ISSN 0254-6426

evergreen

newsletter

No. 37 September 1996

Contents

kerala forest research institute

Peechi, Trichur - 680 653, Kerala, India

evergreen

newsletter of
kerala forest research institute

Peechi, Trichur 680 653
Kerala State, India.

ISSN 0254-6426
No. 37 September 1996

evergreen, the KFRI Newsletter is currently brought out in March and September each year and is intended for free private distribution within the Institute and the Kerala Forest Department. Free copies will also be sent upon request to other persons or institutions connected with forestry activities. The views expressed in the Newsletter are those of the authors and do not necessarily reflect views of the Institute. All interested persons are invited to send comments and opinions. The Newsletter Committee reserves the right to choose among contributions and edit wherever necessary.

Address all communications to : The Editor, Evergreen , Kerala Forest Research Institute, Peechi- 680 653, Trichur, Kerala, India
✆ : 0487-782365, 782061 Fax : 0487-782249
E.mail root@kfri.ernet.in

The Periyar River - Doomed by Dams

Originating from the heavily wooded, chilly, undulating mountains of southern Western Ghats, the Periyar river crosses mountains, gorges, and hillocks through evergreen forests and lush grasslands with an un-ending urge to attain sea. But ends at dry, hot, and sultry croplands through dark tunnels and channalized canals. The waters that similarly originate from various other tributaries of the Periyar river basin do not reach where the Nature intends them to do.

Among the 44 rivers of Kerala, Periyar is the largest and most potential. It traverses a total of 244 km from its origin at Kallimala-Sivagiri Hills (about 1600-1800 m a.s.l.), until it reaches Arabian sea. The Kerala part of the Periyar river basin is located in Idukki and Ernakulam districts with a catchment area of 5284 km^2.

To meet the perennial water needs for power generation and irrigation, the Periyar river has been regulated at 12 sites by dams resulting in small, medium or large-sized reservoirs or lakes. viz., Kundala, Mattupetti, Anayirangal, Ponmudi, Sengulam, Kallarkutty, Neriamangalam, Bhoothathankettu, Periyar, Idukki, Idamalayar, and Lower Periyar. These are meant for hydro-electric and/or irrigation purposes. Another five projects to build dams with the same purposes are proposed and are at various stages of consideration. These are Perijankutty, Neo-Pallivasal, Pooyamkutty, Erattayar, and Kallar. The high density of dams in an unit area (about 17; 12 existing and 5 proposed) would probably make the upper Periyar catchment area as one of the most dammed catchments in the world.

The Periyar stream, after flowing 45 km from its origin gets Mullayar stream and drains into Periyar lake. The Periyar lake (26 km^2) was formed by the construction of Mullapperiyar dam in 1895. The water from the lake is diverted through tunnels to the bordering State, Tamil Nadu, for irrigation and power generation in Madurai district. Hence the water that origins at periyar stream never reaches downstream, while the drainage from the lower and adjacent watersheds of down-stream Periyar empties further into another reservoir, Idukki (60 km^2), by the construction of one of the largest dam-complexes (Idukki, Cheruthoni, and Kulamavu dams) in India. (Astonishingly, the State's 60% of electric power is generated and 21% of agricultural lands are irrigated with the waters of Periyar river basin). Again the regulated waters in Idukki reservoir (mostly) never get an opportunity for a downstream escape (the water after power generation is diverted through underground tunnel to the neighbouring Muvattupuzha river basin for irrigation).

But other major tributaries like Perijankutty, Muthirapuzha, Thotti, Idamala, etc. join the Periyar Main channel after getting dammed at many locations. In between the Idukki dam and the above-said junction, an irrigation cum hydro-electric project is nearing completion. The Periyar latter flows through Kalady, Chowara and reaches Alwaye and bifurcates into Mangalapuzha branch draining into Munambam backwaters and the other Marthanda Varma branch flows through industrial regions before emptying into Varapuzha Kayal.

The major industrial units congregated in the lower part of the Periyar river are

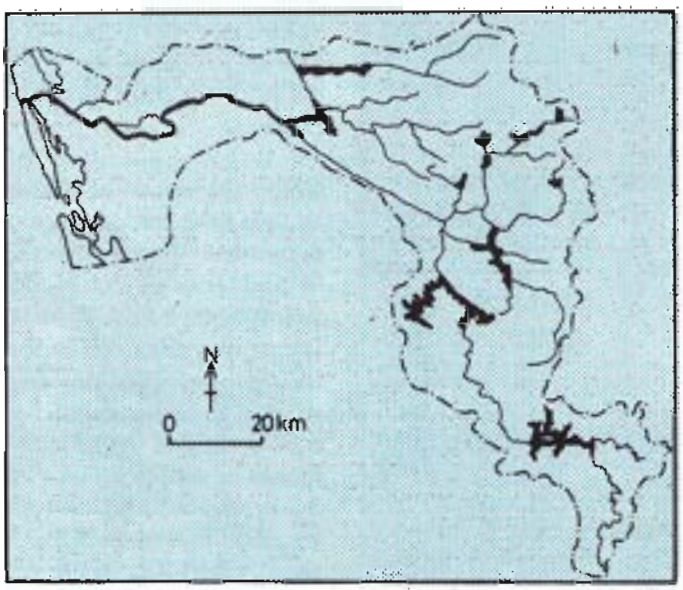
Fertilizers and Chemicals Travancore (FACT) Ltd., Indian Rare Earths Ltd., Binani Zinc Ltd., Catalysts and Chemicals Ltd., Hindustan Insecticides Ltd., Southern Gas Ltd., Travancore Cochin Chemicals Ltd., and Periyar Chemicals Ltd. These chemical industries directly or indirectly pollute the river system.

The regulation imparted by dams and diversion of water in the headwaters coupled with heavy industrial/domestic pollution in lower sections can completely upset the complex and sensitive ecological processes and balances (many of which are still unknown) of this fluvial system.

