension & Consultancy Projects

KFRI Ext 108/2007: Characterization of genomic variations through host generations in understanding its impact on pathogenicity of HpNPV: Development of a quality control protocol w.r.t. genetic variability (C.P. Biji, Three years SERC, DST, GOI , New Delhi,).

KFRI Ext 109/2007: Training cum study tour on propagation, cultivation, management and post harvest technology of bamboos (Myanmar) (K. K. Seethalakshmi, 27 March - 7 April 2007, ITTO).

KFRI Ext 110/2007: Training course on propagation, cultivation, management and post harvest technology of bamboos and rattans (K. K. Seethalakshmi, 3-12 January 07, 10 days, Andhra Pradesh Forest Academy).

KFRI Ext 111/2007: Training course on forest seed management for production of superior planting stock (R.C. Pandalai, 11-20 December 07, 10 days, Andhra Pradesh Forest Academy).

KFRI Ext 112/2007: Training course on modern trends in teak cultivation and management (R.C. Pandalai, 13-22 February 2007, 10 days, Andhra Pradesh Forest Academy).

KFRI Ext 113/2007: Training course on molecular and biotechnological techniques in tree improvement (M. Balasundaran, 1-10 March 2007, 10 days, Andhra Pradesh Forest Academy).

KFRI Ext 114/2007: Upgradation and operation of broadband/ seismological observatories in the peninsular shield of India (Jose Kallarackal, September 06-August 08, two years, DST, New Delhi).

KFRI Ext 20/2007: Production of bamboo seedlings (R.C. Pandalai, KFRI).

KFRI Ext 115/2007: Production and supply of seedlings of various forestry species (P. K. C. Pillai, KFRI).

KFRI Ext 116/2007: Task force meeting of DBT on Biopesticides to Crop Management at KFRI (R.V. Varma, 20-21 April 2007, DBT, New Delhi).

KFRI Ext 117/2007: Ph.D. and Academic attachment programmes (R.V. Varma, Chairperson of Ph.D. Program Advisory Committee, KFRI).

KFRI Ext 118/2007: DNA finger printing of 5 best teak trees of APFD (M. Balasundaran, May-June 2007, 2 months, Andhra Pradesh Forest Department).

KFRI Ext 119/2007: Training Course on tissue culture techniques for forest and medicinal plants (E.M. Muraleedharan, 23 April-2 May 2007, 10 days, Andhra Pradesh Forest Department).

KFRI Ext 120/2007: Computer Training Course in use of Photoshop (Programme Coordinator, Extn. & Training, July- Auguest 2007, 2 months, Self Generating).

KFRI Ext 121/2007: Statistical Analysis of the Elephant Census-2007 (M. Sivaram, 3 months, Kerala Forest Department).

KFRI Ext 122/2007: National Seminar on Conservation, Cultivation & Sustainable Utilization of Saraca asoka, (N. Sasidharan 6-17 October 2007, 2 days, National Medicinal Plant Board, GIO, New Delhi).

KFRI Ext 123/2007: Training Course on Management of Tropical Forest – Issues and Challenges (K. C. Chacko. 6-10 Auguest 2007, 5 days, MoEF, New Delhi).

KFRI Ext 124/2007: Training Course on Propagation, Cultivation, Management and Post Harvest Technology of Bamboos, (K. K. Seethalakshmi., 10-16 September 2007, 7 days, Directorate of Horticulture, Rajasthan).

KFRI Ext 125/2007: Training Course on Propagation, Cultivation, Management and Post Harvest Technology of Bamboos and Rattans, (K. K. Seethalakshmi, 11-20 Sept.2007, 10 days, Renewable Natural Resource Res. Centre, Bhutan).

KFRI Ext 126/2007: Inspection of new Tissue Culture Lab. At NPM, Jagi Road (HPC Ltd.) (E.M. Muralidharan, 5-7 April 2007, 3 days, Hindustan Paper Corpn. Ltd., Kolkatta).

KFRI Ext 127/2007: Examination/DNA test of Teak wood sample pieces, (M.Balasundaran, October-Nov.2007, 2 months, Southern Railway, Railway Protection Force, Thiruvananthapuram).

KFRI Ext 128/2007: Investigations on Environmental loss due to mangrove deforestation in the area of the forthcoming `Dharam Cyber City', Cochin, (K. Swarupanandan, 1 month, KFRI).

KFRI Ext 129/2007: Workshop on Taxonomy of Lichens, (Muktesh Kumar, 10-11 January 2008, 2 days, Kerala State Biodiversity Board, Thiruvananthapuram).

KFRI Ext 130/2007: Training Course on Wood Microtechniques, Pulpwood Quality and NIRS, (K.M. Bhat, 19-24 November 2007, 6 days, ITC, R & D Centre, Hyderabad).

KFRI Ext 131/2007: Training Course on Propagation, Cultivation, Management and Post Harvest Technology of Bamboos for forest officers from Gujarat Forest Department, (Muktesh Kumar, 30 December 2007 to 5 January 2008, 6 days, Gujatath Forest Department).