The River Continuum Concept (RCC) proposed by Vannote and co-workers hypothesizes that the gradient of physical factors exerts a direct control upon the biological strategies and to the dynamics of river systems resulting in continuum of biotic adjustments and a consistent pattern of organic matter dynamics prevails along the length of the river. Due to heavy regulation by dams in upper stretches of Periyar, the continuity of this fluvial system has been lost and hence the geomorophological, biological, and physical settings of the river could be at stake. The construction of dams and consequent formation of reservoirs can in many ways impart serious ecological and environmental disasters in the system or in the nearby areas. Some of the most negative consequences of dams are (i) the loss of forests to flooding resulted by dams and consequent loss in biodiversity (ii) the reduction in downstream fertility; the impoundment blocks downstream transport of organic matter and nutrients (iii) increase in coastal instability, alluvial deposition in estuarine zones is decreased by dams and coastal erosion is increased (iv) a short-term success and long-term failure in fishery, immediately after the closure of the dam, the local fishery is augmented, but in long run the entire fishery, both upstream and downstream is spoilt due to the changes in habitat structure and quality and fish composition (v) reservoir- induced sesimicity; this could be the most dangerous and destructive impact which has an instant social and economic effect on local communities. Weak dams or dams in seismic zones can cause consistent fear or insecurity among local people living down the dams.

The fish species and other aquatic populations can become extinct as a result of natural evolutionary events, but perturbations by river impoundments have markedly increased the species extinguishing rates in aquatic communities. Fishes of streams and rivers depend largely on flowing waters for all their ecological requirements. The diadromous fishes (which migrate between river system and sea and vice-versa for breeding and feeding) of commercial and biological value are seriously affected. Though much has been known on the migration routes and behaviour of many temperate fishes, almost nothing is available on the tropical fishes with no exception to the unique fishes of Periyar. The inundation by dams destruct or sink the spawning grounds of the resident fishes. The fishes in the streams are highly specific on their breeding behaviour. They need pebble, cobble, gravel, sand or boulder in the cold, clear waters for egg-laying. Any one of this habitat characteristics could trigger their breeding activity and the absence of any one of which could retard or even stop the process. Hence a successful breeding and later recruitment might be affected through generations due to inundation by dams. Furthermore, the dams act as physical barriers to migratory routes of fishes. The provision of fish passages or fish ladders are ineffective in high-headed dams (> 100m) like that of the ones in the Periyar basin. The downstream water quality might be seriously affected by the upstream regulation by dams since it alters flow regime, water quality and habitat structure in downstream which is again a pre-requisite for successful existence of aquatic communities downstream.

Dissimilarities in fish species mix have been noticed along the length of the river in the upper stretches of the Periyar. The unregulated upstream sections have a diverse fish fauna (27 species) compared to regulated downstream sections (13 species). A 50% reduction can also be attributed to the presence of dams. A series of dams (Mullapperiyar and Idukki dam complex) in upper river course of Periyar have demarcated and isolated the river into individual patches and



Periyar river basin showing reservoirs

movement or accessibility of fishes to adjacent areas become impossible. This is more evidenced by the loss of few fish species especially eels in Periyar lake which were reported once in 1948 (Eels are classical cases of river impoundment victims in Africa and elsewhere). Adding to the havoc are the exotic carps and tilapia in the reservoirs/lakes 'performing' well (viz., growth and reproduction) and heavily exploiting the resources of resident fish populations. This biological invasion can replace the sensitive and unique fishes of the Periyar in the long run. Interestingly, more than 50% of fish species found in the unregulated section of the upper Periyar is endemic and/or threatened. Among these, four species (Periyar latia, Periyar barb, Channa barb and Periyar trout) are exclusively endemic to these waters with unknown migratory behaviours and ecological requirements. The conditions to fulfill their unknown requirements have to be maintained and their existence have to be confirmed for unknown future benefits, at least as an intergenerational obligation.

L.K. Arun
Division of Wildlife Biology

Wildlife census - 1993 (Kerala)

Name of Animal	Total Nos.
Lion-tailed macaque	564
Bonnet macaque	4,860
Nilgiri langur	2,987
Common langur	175
Elephant	2,388
Gaur	793
Sambar deer	814
Spotted deer	476
Mouse deer	127
Nilgiri tahr	958
Wild boar	1,695
Malabar giant squirrel	1,384
Grizzled giant squirrel	75
Porcupine	68
Small Indian civet	34
Common palm civet	23
Sloth bear	20
Tiger	57

Source: Forest Statistics 1994, KFD.

Silent Valley - a Habitat of Endangered Primates

India is well known for her extensive diversity of primates with 19 species distributed all over the country. Of these only five species have been reported from Kerala State. They include two macaques (Bonnet macaque and lion-tailed macaque), two langurs (Nilgiri langur and Hanuman langur), and one prosimian (Slender loris). Among these, the lion-tailed macaque (*Macaca silenus*) and Nilgiri langur (*Presbytis johni*), are highly endangered and endemic to the Western Ghats.

The distribution of the lion-tailed macaque is confined to the tropical wet evergreen forests. In Silent Valley National Park, two distinct populations of lion-tailed macaque occur on either side of Kunthipuzha river. Their distributional range is limited to the *Cullenia-Palaquium* tree association areas at elevations ranging from 700 to 1500 m a.s.l. In these areas a total of 14 distinct troops with 275 individuals occur with an average troop size of 19 individuals. About 53% are adults and the rest immatures; the adult sex ratio estimated is 1:5.6 females.

Unlike the lion-tailed macaque, Nilgiri langurs have a wide range of distribution extending from 400 to 2300 m a.s.l. in and around the National Park. Eventhough, the main habitat of Nilgiri langur was described as the high altitude montane shola, they are found well adapted to the low altitude evergreen, semi-evergreen, and moist deciduous forests in the border. A population of this primate with high density occurs in the medium altitude (900 - 1300 m a.s.l.) also. Nilgiri langurs are often sighted along with Hanuman langur troops foraging together in the fringes of moist deciduous forests of Mannarkad Forest Division bordering the south-western region of the National Park. About 501 individuals belonging to 85 distinct troops occur in the National Park.

Our long-term observations revealed that the major food items of lion-tailed macaque are fruits, flowers, seeds, and invertebrates. Of these the mesocarp of different fleshy fruits rank top. But during February, March, October, and November, the flower intake is higher than any other food items. The lion-tailed macaque depends on about 71 plant species for its diet. Among these *Cullenia exarillata, Palaquium ellipticum, Ficus beddomei, Ficus racemosa, Ficus amplissima, Artocarpus heterophyllus, Syzygium cumini, Mangifera indica, Turpinia malabarica, Drypetes elata,* etc. are the major species.

In the case of Nilgiri langur, the major food item is foliage of different tree species. They also feed on fruits, seeds, and bark. However, tender leaves and shoots are highly preferred by these monkeys.

Habitat fragmentation and poaching have affected the populations of lion-tailed macaque and Nilgiri langur. Silent Valley and Ashambu Hills in the Agasthya forests are considered as the only viable habitats for lion-tailed macaque in its entire range of distribution. Intensive management and conservation strategies should be adopted to ensure long-term survival of these primates.