KFRI Ext 132/2008: Establishing global Teaknet Secretariat at KFRI, (K. M. Bhat, January to June 2008, 6 month, FAO – RAP).

KFRI Ext 133/2008: Waterfowl Census between Bharathapuzha and Periyar (E. A. Jayson, January 2008, 1 month, Kerala State Biodiversity Board, Thiruvananthapuram).

KFRI Ext 134/2008: Collection, compilation, validation and dissemination of forestry statistics, (M. Sivaram, 21-22 February 2008, 2 days, MoEF, New Delhi).

KFRI Ext 135/2008: Troidine Butterflies as Ecological Indicators for Biodiversity Assessment Studies in the Western Ghats, (Dr. Mary Anto, 3 years, Women Scientist Scheme, DST, New Delhi).

KFRI Ext 136/2008: Training Course on Propagation, Cultivation, Management and Post Harvest Technology of Bamboos, (K. K. Seethalakshmi, 4-10 May 2008, 7 days, Govt. of Rajasthan).

KFRI Ext 137/2008: Training Course on Propagation, Cultivation, Management and Post Harvest Technology of Bamboos, (E. M. Muralidharan, 9-15 March 2008, 7 days, Govt. of Rajasthan).

KFRI Ext 138/2008: Training Course on Molecular and Biotechnological Techniques in Tree Improvement, (M. Balasundaran, 27 February to 7 March 08, 10 days, ITTO).

KFRI Ext 139/2008: Training Workshop on Environmental impact assessment, (S. Sankar, 25 -27 March 2008, 3 days, Kerala State Biodiversity Board, Thiruvananthapuram).

KFRI Ext 140/2008: Training course on Tree farming in agroforestry systems and wastelands, (S. Sankar, Tamil Nadu Forest Department).

KFRI Ext 141/2008: Training Course on collection, compilation, validation and dissemination of forest statistics, (M. Sivaram, 21-25 April 2008, 5days, MoEF, GOI, New Delhi).

KFRI Ext 142/2008: National Green corps training for Master Trainers, (K. C. Chacko

28-30 April 2008, 3 days, KSCSTE, Thiruvanathapuram).

KFRI Ext 143/2008: Environmental impact assessment of the proposed Angamaly-Azhutha railway line area, (S. Sankar, 2 weeks, Kerala State Biodiversity Board, Thiruvananthapuram).

KFRI Ext 144/2008: Crash Course for the M. Sc. Wood Science Technology students of School of Wood Technology, Kannur University, (T. K. Dhamodaran, 11 days, Kannur University).

KFRI Ext 145/2008: Systematics and phylogeny of the tribe phaeniceae (Family Arecaceae), (C. Renuka & T. N. Manohara, July. 2008- June 2009, 1 year, CSIR. New Delhi).

Publications 2007-2008

Papers in Journals

Bhat, K. V., Sunil Kumar, K., Sumesh, P. M. Renjithkumar, K. S. and Kallarackal, J. 2007. Amylolytic breakdown of storage starch in felled bamboo culms during post-harvest period. *Journal of Bamboo and Rattan* 6(1&2): 51-60.

Dinesh Babu, K., Parameswaran, K., Rajeevan, P.K., Radha, T., Augustin, A. and Balasundaran, M. 2007. Effect of enzyme α-amylase on the promotion of polyembryony in mango (*Mangifera indica* L.). *Environment and Ecology* 25(2): 250-253.

Indira, E .P. 2007. Effect of seed source and site on growth characters in *Eucalyptus grandis*. *Indian Journal of Forestry* 30 (2): 199-204.

Jayaraman, K. and Sunanda, C. 2007. Yield prediction models for *Acacia mangium* and *Acacia auriculiformis* plantations in Kerala. *Indian Journal of Forestry* 30 (1): 1-4.

Jayaraman, K. and Zeide, B. 2007. Optimizing stand density in teak plantations. *Journal of Sustainable Forestry* 24(4): 1-22.

Joyce Jose., Ramachandran, K. K. and Nair, P. V. 2007. A rare and little known lizard, *Otocryptis beddomi* from the Myristica swamps of southern Kerala, India. *Herpetological Bulletin* 101: 27-31.

Mohanan, C. 2007. Biological control of seedling diseases in forest nurseries in Kerala. *Journal of Biological Control* 21(2): 189-195.

Nair, K. K. N. and Jayakumar, R. 2007. Flora of New Amarambalam Reserved Forests of the Western Ghats of India. *Journal of Economic & Taxonomic Botany* 29:113-172.

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Renuka, C., Thomas, J. P. and Rugmini, P. 2007. Effects of light on the growth and production of edible shoots of rattan. *Journal of Tropical Forest Science* 19(3): 164-167.

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Anitha, V., Muraleedharan, P. K. and Santheep, K. V. 2008. Traditional bamboo products and its market sustainability in the wake of globalization -An opportunity cost analysis. *Indian Forester* 134 (3): 428-434.

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Analysis to Detect the Genuineness of Substitutes of the Plant Moovila in Drug Preparations. *Journal of Basic Clinical Physiology and Pharamacology* 19:119-130.

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Participation in seminars/workshops/symposia

Seminar(s)/workshop(s) attended

Dr. Jose Kallaraekal attended a Conference on the Stern Review- the Economics of Climate Change – presentation and discussion held on 23rd March 2007 at Taj Coromandel Hotel, Chennai.

Dr. E. A. Jayson attended two days workshop of the Taxonomists at Thiruvananthapuram, convened by the Kerala State Biodiversity Board and chaired the working group on birds from 23rd to 24th March 2007.

Dr. E. A. Jayson attended the 36th Annual conference of the Ethological Society of India at Bangalore on 10 to 12th April 2007. Presented a key note addresses entitled Status distribution, food and feeding of Malabar Spiny Dormouse in the Western Ghats of Kerala.

Dr. Jose Kallarackal participated in the Seminar on Global warming and its impact on the world today held at Don Bosco Higher Secondary School, Thrissur and delivered the key note address on Global Climate Change on 5th August 2007.

Dr. K. K. N. Nair attended the National Conference on Prioritisation and Characterization of Fast Growing Native Tree Resources, organized by the Institute of Forest Genetics and Tree Breeding, ICFRE, Coimbatore during 8-9th August 2007.

Dr. M. Balagopalan participated in the National Workshop on Fertility Evaluation for Soil Health Enhancement organized by Soil Survey Organisation, Govt.of Kerala, Thiruvananthapuram, 11-13th September 2007

Dr. C. K Soman, Attended workshop in AWS network and application on 27th September 2007 at CUSAT.

Mr. P. K Thulasidas,., Dr. K. M. Bhat, and Dr. E. J Maria Florence, attended the Regional Workshop Processing and Marketing of Teakwood Products of Planted Forests, 25-28th September 2007, Kerala Forest Research Institute, Peechi, Kerala and presented a paper entitled "Wood quality of teak grown outside forests (ToF)

Dr. M. Balagopalan participated in the Regional Workshop on Processing and Marketing of Teak Wood Products of Planted Teak 25-28th September 2007 at Kerala Forest Research Institute, Peechi.

Dr. E. A. Jayson attended a seminar at Calicut on 07th October 2007 and presented a paper entitled The problems of wildlife management in the Northern Malabar, Kerala organized by the Kerala Forest and Wildlife Department.

Dr. Jose Kallaraekal participated in the National Conference on Wetlands, Science and Society – An assessment of their integration - organised by the Delhi University Botanical Society. He chaired the Plenary Session of the above conference held at INSA, New Delhi on 11-13th December 2007.

Dr. C. Mohanan attended 2nd Asian Congress of Mycology & Plant Pathology at Osmania University, Hyderabad, A.P., during 19-22nd Dec. 2007.

Dr. M. Sivaram was invited to present a paper on Database on Kerala forest resources and its applications in forest planning and management in the one day Regional workshop on Establishment of Network to Facilitate

Collection, Processing and Dissemination of Statistics Pertaining to Tropical Timber and Other Forestry Parameters of India (ITTO Project) held on 20th December 2007 at IFGTB, Coimbatore, Tamil Nadu.

Dr. K. K. N. Nair as Programme Coordinator, Biodiversity Technical Programme Committee of Kerala State Biodiversity Board at KFRI, attended various meetings of the Kerala Biodiversity Board, Thiruvananthapuram, as a special invitee and contributed to chalking out and implementation of various programmes of the Board.

Dr. M. Sivaram was invited to present a paper on Computerized database on Kerala Forest Resources and its applications in the National Seminar cum Workshop on Forestry Statistics, and also Co-chaired the session on Forestry sector in GDP estimates: Central Statistical Organization (CSO) Study Outcome in the National Seminar cum Workshop on Forestry Statistics, Indian Council of Forestry Research and Education, Dehra Dun 26-27th March 2008.

Dr. Jose Kallaraekal attended a seminar on Modern Tools for Plantation Forestry on 25th March 2008 at Forestry College, Mettupalayam, Tamil Nadu Agricultural University.

Extension activities

Dr. M. Balagopalan, carried out analyses of soil samples from teak, eucalypt and acacia plantations belonging to Kerala Forest Department and Kerala Forest Development Corporation and gave necessary recommendations to over 30 forest ranges in the State.

Dr. M. Balagopalan, carried out analyses of Compost samples for assessing their suitability. Samples from Central nurseries – Nilambur, Chettikkulam and Kulathupuzha and Munnar Forest Division and M/s. Sevana Biofertilisers & Biopesticides, Kurumpilavu P. O., Chirakkal, Thrissur.

Dr. E. P. Indira, edited scientific articles for Journal of Tropical Forestry and Journal of Non Timber Forest Products.

Dr. K. Jayaraman advised the Kerala Forest Department on experimental design for field trials on teak.

Dr. E. A. Jayson visited the Kadalundy area, in the Malappuram District, as per the request of DFO, to study the damage done by the birds on the windows of the houses. A detailed report was submitted to the DFO.

Dr. E. A. Jayson attended the Nilgiri Tahr census program of the Eravikulam National Park on 22nd April 2007.