Gigi K Joseph
and
K.K. Ramachandran
Division of Wildlife Biology

Nageia wallichiana - a Rare Tree Species in Kerala Forests

We were driving through the Goodrickal Forest Range (Ranni Forest Division) of Kerala. We suddenly caught a glimpse of a large tree with dark lush green phylloclades like Acacia. It is impossible for an acacia to achieve a girth of more than two meters since it has been introduced only recently. We stopped to investigate. On closer examination it was identified as *Nageia wallichiana*, the only conifer found in Peninsular India. When we looked around we found another tree which was slightly smaller than the first one.

When a person from Kerala hears about a conifer he conjures up images of trees with a conical architecture and needle-like leaves which bear snow flakes. This is the impression imposed on us by the visual media. Very few of us are aware of the existence of a conifer which looks like any other angiosperm tree of the tropical region.

The conifers found in the Tropical forest belong to the families Araucariaceae, Cupressaceae, Pinaceae, Podocarpaceae, and Taxaceae. The family Podocarpaceae is the largest tropical conifer family, which includes 17 genera and more than 200 species of shrubs and trees widely distributed in the Gondwana region. The genus *Nageia* belonging to the family Podocarpaceae, is the most widely distributed genus of the family with its members spread in Africa, Asia, and South America. It comprises 12 species. *Nageia wallichiana* (Presl) O.Koord. (*Decussocarpus wallichianus* (Persl) (de Laubenfels) is the only conifer native to Peninsular India.

The plant is scattered in its distribution in the primary rainforests of Southern Western Ghats. It is no where reported to be gregarious and dominant. It is found from an elevation ranging from 5 m to 2100 m a.s.l. The species has been found to occur in India, Myanmar, Malaysia, Thailand, Indonesia, Papua and New Guinea Islands, Norfolk Islands, the Philippines, and Southern Islands of Japan.

The tree is dioecious, grows to a height of 25 m, bark smooth, peeling in large, thin very irregular plates, tan to brown within, leaves decussate, distichous, amphiostomatic, equally turned so that the lower surface is exposed on the left and the upper surface on the right side of the branch.

The trees were located at a distance of 2 km from the Pamba Dam in the north west direction, on the left side of the Reservoir and 7 km from Ponnambalamedu at an altitude of 1000 m a.s.l. The aspect was sloppy and shallow in soil depth. The forest patch has been subjected to disturbance owing to the Vandiperiyar-Ranni road and settlement in its proximity. The larger tree has a girth of 2.5 m and the smaller 1.5 m at breast height. The former has a height of 25 m and the latter 20 m. The tall tree had its first branch at seven meters. The species was found to occur in association with *Persea macrantha, Cullenia exarillata, Mallotus philippinensis, Aglaia lawii, Pterospermum reticulatum*, etc. Reed bamboo clumps were also present. The soil was subjected to moderate erosion. The annual rainfall of this area ranges from 2000-4000 mm.

In Kalakkad National Park, the tree was found to occur between altitudes of 1200-1500 m.a.s.l. Studies by Vinayak revealed that *Nageia wallichiana* exhibited the demographic attributes of a typical shade tolerant species. Its regeneration is poor in area subjected to openings and disturbances. Saplings were scarce and juveniles of the species were not be seen at Pamba. This may be because *Nageia wallichiana*, a slow growing, sub-canopy species, is not able to compete with the gap invaders. The species being dioecious, is vulnerable in the events of habitat fragmentation and its related disturbances. *Nageia wallichiana* merits attention not just for being the only conifer indigenous to the Western Ghats but it is very vulnerable to the impact of forest degradation and habitat fragmentation which is an ubiquitous phenomenon in the Western Ghats.

Foliage of N. wallichiana

Vinayak Mohan,
M.G. Sanal Kumar,
M.K. Harinarayanan,
K.C.Suresh
and
S. Sankar
Soil Science Division

Opportunities and Constraints of Bamboo Farming in the Homestead Agroforestry System in Kerala

Bamboos are one of the important forest resources providing raw material for the pulp and paper industries and generating employment and income to the rural poor. Gradual shrinkage of forests along with increasing demand and over exploitation has resulted in the fast depletion of bamboo resources in the State. Present approach of conservation oriented forestry coupled with low productivity of bamboo forests instigate doubts about the possibility of future supply of bamboos from the forests. This also raises the issue of exploring other sources of bamboo. Homesteads and farm-lands can be viewed as one of the viable options for developing bamboos in the State. Promotion of bamboo cultivation in the homesteads has the potential of considerably enhancing the future supply of bamboos, simultaneously providing supplementary source of income to the households. Though bamboo farming claims multiple advantages such as low gestation period (compared to other tree crops), fast growth, low maintenance and low labour input, commercial farming by farmers is possible only when its advantages are realized clearly. Not only that, many social and economic factors also influence the decision of farmers towards bamboo cultivation. This article is based on the study conducted in this Institute on different aspects of homestead bamboo farming in Palakkad district, Kerala.

Present management of homestead bamboos

Bamboos (*Bambusa bambos*) are traditionally grown in village homesteads in the central and northern regions of Kerala. This is usually grown as two or three clumps in each side of the homestead boundaries or extensively on unused farm lands. The main objective of growing bamboos by the households is for getting fencing thorns and poles. Like other homestead crops, bamboos are also managed with family labour. In most cases only very low labour input is used and left it to grow naturally.

Farmers seldom use fertilizers, pesticides and the only cultural practices followed is sand mounding on clumps for stimulating culm production. Sometimes households resort to cutting top portion of culms ('detopping') to avoid the problems of shade to other crops. Pruning of thorns (branches) for fencing is done during the months of December-February, as households are relatively free from other agricultural activities during this season. One bundle of thorns may fetch Rs. 25-50, depending on the size of the bundle. Farm price of one full length bamboo culm ranges between Rs. 10 to Rs. 75 based on the size (between 16 to 45 cm bottom girth). Domestically, bamboo splits are used for supporting the fences and culms are used for making ladders, sheds, mats and baskets, etc. Usually households sell bamboos when they need money or the clump become congested. They sell bamboos to village agents/subtraders on clump basis, where as locally to the neighbours and mat and basket weavers on the basis of individual culms. Very often sale of bamboos forms a supplementary source of income to the farmers. Since traders buy bamboos on the basis of whole clump, they used to clearfell the same. But selective felling is practised by local buyers.