Dr. E. A. Jayson surveyed the Juvenile Home premises at Trichur to study the human-snake problems as per their request.

Dr. E. A. Jayson valued a Ph. D. thesis submitted to Mahatma Gandhi University, Kottayam and of SACON, Coimbatore.

Dr. Jose Kallaraekal conducted a course in Ecological Philosophy to the IInd Year Philosophy students of Mary Matha Major Seminary, Mulayam, Thrissur.

Dr. Jose Kallaraekal Provided the necessary inputs to an Advocates' Commission enquiring into the impact of HNL eucalypt plantations in Munnar on 19th October 2007 at Munnar.

Dr. Jose Kallaraekal gave a talk on Biodiversity and Climate Change organized by the Biodiversity Board, Kerala on 14 March 2008 at St. Thomas College, Thrissur.

Training imparted

Dr. V. Anitha acted as a resource person and imparted training for college lecturers, Agriculture University lecturers and teachers, on Inter- linkages between environment and economics a theoretical and empirical approach & economic valuation, of ecotourism development , of a recreational site in the natural forests of southern Western Ghats, in September 2007.

Dr. V. Anitha as a resource person and imparted Training for field functionaries of the Bamboo Technical Support Group for south Zone, part of the National Bamboo Mission sponsored Project. She delivered a talk on the Economics and Livelihood potential of Bamboo Resource in Kerala.

Dr. E. P. Indira gave training to two M.Sc. Biotechnology students as supervisor under M.Sc. attachment programme.

Dr. Muktesh Kumar imparted training to the college teachers from different colleges affiliated to Calicut, Mahatma Gandhi and Kerala Universities on 'Lichen diversity, significance and taxonomy' at KFRI during 10-11 January 2008.

Dr. Muktesh Kumar served as a resource person and imparted Training for field functionaries of the Bamboo Technical Support Group for south Zone, on the topic 'Bamboo taxonomy and identification', as a part of the National Bamboo Mission sponsored Project.

Dr. Jose Kallaraekal acted as a resource person for the training of IFS Officers in Statistical methods in Forestry. He gave a talk on acquistion and processing of weather data using automated instruments from remote locations on 21st February 2008.

Dr. M. Sivaram delivered a lecture on 'An overview of

Forestry Statistics with particular reference to Kerala State' in the Training Workshop on Collection, compilation, validation and dissemination of Forestry Statistics' for Indian Forest Service (IFS) Officers, 21-22nd February 2008, held at Kerala Forest Research Institute, Peechi.

Dr. V. Anitha functioned as a resource person conducted a Training course on Social Environment Impact Assessment, 25-26th March 2008.

Dr. M. Sivaram delivered a lecture on 'Computerized database on Kerala Forest Resources and its applications' in the Training Workshop on 'Collection, compilation, validation and dissemination of Forestry Statistics' for Indian Forest Service (IFS) Officers, 21-25th April 2008, held at Kerala Forest Research Institute, Peechi.

Institute training programmes

Dr. K. K. N. Nair took classes on Biodiversity to the trainees from the Indian Institute of Public Administration, New Delhi, teachers of Irinjalakuda, students of Forestry College, KAU, Mannuthy.

Dr. K. K. N. Nair co-ordinated the Kerala Biodiversity activities and also took classes for more than 750 Grama Panchayath Presidents on Biodiversity in collaboration with Kerala Institute of Local Administration (KILA).

Dr. N. Sasidharan gave a talk on the concept of plant taxonomy and plant nomenclature to the MSc Botany students of Govt. College, Pattambi during their visit to KFRI on 05th February 2008.

Dr. M. Sivaram served as the course coordinator of the Training Workshop on Collection, Compilation, Validation and Dissemination of Forestry Statistics for Indian Forest Service (IFS) Officers, 21-22nd February and 21 - 25th April, 2008, Kerala Forest Research Institute, Peechi.

Matters of general interest

Dr. Jose Kallarackal functioned as associate editor for Iforest (Internet Journal), Journal of the Italian Silviculture Society.

Dr. Jose Kallarackal acted as a member, Faculty of Environmental Studies, Cochin University of Science and Technology.

Dr. Jose Kallarackal acted as a member, District Level Technical Advisory Committee of the Trichur District Planning Committee.

Dr. Jose Kallarackal acted as a member, Committee for Evaluating Clean Development Technologies and Project Evaluation under Carbon Credit, Local Self Government Department, Kerala.

Dr. Jose Kallarackal functioned as a member, Management Board, St. Berchmans College, M.G. University, Changanacherry, Kerala

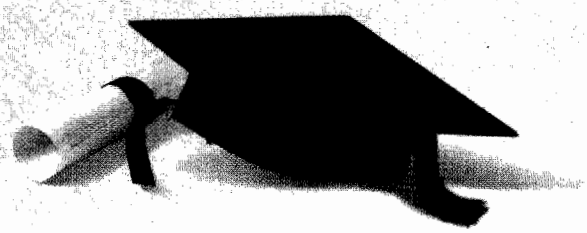
Congratulations!