Advantages of homestead bamboo production

Many studies have shown the potential of private lands, especially homesteads in Kerala form the major source of timber and firewood. This is also true in the case of bamboos. It was estimated that nearly 63% of the total production of bamboos in Kerala is from homesteads. Homestead bamboos are traded through private depots, which are concentrated in Palakkad district. These depots mainly cater the demands of Mysore Paper Mills (MPM) and Hindustan Newsprints Limited (HNL), besides supplying large quantities of bamboos to the bamboo traders and agriculturists in Tamil Nadu. Demand from the bamboo traders in Andhra Pradesh and Karnataka also constitutes a small portion. Of the total sales of these depots, about 68% goes to Tamil Nadu (this includes demand from Andhra Pradesh and Karnataka) and 15% to paper mills (MPM and HNL), and the rest is sold locally. Present bamboo marketing system in Palakkad possess considerable degree of efficiency. A reasonable degree of competitiveness in the marketing system ensures a fair returns to the households. In bamboo trading, households receive nearly 48% of the final price (which is high compared to similar forest products), where as the traders and subtraders together receive nearly 27%. The rest comprises the marketing costs such as for felling, grading, transportation, obtaining forest pass, etc. High competition between subtraders, lesser number of intermediaries, increased demand for bamboos and absence of credit relation with traders are the reason for higher share of farmers. The price of bamboos has also increased considerably over the years. For example, the index of current bamboo prices has increased from 100 to 433 between 1988 and 1994. The compound real growth rate of bamboo prices has increased nearly 7% since 1965, and current prices showed an increase of 20% annually. The price of bamboo supplied to the paper industry has increased from

Rs. 700 per tonne in 1984 to about Rs. 1250 in 1994 showing an increase of nearly 79% over 10 years.

Growing bamboos in the homesteads has many advantages. In the homesteads bamboo clumps may get better care in terms of water and nutrients while managing other crops. In the present circumstances, a farmer can easily realize Rs. 1000-2000 annually, if the clumps are managed properly. A systematic financial analysis of homestead cultivation of bamboos (*B. bambos*) in Palakkad under present conditions revealed that bamboo farming yielded Benefit Cost ratio higher than unity. Internal rate of return ranged between 18% to 66%, under different cost conditions, which shows higher return for the investment.

There are also other attributes to view bamboo as a potential crop considering the peculiar conditions existing in Kerala. Because of high cost of labour and other inputs, the profitability of common seasonal crops like paddy, tapioca, banana, etc. are very low. In the case of common plantation crops, (like rubber, coconut, cashew) both the establishment and the maintenance cost is very high. So the profit rate is very low for the large plantations. The long gestation period is also a hindering factor for growing these crops. As home garden crops they may seem to be profitable to small and marginal farmers because the main cost - the labour - is of family labour. The constantly fluctuating prices of these products also causes considerable risk to raise these crops. Compared to this, bamboos command the advantages of less maintenance cost, higher returns and possibility of annual harvest at any time in a year.

Constraints

There are several social, economic, technological, and institutional factors which directly and indirectly, influence the cultivation of bamboos in the homesteads. Although both small and large farmers are interested in growing bamboos in their homesteads, the possession of farmland positively influences their decision towards bamboo farming. Besides, farmland holding, occupation, income, caste, knowledge, etc. also influence the households approach towards bamboo farming. Households who are fully engaged on farming and possessing high share of farm income preferred bamboo farming most. It is also noticed that most of the small farmers who preferred bamboo farming are from backward castes. Where as majority of the large farmers from forward castes preferred bamboo farming than backward castes.

Technical knowledge of farmers regarding farming and marketing is another influencing factor. Lack of knowledge negatively affects the interest towards bamboo farming. Those with adequate knowledge of these aspects are very much interested and preferred bamboo farming. The knowledge seems to be high for those households whose full time occupation is farming and having high farm income.

Many farmers, especially small and marginal farmers, are reluctant to grow bamboo for the fear of shade and root competition between bamboos and other cultivated crops. Farmers generally feel that it is difficult to grow any plants under bamboos because of roots and shade of bamboo clumps. But field experience shows that some farmers have succeeded in growing shade tolerant plants such as ginger, turmeric, etc. under the bamboo clump. These problems also result in conflicts with neighbours. But detopping and trenching around the clumps considerably reduce these constraints. Though this method seems to be effective, very few farmers are resorting to it. The system of clear felling followed by traders is another important factor which reduce the scope of bamboo farming in the homesteads. This practice normally led to complete destruction of the clump or much deferred next harvest. This delays perpetual income from bamboos and consequently reduce the interest of farmers.

There are also institutional factors constraining homestead bamboo farming. This include the legal barriers like the restrictions on the free transport of bamboos. Since bamboos come under the purview of Timber Transit Rules, transit permits from Forest Department are required for transporting bamboos. Obtaining these passes is a cumbersome process and involves considerable transaction costs. Though these costs are borne by the traders, ultimately the burden is shifted to the farmers. Agroforestry extension, credit facilities, subsidies, etc. are limited or does not exist to persuade the farmers to cultivate bamboo.

Conclusion

Bamboos can be considered as a potential crop for homestead farming, providing a supplementary income to the farmer without much effort and investment. The present marketing and price advantages can be considered as the motivating factors for enhancing the cultivation of bamboos. The major constraints in developing bamboos is the lack of awareness of farmers about the potential of bamboos. Proper extension efforts for promotion of bamboo cultivation will be of great help in removing misconceptions of farmers towards bamboo farming. There should also be efforts to disseminate scientific information to strengthen farmers' knowledge. The possibility of identification, and introduction of new species of bamboos which can be grown economically in combination with other crops may have to be explored. Studies on technical parameters like canopy spread, rooting pattern and distribution, standardization of management practices under homestead conditions, etc. have to be carried out which will go a long way in developing bamboo resources in private lands. These steps would not only enhance the future supply of bamboo but also increase the income of the farmer.

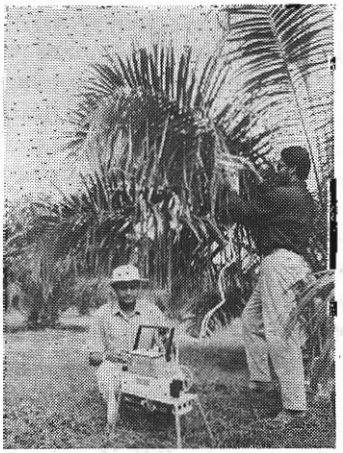
B. Jayasankar
and
P.K. Muraleedharan
Division of Economics

Oil Palm - Caution Required on Its Introduction

Oil palm (*Elaeis quineensis* Jacq.) which evolved in West Africa has been widely introduced to Malaysia, Indonesia, and South America. Noting the incredibly high productivity of this crop in the above countries, oil palm has been introduced to India for more than a century. However, its production in Kerala and Andaman, where it has been introduced on a commercial scale, is not satisfactory when compared to international levels. For example, a hectare of oil palm has been yielding only 700 kg of oil in Kerala, when it is 5 to 6 tons in Malaysia.

One of the latest move by the Federal Government has been the introductory trials of oil palm in the states of Andhra Pradesh, Karnataka, and Maharashtra. KFRI was given the responsibility to monitor the environmental constraints to the performance of the newly introduced oil palm in the above three States. Field measurements of the various microclimatic and physiological parameters have shown that atmospheric temperature, vapour pressure deficit and light availability are very important for oil palms. It was found that in Karnataka and Maharashtra, the temperatures fell to 12 or 14°C when it should not fall much below 20°C. The high vapour pressure deficit in all the three States, is certainly bringing down the photosynthetic rate of the palms. The coastal districts of Andhra Pradesh were found to be the most suitable out of the three States monitored. Any expansion of oil palm in Karnataka or Maharashtra should be done only after further monitoring of the present trial plantations. KFRI studies have clearly shown that while choosing new sites for oil palm introduction, the influence of microclimate parameters on the physiology of the palm should be taken as an important criterion. The study also implies that the reasons for the low productivity of oil palm in Kerala should be seriously looked into.

Jose Kallarackal
Plant Physiology Division



Photosynthesis measurements in oil palm using a portable infrared gas analyser

Caecilians - The Limbless Amphibians

Caecilians, limbless fossorial snake-like amphibians are often mistaken as snakes. They are considered as primitive among the living amphibians because of the presence of filamentous gills and rudimentary scales. These are considered as some of the ancestral characters which make them as connecting link. Body is annulated except the head region like that of an earthworm. The eyes are often hidden and appears as blind so that they are called Kurudi pambu (in Malayalam), means blind snake. Body is elongated with short tail. The tail may be absent in some genera. Head is long with a short tentacle between the eye and nostril. Mouth is armed with teeth which may be in many rows. Body, especially the posterior region have rudimentary cycloid scales.

Caecilians are distributed only in the tropical regions of Asia, Africa, and America. Five genera reported from India include *Indotyphlus, Uraeotyphlus, Gegeneophis, Ichthyophis,* and *Herpele.* Among these, *Herpele* is distributed in eastern India and other four genera occur in western India. *Ichthyophis* is the widely distributed genus among these. Western Ghats of Kerala is the richest zone of Caecilians. Ten species have already been reported from Kerala. Recently one more species *Ichthyophis longicephalus* has been described from Silent Valley National Park. The common species reported from Kerala are *Ichthyophis beddomii, Ichthyophis malabaricus, Uraeotyphlus menoni,* and *Uraoeotyphlus malabaricus.*

Caecilians live in marshy areas and streams and feed mainly on earthworms. Their mode of life makes difficult to locate them in the field and is the main limitation to study this group. Nothing is known about their feeding and breeding ecology.

C.P.Shaji
Division of Wildlife Biology

Heartrot in Natural Forest - Detection, Estimation, and Prediction

In natural forests, heartrot - decay of the central core of heartwood in living tree, is the most important single factor responsible for considerable loss to the standing crop. Usually, heartrot does not set in till the heartwood is formed. Some trees develop visible heartwood earlier, while in others the process is much delayed. In tropical trees, heartwood develops between 10 to 25 years of age, depending on tree species and various site factors. Heartwood comprised of dead tissues is formed by the aging and death of parenchymatal cells in centrally located xylem. It develops centripetally and may or may not involve a pigmentation change.

The central core of heartwood is protected from the decay fungi by the outer living sapwood and the bark. However, when the heartwood becomes exposed due to injuries, decay may establish in the heartwood as heartrot which becomes progressive. Concepts of wood decay are still being formulated and tested. Robert Hartig's original idea that infection occurs only through branch stubs and wounds that expose the heartwood is no longer fully accepted. Much of the extensive research on invasion of stem tissues by decay fungi was stimulated by Shigo's Concepts of Organism Succession and Compartmentalization developed to explain the patterns and progress of decay observed in living trees. Heartrot fungi normally develop only in living trees; when the tree dies, they are replaced by fungi which are better adapted to a saprobic system. Heartrot fungi can be classified as causing either white-rot or brown-rot. The two types of decay differ markedly in physical and chemical characteristics. White-rot fungi degrade cellulose and the hemicellulose at approximately the same rates relative to the original amount present, whereas lignin is decomposed at a similar rate, or usually somewhat faster on a relative basis. Brown-rot fungi utilize the hemicellulose and cellulose of the cell wall at approximately the same rate leaving the lignin essentially unaffected.

Heartrot is common in relatively-aged stands and the intensity as well as the extent of decay depend upon various factors such as stand composition, age, degree of biotic and abiotic interference, site factors, etc. As the decay occurs in the heartwood, tree is not killed outright but it continues to grow and may exhibit all the external appearance of a healthy tree, as the living sapwood remains mostly unaffected, which often result in faulty marking of trees for timber extraction. However, trees affected with heartrot may also exhibit certain external visible signs of decay which are called as decay indicators. In a natural stand, trees belonging to different genera and species, age, diameter classes, and containing heartrot of various extent may exhibit many of these external decay indicators. Depending on the nature, position and frequency of occurrence of these decay indicators, a well experienced forester can detect the potential defective trees in the stand. Thus, the trees suspected to contain extensive decay can either be excluded from the felling list in order to obtain a better out-turn as well as to reduce the logging expenses, or included for salvaging maximum wood and also for saving the stands from excessive losses due to decay, whichever is desirable. However, usually, the significant role of heartrot along with other cull factors in reducing the net merchantable volume of wood has been often overlooked in timber extraction in the country, and hence, the expected out-turn is not always obtained.

Vateria indica tree with heartrot indicators

Prevalence of heartrot in natural forests

In natural forests, prevalence of heartrot in trees and the quantity of wood decayed depend largely on age of the stand, environmental conditions, biotic pressure on the stands as well as various abiotic factors including occurrence of successive annual forest fires. Usually, the tree becomes vulnerable to attack by heartrot fungi as soon as the heartwood develops.