Winners of Forest Sports and Games Meet 2007

KFRI participates every year in the annual Kerala Forest Sports and Games meet organized by the Kerala Forest Department, as a separate KFRI Circle. The Xxth Kerala Forest Sports and Games Meet-2007 was held at Kozhikode form 11th to 13th of November 2007. Forty three staff members (including project staff) from KFRI participated in the meet in items like Volley Ball, Cricket, Power Lifting, Weight Lifting, Swimming, Table Tennis, Rifle Shooting and other track and field events. KFRI secured 5 Silver medals, and 7 Bronze medals in the Meet as given below.

Evergreen congratulates the winners on their grand success.

- Mr. Rajesh Kumar K.C. won Silver Medal for Discus throw Competition.
- Mr. Achuthan Kutty obtained Silver Medal for Shot put Competition.
- Ms. Bindu K. Jose. won Silver Medal for Javaline throw & Discus throw for women.
- Ms. Bindu T.N. bagged three Bronze medals for Duscus throw, Javaline throw and Carroms(women doubles) with Ms. Swapna Francis.
- Mr. Vivek K.T. bagged one Silver medal for Table Tennis Open and one Bronze medal for Table Tennis (doubles) with Dr. Mamman Chundamannil.
- Dr. Mohandas.K and Raveendran V.P. obtained Bronze Medal for Table tennis(Men veteran doubles) competition.
- Dr. Mohandas.K and Dr. Mammen Chundamannil obtained Bronze Medal for Badminton (Men veteran doubles) competition.
- Ms. Swapna Francis obtained Bronze Medal for Carroms (doubles).
- KFRI Team won Bronze medal for Volley ball competition



Ph.D. Awarded

Mr. R. Sheik Mohammed Shamsudeen, was awarded doctorate degree by the Forest Research Institute (FRI) University, Dehra Dun, in 2008 for his work on Studies on Microheterocera (Insecta:Lepidoptera) in Kerala Part of Western Ghats, under the guidance of Dr. George Mathew, Entomologist, Programme Coordinator, Forest Protection Division, KFRI.

Microheterocera comprises an informal grade of moth taxa. Essentially, it includes a paraphyletic assemblage, of all the primitive as well as higher taxa of the Ditrysian Lepidoptera. Many species of Microheterocera are economically important as pests of various cultivated crops and stored commodities. They also have great ecological significance as indicators of environmental health because of their close association with vegetation. So far, about 2,420 species of Microheterocera belonging to 458 genera grouped under 22 super families and 80 families have been described from all over the world. Except for the pioneering work on Microheterocera fauna of India in the Exotic Microheterocera series by Meyrick during 1912-1936, no comprehensive study on this group of moths has been made from the Indian region. Segregation of taxa belonging to this group is rather difficult since no satisfactory identification scheme is available for their separation.

The Kerala part of Western Ghats is known to be rich in faunal diversity and no detailed survey of Microheterocera has been made in this region. It was in this context that the present study on this group of insects in the Kerala part of Western Ghats was undertaken to generate baseline data on the fauna of this region and to develop an easy identification scheme. Considering the large number of taxa involved, the scope of the present study has been limited to three super families viz., Tineoidea, Gelechioidea and Yponomeutoidea.

Intensive survey of Microheterocera has been made in different parts of Kerala viz., Silent Valley, Mukkali, Muthanga, Sultan Bathery, Amarambalam, Meenmutty, Vellimuttam, Nilambur, Peechi, Vazhani, Sholayar, Thekeddy, Rajamalai, Ranni, Thenmala, Arienkavu, Rosemala, Kattlapara, Achenkovil, Neyyar and Peppara.

Sampling of insects was done by light trapping using a lighted sheet. Altogether, 66 species of Microheterocera belonging to the families Psychidae, Tineidae (Tineoidae); Oecophoridae, Ethmiidae, Lecithoceridae, Gelechiidae, Blastobasidae, Cosmopterigidae (Gelechioidea); Plutellidae, Yponomeutidae, Lyonetiidae, Glyphipterigidae and Heliodinidae (Yponomeutoidea) have been recorded in this study. A major share of moths collected in the study belonged to Gelechiidae, Tineidae, Oecophoridae and Cosmopterigidae. The faunal elements were interesting in that they contained several new records for the region- six species as new records for Kerala; 45 species as new records for Southern India; two species as new records for India and three species that are new to science.

Studies on the morphology of various species with special reference to head appendages, wings and external genitalia have shown that characteristics of the labial palpi, wing venation and parts of external genitalia such as uncus, saccus, gnathos, juxta, tegumen of the male as well as corpus bursae, ductus bursae and signum of the female have diagnostic value in species identification.

In the super family Tineoidea, the labial palpi are stout, erect, bearing piliform scales (bristles) from the apical and lateral surface of second segments. In the forewing, vein R4 usually terminates on costa. In the male external genitalia, the valvae and saccus showed several characters useful in the segregation of species. Valvae are sickle-shaped and broad at the base in Edosa glossoptera, while in Edosa opsigona, valvae are elongated, broad and densely setose on inner surface. Valvae are leaf- shaped in Tinea pellionella. Saccus is low in Edosa glossoptera and E. opsigona while in Tinea pellionella it is elongated. In the female external genitalia, corpus bursae is sac-like and slightly curved at the end in Setomorpha rutella; it is sub ovate and simple in Edosa opsigona. Ductus bursae is slender and tube-shaped in Setomorpha rutella; long and thin, almost straight in Edosa opsigona.