A recent study in representative areas of evergreen, semi-evergreen and wet-evergreen forests in Kerala state by the author revealed that occurrence of heartrot is very high in all the forest areas which ranges from 18 to 24%. Apart from the role of stand composition and site factors, the occurrence and the extent of losses due to decay is found to be mainly influenced by the level of biotic interference, especially the earlier

logging operations carried out in the area. The nature and position of the decay indicators exhibited by the trees, especially hollow, canker and open wound in the bole, rotten branches, etc. show that many of the infection courts of the decay in standing trees may be traced back to the earlier logging injuries.

Fungi associated with heartrot

Despite the diversity of the microbes associated with heartrot of living trees, the degradation of the cell wall components is still ascribable to hymenomycetes. Of the thousands of wood decaying fungi recorded so far, only a few hundred can cause decay in heartwood of living trees. A recent study by the author revealed that 44 polypores belonging to 18 genera were associated with heartrot in trees in different forest areas in Kerala. Most of the fungal species are widely distributed in the semi-evergreen, evergreen and wet-evergreen forests and exhibit a wide host range. While a few species like *Fomitopsis palustris, Hexagonia sulcata, Rigidoporus lineata,* etc. exhibit restricted distribution and very narrow host range. Only nine decay fungi were causing brown-rot and all others were associated with white-rot. Generally, in tropical forests, white-rot fungi dominate over the brown-rot fungi; brown-rot fungi are widely distributed in the coniferous forests.

Heartrot - detection and estimation

Detection and estimation of heartrot in living trees in natural stands is important for exploiting the available timber resources judiciously as well as for a fair and honest deal in logging contracts. The ideal method for detecting and appraising heartrot in living trees should be rapid, simple, accurate and non-destructive. Earlier, destructive sampling methods by felling and dissecting the trees were employed for studying the decay process in trees. Ocular observations on visible external decay indicators exhibited by the trees as well as direct probing into the heartwood of the trees were the non-destructive methods usually used for detecting and estimating the decay in trees. Reliability on the external decay indicators for detecting the decay in different tree species has been reviewed by various workers. However, such data on tropical hardwood species are meagre. In a recent study in Selection Felling Coupes in the State, the author has found that decay indicators like swollen bole, sporophore, hollow bole, canker and open wound, and swollen knot are the reliable indicators in detection and estimation of decay.

Direct probing methods, earlier employed for detecting and appraising the heartrot include: increment boring, radiography, video processor image analyses, measuring the electrical resistance of wood, transmission of ultrasonic energy, etc. The author used Shigometer, an electrical device for quantifying progressive stages of discolouration and decay in wood by measuring the resistance to a pulsed electric current which decreases with increase in concentration of cation due to the discolouration in the wood. A decrease in resistance of at least 75% of the highest reading indicates the deterioration of wood tissues. Even though, Shigometer has been successfully used to detect decay in softwood as well as hardwood species in plantations, the data collected by the author show certain limitations in practical application of the device in tropical hardwood species. Drilling of probe holes in dense wood encountered difficulty and also found more time consuming. The success rate in detection of decay is much lower than that obtained from ocular observations on external decay indicators. Moreover, the use of the technique as a means of detecting decay in living trees, generally has also been questioned.

Heartrot in V. indica

In a destructive sampling study, nearly 66% of the trees belonging to 12 species were found affected with heartrot, entailing a loss of 7.12% of timber. The actual loss in volume may be greater than as indicated, since gross volume of only main bole was accounted.

Heartrot - prediction

Accurate prediction of decay in trees in the natural stands employing non-destructive methods will be of great help in the effective management of forest stands as a whole, as well as for deducing the net out-turn from a particular logging operation. Ocular appraisal employing decay indicators viz., swollen bole, sporophore, hollow in the bole, canker and open wound, etc. was found simple, accurate, and reliable for detecting and estimating the decay in trees in the natural stands. Girth and age of tree are useful variables for the effective utilization as well as management of the stands. In natural forests, where age of the trees cannot be determined, girth forms an important variable in the classification as well as management of the stands for different purposes. There is a direct relationship between girth of the trees and gross volume as well as decay volume. Since heartrot is progressive more and more wood becomes decayed with an increase in tree diameter. As the tree grows, opportunities for the infection also increase, the rate of healing of wounds becomes slow, the relative proportion of heartwood increases with a consequent decrease in the resistance to decay. With the age, the increment of new wood slows down while heartrot progresses, so that at a particular stage

the volume of wood decayed overtakes and then surpasses the new wood added to the tree. From this stage onwards the tree suffers from an increasing net loss year after year. Thus girth of tree is an important variable in estimating the heartrot irrespective of the tree species.

Heartrot prediction equation generated for a mixed natural stand following stepwise regression taking all the decay indicators and tree dbh as variables is as follows:

$$\sqrt{DV} = -0.6999 + 0.24541\,S + 0.22194\,C + 0.73331\,D + 0.11254\,H + 0.37320\,SB$$

where DV = decay volume (m^3), S = sporophore (number), C= canker and open wound(number), D = dbh of the tree (cm), H= hollow bole (number), SB = swollen bole (number). Adjusted R^2 0.65127.

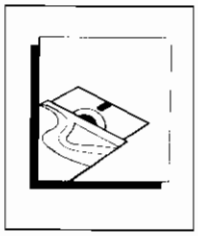
The relative significance of the reliable estimates may vary depending upon the tree species, however, in a mixed natural stand, all the five ocular estimates including dbh of the tree may be used for predicting the decay volume more accurately.

C. Mohanan
Division of Pathology

Average Price of Some Major Industrial Wood

Species (Trade Name)	Average price for 1993 - 94 rate/cu.m (Rs.)
Teak	15,227
Rosewood	29,205
Anjily	6,725
Kambakam	8,787
Thembavu	5,373
Venteak	6,597
Jack	9,022
Irul	5,022
Chadachi	6,562
Kunnivaha	7,244
Karanjily	3,363
Vellapine	1,824

Source : Forest Statistics 1994, KFD



KFRI Stat Pack

Software Package for Statistical Analyses in Forest Mensuration

A software package dealing with certain statistical analyses in forest mensuration has been developed at the Division of Statistics, Kerala Forest Research Institute, Peechi. The package consists of three modules viz., *Sample, Treevol* and *Treebiom.*

Sample is a collection of programmes useful for estimating population parameters like mean, total and ratio for different sampling schemes. The package covers a wide array of sampling schemes involving stratification, multistage and multiphase sampling with systematic or random sampling patterns at the final stage. It also takes care of ratio or regression estimation with an auxiliary variable and performs computations associated with probability proportional to size (PPS) sampling. The programme can handle up to 3 response (main) variables at a time and has built-in data editing facilities.

Treevol is for developing prediction equations for commercial volume at tree level based on measurements of diameter at breast height (dbh) and height or dbh alone. The programme accepts billet level or tree level data, selects the best fitting regression function from a set of candidate functions for predicting commercial volume and provides the user with a volume table for the range specified.

Treebiom is useful for developing biomass prediction equations for the whole tree or its components like stem, branches and leaves based on diameter at breast height (dbh) and height or dbh alone. The programme offers facilities for entering and editing measurements on dry weight and fresh weight of samples, develops estimates of dry weight at tree level, selects the best fitting regression function from a candidate set of functions for predicting biomass and provides a biomass table for the range specified.

The present version of the package is PC based and runs under DOS 3.0 and above. The modules are self-contained, user-friendly and require around 384 KB run time memory. The software is nominally priced at Rs.5,000 per copy. Individual modules can be bought at Rs.2,000 per copy. Interested persons may make a request with a Demand Draft drawn in favour of: The Director, Kerala Forest Research Institute, Peechi.

K. Jayaraman
Statistics Division

Area Under Some Important Plantation Species in Kerala

Species	Area (ha)
Teak	74,946.700
Eucalypts	29,086.400
Acacia	550.200
Casuarina	31.800
Rosewood	163.900
Mahagony	169.900
Grevillia	1,220.100
Albizia	489.700
Wattle	3,810.700
Ailanthus	543.500
Pine	452.200
Sandalwood	11.100
Cashew	4,525.200
Bamboo	1,035.600
Mixed plantation	34,526.100
Other hardwood spp.	846.900
Softwood	787.200

Total area under plantations : 1,55,071.800 ha.

Source : Forest Statistics 1994, KFD

Recent Publications

Research Papers

Gnanaharan, R. 1994. A need for standardization of bending test procedures for bamboo. BIC-India Bulletin, 4 (1 & 2): 43-45.

Benny, A.G. and Bhat, K.M. 1994. Strength properties of *Eucalyptus tereticornis* grown in wet and dry locations of Kerala. J. Indian Academy of Wood Science, 25: 47-50.

Viswanath, S., Surendran, T., Chacko, K.C. and Suresh Chand, 1995. Effect of fruit grading, presowing treatments and media on germination and growth of *Tectona grandis* Linn. f. J. Trop. For., 11: 99-109.

Jayson, E. A. and Mathew, D.N. 1995. Roosting behaviour of common Indian myna (*Acridotheres tristis*) at Trichur, Kerala. Pavo, 33: 31-46.

Sudheendrakumar, V.V., Jalali and Singh, S.P. 1995. Acceptance of the teak defoliator *Hyblaea puera* (Lepidoptera: Hyblaeidae) by two exotic species of Trichogramma (Hymenoptera: *Trichogrammatidae*). J. Biol. Control, 9 (1): 43-44.

Bhat, K.M., Ancy Mathew and Kabeer, I. 1996. Physical and mechanical properties of rattans of Andaman and Nicobar islands (India). Journal of Tropical Forest Products, 2 (1): 16-24.

Indira, E.P. 1996. Species selection for higher productivity in *Ailanthus*. Indian Forester, 122 : 404-408.

Gnanaharan, R. 1996. Technical properties and specifications for Indian rubberwood. In: Proceed. Global Forum on Investment Opportunities in the Indian Rubberwood Industry, 19-21 March, 1996, Cochin. Indian Rubberwood Task Force, Kottaym, Kerala, pp. 113-123.

Muktesh Kumar, Stephen, S. and Joy, C.C. 1996. Report of abnormal branching in two species of orchids from Kerala. Indian Forester, 122: 343-345.

Renuka, C. and Rugmini, P. 1996. Studies on the *ex situ* performance of different species of rattans. Indian Forester, 122: 235-240.

Surekha, K. La Saile, J., Sudheendrakumar, V.V. and Murphy, S.T. 1996. A new species of *Sympiesis* (Hymenoptera: Eulophidae) parasitic on the teak defoliator, *Hyblaea puera*. Bull. Ent. Res., 86: 73-76.

Chandrashekara, U.M. 1996. Strengths and weaknesses of traditional systems of bamboo cultivation in rural Kerala. Agroforestry Forum, 7 (1): 21-23.

Arun, L.K., Shaji, C.P., and Easa, P.S. 1996. A record of new fishes from Periyar Tiger Reserve. J. Bombay nat. Hist. Soc., 93(1) : 103 - 104.

Chapter in Book

Muralidharan, E.M. and Mascarenhas, A.F. 1995. Somatic embryogenesis in *Eucalyptus*. In: S. Jain, P. Gupta and R. Newton (Eds.), Somatic Embryogensis in Woody Plants. Vol. 2, Kluwer Academic Publishers, The Netherland, pp. 23-40.

Popular Article

Pandalai, R.C. Neela amariyum Pachilayum - vilapetta oushadhangal (Malayalam). Karshakashree, March, 1996.

Research Reports

Genetic improvement of *Ailanthus triphysa*. KFRI Research Report, 100. Final Report of the Project No. KFRI 115/87. Investigator: Smt. E.P. Indira, April 1996.

Abstract

Ailanthus triphysa, (Dennst.) Alston, the most suitable species for match industry, needs productivity improvement, since the plantations are pest susceptible and less productive. There is a very high demand for this species while the supply is very much limited. Two of the options for productivity improvement were selection of suitable species of *Ailanthus* and genetic improvement of *A. triphysa*.

Experiments were conducted to study the nature of genetic variability, heritability, and correlation of economically important characters and also the breeding system prevailing in *A. triphysa*. *A. triphysa* has a high family heritability for height and moderately high heritability for basal girth. The single tree heritability was found to be moderately high for height while it was low for basal girth. The phenotypic and genotypic coefficient of variation were found to be low for both characters. Strong positive genetic correlation was noted between height and basal girth which makes the improvement programme easy. Growth characters with high heritability value also make productivity improvement faster in the sense that phenotypic selection without the recourse of progeny test will suffice to a certain extent.

The results from species trial indicate that *A. integrifolia* ssp. *calycina* is better in growth performance in early years in

addition to its quality of pest resistance. But *A. triphysa* is preferred for the match industry since it has aromatic resin in its wood which avoids waxing of splints. It also grows well in degraded and lateritic soil while *A. integrifolia* ssp. *calycina* fails in each type of soils.