In the super family Gelechioidea, labial palpi are three-segmented, upturned with the third segment long and acute. Forewing with veins R4 + R5 stalked and the male external genitalial characters particularly of uncus and saccus presented several characters useful for segregating species.

Uncus is hook-shaped and basally enlarged in Anarsia patulella; it is small, apically pointed and triangular in Sitotroga cerealella and it is about one third length of valvae in Hypatima haligramma. Saccal region is well developed in Anarsia patulella; saccus distinct and V-shaped in Sitotroga cerealella and saccus very short in Hypatima haligramma.

In the female external genitalia, corpus bursae are foot-shaped in Timyra xanthaula and in T. pastas; large and sub ovate in Anarsia patulella; membranous and oval in Hypatima haligramma and Symmoca signetella. The ductus bursae are small, thin and slightly banded in the middle in Anarsia patulella; narrow and slightly dilated in Hypatima haligramma; relatively short and broad in the middle in Symmoca signetella. In the super family Yponomeutoidea, labial palpi are drooping, porrect or ascending. In the forewing, R4 terminates on termen and M-stem in the cell is usually absent. With regard to the genitalial characters of taxonomic significance, the corpus bursae and ductus bursae of female genitalia are useful. Corpus bursae is round and ball-like in Plutella xylostella and large balloon-like in Atteva fabriciella. Ductus bursa is a small tubular structure in Plutella xylostella which is slightly curved at the end in Atteva fabriciella. An identification key for the various species using wing venational and external genitalial characters was prepared for easy segregation of species studied here. In addition, an inventory of species recorded in this study along with details of collection localities, distribution and hosts is also given along with a microdem distribution map. Thus, the study has generated essential basic information on this group of moths and updated the taxonomy of Microheteroceran fauna using genitalic characters.

Mrs. P. Rugmini was awarded doctorate degree by the Mahatma Gandhi University, Kerala in 2008 for her work on Optimising stand density in teak plantations using growth models based on intrinsic biological units, under the joint guidance of Dr. A. P. Thomas (Prof. and Director, School of Environmental Sciences, Mahatma Gandhi University, Kottayam) and Dr. K. Jayaraman, Programme Coordinator, Forest Information Management System, KFRI.

Attempts were made to develop a growth simulation model for even-aged teak stands using intrinsic biological units and to utilize the model to derive optimal density management plans. Additionally, optimal rotation age, effect of understorey species on the growth of teak and certain eco-physiological parameters of the species were examined.

The growth model consisted of five modules such as effects of site index, unrestrained growth, aging, density of teak and density of miscellaneous species. Age and size at inflection point of diameter at breast-height were taken as intrinsic units. Since the study was aimed at developing growth models based on intrinsic biological units, the values of these units were utilized for estimating the parameters of the growth model. The intrinsic units' viz., age and size (diameter) at inflection point were estimated from an external data set as 8 years and 10.6 cm including the bark at breast-height level, respectively.

The growth model was calibrated based on the data gathered from sixty-nine permanent sample plots established in teak plantations in the State of Kerala, India. One parameter of the growth model of special importance was the index of self-tolerance, which was estimated as 1.28. By the value that is obtained for the said parameter, high mortality should not be caused by slight increases in mean diameter of the stand.

The value of fractal dimension (2.13) obtained was biologically justifiable considering the light demanding nature of the species.

Based on the estimated equations, a growth simulator was developed in SAS language and several alternative runs were made in order to identify the optimum density trajectory that maximized the net present value (NPV) of cash flows. Optimum density regimes were worked out for different interest rates in all the site quality classes, with and without miscellaneous species (understorey) in the stands. The relative initial density that maximized the NPV varied from 0.41 for site quality I to 0.21 for site quality IV regardless of interest rate. The rate of increase in initial density required for attaining the optimum was 3 per cent every five years. For any particular interest rate, the optimal rotation age remained the same under all site quality classes. However, the optimal rotation age changed from 65 years to 40 years as the interest rate changed from 2 to 5 percent.

Analyses with the growth simulator revealed that miscellaneous species in teak plantations have a significant effect on growth of teak trees. The percentage increase due to the absence of miscellaneous growth was about 16 per cent for crop diameter, 23 per cent for MAI of volume and 56 per cent in NPV over a rotation period, site quality and interest levels. Economic impact of the above findings was also worked out.

Major environmental effects of growing teak plantations viz., nutrient cycling and carbon sequestration were discussed in the light of results obtained on optimisation of stand density levels.

Farewell

Since the establishment of the Kerala Forest Research Institute in 1975, the first generation of its staff began preparing for superannuation in the recent years. Five of our staff has superannuated recently and the process will continue over the coming years. KFRI bids them a fond farewell hoping that they will have a happy retirement and will continue to take an interest in the activities of the Institute.

Dr. J.K. Sharma

Director

Dr. Jyoti Kumar Sharma, joined Kerala Forest Research Institute in 1978 as Head of Forest Pathology Division where he played a key role in setting up the Forest Pathology Division. He became the Research Coordinator in the Institute in 1997. Two years later, he was appointed as the Director and continued in the position until 22 January 2007 when he took voluntary retirement to join as Professor, School of Environment & Natural Resources, Doon University, Dehra Dun. He had also served as the Member Secretary (Additional Charge), Kerala State Biodiversity Board, Thiruvananthapuram, during 2005-2007. Dr. Sharma is highly regarded both nationally and internationally for his work on forest tree diseases. He has worked as a consultant of FAO in Vietnam and Myanmar and served in the FAO Expert Committees to frame guidelines for safe movement of germplasm of Eucalyptus, Acacia and pines. He served as Chairman/Coordinator of Working Party on Tree Diseases of International Union of Forestry Research Organizations (IUFRO), during 1995 to 2005. He has also served in several national expert committees of MOEF and DBT, GOI. Currently, he is an Expert Member in the Appraisal Committee of EIA for River Valley and Hydro Electrical Projects; Committee on Conservation and Sustainable Utilization of Natural Resources; National Advisory Committee on B.P. Pal Award on Biodiversity, MOEF and National Steering Committee, TSBF/GEF Project on Below Ground Biodiversity, JNU. Dr. Sharma's main research interests are Forest Pathology, Tree improvement, conservation and sustainable utilization of Biodiversity, Natural Resource Management and Forest Science and Policy. Dr. Sharma has guided 7 doctoral students and has published over 110 research papers in national and international journals. KFRI attained greater heights in forestry research during his leadership

Dr. R.V. Varma

Program Coordinator,
Forest Protection Division

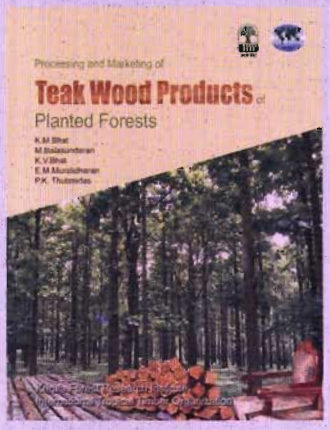
Dr. R.V. Varma, joined KFRI in 1976 as a Scientist in the Division of Entomology.. Dr. Varma is a Fellow of the Royal Entomological Society (FRES), London and a life member of the Indian Society for Biocontrol Advancement. He is highly acclaimed for his work on termites in forest ecosystems. Dr. Varma superannuated from KFRI on 31 July 2007 as the Programme Coordinator, Forest Protection Division. After retirement, he joined the Kerala State Biodiversity Board, Thiruvananthapuram, as its Member Secretary. Dr. Varma has over 30 years research experience and has been working on various aspects of forest insects during his tenure at KFRI. He has over 90 publications in National and International Scientific journals.

Mr. K.R. Mukundan

Spl. Grade Engineer

Mr. K. R. Mukundan has been working as Engineer since 1980 at KFRI. He is the master mind behind most of the buildings and facilities that we see at KFRI today. He superannuated from the Institute on 31May 2007.

New Releases/ Publications



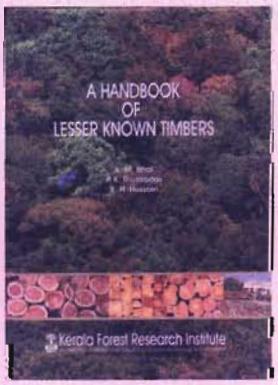
Processing and Marketing of Teak Wood Products of Planted Forests

Bhat KM; Balasundaran M; Bhat KV; Muralidharan EM and Thulasidas PK (eds.) 2008.

Kerala Forest Research Institute, Peechi, India & International Tropical Timber Organisation, Japan, 336p.

This is a newly released Proceedings of the Regional Workshop on "Processing and Marketing of Teak Wood Products of Pl anted Forests" held during 25-28 September 2007 at Kerala Forest Research Institute, Peechi, India. The proceedings presents some of the very recent scientific information on teak wood production in planted forests, productivity and quality of teak from short rotation plantations, its processing, marketing and the price trends in the global market scenario. The proceedings consists of a total of 39 papers presented during the Workshop. The papers are organised under 4 different headings such as plenary papers, wood production in planted forests, productivity and quality of planted teak, processing, marketing and price trends.

For copies please contact Librarian, KFRI at library@kfri.org



A Handbook of Lesser Known Timbers

(KFRI Research Report No. 304)

K M Bhat, P K Thulasidas and K H Hussain (2008)

Kerala Forest Research Institute , Peechi, India , 180p.
Price: **Rs.500/- (India) / US$50 (Overseas)**

This is a newly released handbook which may serve as an essential source of ready reference not only in timber trade/user sectors but also among the wood technologists in India and overseas. The hand book describes 77 relatively less known and imported timbers with colour illustrations including the well known teak timber displaying various types of wood with varied colour, grain and texture among different countries of origin. Besides the hard copy, computer CD-ROM is also provided for the benefit of those who seek real images of wood figure (colour, grain, texture) and the contents can be browsed using Adobe Acrobat Reader in addition to navigation through suitability indices.

For copies please contact Librarian, KFRI at library@kfri.org

LIST OF PRICED PUBLICATIONS

		Price	
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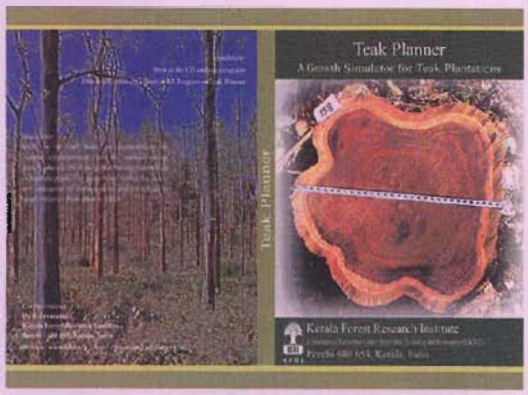
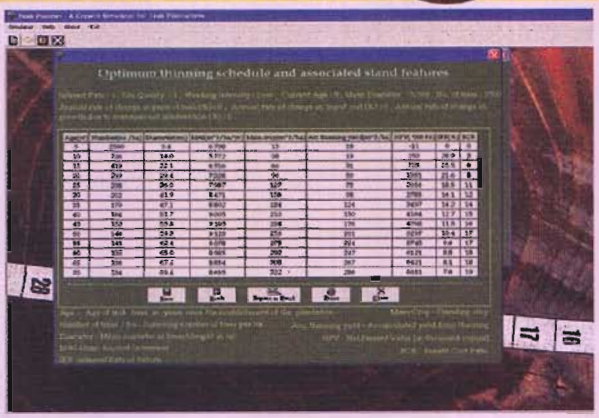
Teak Planner

Teak Planner functionally is a growth simulator for teak plantations. Its scope of application is the range of growing conditions that is available in Kerala. This programme can be used to identify the optimum thinning schedule and rotation age for even-aged teak stands under a range of site quality and management levels. The optimum thinning schedule is that which maximizes the net present value of cash flows, out of a variety of possible thinning schedules in a plantation. It also enables the user to make an investment plan by providing information on net present value (NPV), internal rate of return (IRR), benefit cost ratio (BCR) and payback period (PBP) for a range of management options. The software is also an effective tool for financial valuation of the growing stock for commercial purposes.

The input data at the first level consists of interest rate that is to be used for discounting purposes, site quality class and weeding intensity. The system can then generate mean diameter at 5th year which is the starting point of simulation assuming an initial planting intensity of 2500 trees per ha. In case, the user wants to optimize purchase cost of a plantation or maximize the returns from a purchased plantation, the corresponding input values can be entered and can proceed further. With the input data that is supplied, the programme identifies the optimum thinning schedule for the stand under consideration and displays the number of trees to be retained at 5 yearly intervals with information on several associated stand features like mean diameter of trees, volume of standing crop, accumulated yield from thinning and mean annual increment in total volume (MAI).





It also displays the NPV, IRR and BCR. The optimum rotation age can then be taken as the age at which NPV reaches its maximum. This programme thus fills in the need for a self-contained user-friendly software for finding out optimum thinning schedule and associated stand features for any given stand.

One additional feature is that the user is supplied with the option of making the financial projections either under 'constant' levels of teak timber price, input cost and management interventions or under 'varying' rates. This option provides the user a whole scenario of possible projections and every time the simulator identifies the best thinning schedule to be followed to maximize the returns.

The simulator has been built using Visual Basic software. The equations used for projecting the different stand features were developed using long-term data gathered from permanent sample plots laid out in teak plantations in Kerala. Whole stand models based on Richards function with biologically meaningful parameters formed the basis of diameter and volume growth functions.

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Training programmes

KFRI offers specialized training courses in tropical forestry. It will also be possible to provide tailor-made training depending upon specific needs of the stakeholders. The medium of instruction is English. KFRI is an approved training centre of the Ministry of Environment and Forests, Government of India for the training courses and workshops for the officers of Indian Forest Service. Also, various state forest departments have sponsored candidates for several training courses in the past. Overseas participants from Myanmar, Sri Lanka, China, Nepal, Ethiopia and Uganda have attended different training courses.

Faculty

The Institute has 56 well -qualified and trained scientists with national and international exposure. Apart from the scientists of the Institute, renowned experts from other reputed institutions/ universities are also engaged as resource persons/ guest faculty.

Facilities

Training courses are conducted in the Training Extension Centre with modern lecture hall, seminar hall, meeting room and computer hall with internet facility. The Institute has well-equipped laboratories, library, herbarium, insect museum, wildlife museum, nursery and live collection of bamboos, rattans, palms, medicinal plants and tropical tree species. Kerala Forest Seed Center, Teak Museum and Bioresource Nature Park are other attractions for the visitors. Accommodation is provided in the Trainees Hostel having modern facilities.

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