Seventy plus trees of *A. triphysa* were selected from natural forests, house compounds and plantations in Kerala and a seedling seed orchard established. The study carried out to understand the breeding system shows that *A. triphysa* is dioecious and strictly cross breeding. Since it is widely out crossing species, intrapopulation variation is expected to be very low.

Studies on growth and architecture of tree species of homegarden agroforestry system of Kerala. KFRI Research Report 101, Final Report of the Project No. KFRI 187/93. Investigator: Dr. U.M. Chandrashekara, February 1996.

Abstract

Characters such as crown architecture, growth, leaf phenology, and branch display were studied in nine forest trees namely *Ailanthus triphysa, Albizia odoratissima, Artocarpus hirsustus, Grewia tiliifolia, Macaranga peltata, Mangifera indica, Tectona grandis, Terminalia paniculata, and Xylia xylocarpa* grown in homegardens of Pananchery Panchayat, Kerala, with a view to assess their suitability as components in homegarden agroforestry systems. Among these *Albizia* and *Xylia* fall under Troll model, while *Grewia* and *Ailanthus* come under Roux and Koriba models respectively. *Mangifera* and *Terminalia* grown under the shade and in the open exhibited different architectural models namely Scarrone under shade and Leeuwenberg in the open. *Artocarpus, Macaranga,* and *Tectona* conform Rauh model. *Albizia, Grewia* and *Xylia* showed the low and dome shaped crown under the shade in contrast to a narrow and conical crown in the open. On the other hand, *Artocarpus, Macaranga, Mangifera, Tectona,* and *Terminalia* have the tendency to develop wider crown in the open in contrast to a narrow and conical crown under shade.

The growth and architectural characteristics of all these species have relevance especially in agrisilvicultural system in which more shade demanding components are used. The study reveals that *Albizia, Grewia* and *Xylia* could be introduced in the early stages of perennial crop establishment as these trees are having the tendency to grow straight with a narrow conical crown under less shade. In the case of *Artocarpus, Tectona* and *Terminalia* orthotropy enhances production of straight timber. But in the early stages of establishment of polyculture agroforestry system, these species may not be suitable as they have the tendency to develop wider crown in relatively open area. However, these trees when introduced in the established agroforestry system may produce straight timber and less crown spread. The study also indicated that foliage phenology is also important in deciding appropriate crop mixture. Some of the species such as *Tectona, Macaranga, Xylia, Terminalia,* and *Grewia* are deciduous in nature and leafless for three to four months. There is scope for cultivating light demanding short duration crops under such trees.

Growth performance of teak nursery stock from genetically better sources for developing improved plantation technology. KFRI Research Report, 102. Final Report of the Project No. KFRI 144/92. Investigators: Smt. E.P. Indira, Sri. K.C. Chacko, Sri. C.N. Krishnankutty, May 1996.

Abstract

In India, efforts were made to standardize the nursery practices in teak since 1840s. The effects of factors like genetic sources, graded seeds, sowing methods, and seed rate on seedling growth have been tested by several workers since long, but the results were often contradictory and inconclusive. In this context, a study was undertaken to suggest methods to improve the nursery technology. The project also envisaged to estimate the mean number of plantable stumps per bed in teak nurseries in Kerala and to suggest an easy and non-destructive plantability criterion instead of the one based on stump diameter that is in vogue at present.

Performance of 31 teak nurseries located in different parts of Kerala has been analyzed in detail with respect of total and plantable stumps. The results revealed that the total number of stumps per standard nursery bed varied from nursery to nursery and the proportion of non-plantable seedlings was found to be much higher in most of the nurseries.

A new plantability criterion was developed based on the height of seedlings with a value in between 23 and 56 cm. For assessing the planting stock in any nursery, this criterion will be of much use since it is easier to adopt and at the same time non-destructive.

Nursery experiments conducted at Palappilly, revealed that fruits having higher germinability are preferable for better nursery stock irrespective of the genetic source and through proper management of the nursery, the proportion of plantable material can be raised to about 90% of the total seedlings in the nursery. The study also shows that the fruit size does not have any influence on seedling growth and hence, there is no need for grading of fruits. However, it was observed that fruits with less than 9 mm dia give less number of seedlings. When the sowing methods were compared, broadcasting was found to be better than dibbling. The results indi-

cate that seed rate can be increased up to 8 kg per standard bed (12 x 1.2 m) for getting more plantable seedlings.

Experiments to compare pit planting and crow bar planting with stumps of different thickness indicated that pit planting is better than crow bar planting and stumps of 1.5 to 2.0 cm dia performed better than stumps of 1.0 to 1.49 cm dia.

A survey of the habitat and distribution of stream fishes in the Kerala part of Nilgiri Biosphere Reserve. KFRI Research Report 104, Final Report of the Project No. KFRI 185/92. Investigators: Dr. P.S. Easa, DR. S. Chand Basha, December 1995.

Abstract

A survey of freshwater fishes was conducted in Kerala part of Nilgiri Biosphere Reserve during 1993-95. The major river systems - Kabani, Vythiripuzha, Chaliyar, Kunthi, and Bhavani were visited and fishes collected using conventional and traditional methods. Physical features of the habitat were qualitatively assessed. Water quality parameters were estimated using standard techniques. Dietary analyses of the most common species were made. A questionnaire survey was conducted among the tribals to understand the traditional fishing methods and to assess their dependence on fish resources.

A total of 91 species were recorded from the rivers in Kerala part of Nilgiri Biosphere Reserve. Kabani and Vythiripuzha harbour 58 species followed by Chaliyar with 50. Twenty four species were recorded from Bhavani and 12 from Kunthi river. Two new species of fishes, *Pangio bashai* and *Homaloptera menoni* were described from Chalikkal and Muthikkulam respectively. New additions to the freshwaters of Kerala and range of extensions were also recorded. Freshwater fishes in the area included 25 species endemic to the Western Ghats and five endangered ones. Water quality parameters were within the optimal ranges in most of the areas. The dietary analyses of selected fishes revealed that majority of them were benthic insectivores. The tribals of the area depend heavily on the fish resources for their own consumption. Fishing methods employed by the tribals are largely destructive to the aquatic system. Major threats to the aquatic fauna in general and the fishes in particular are the unscientific and non-sustainable methods of fishing and pollution due to biotic factors.

Status, food and feeding habits of larger mammals in Chimmony Wildlife Sanctuary. KFRI Research Report, 108, Final Report of the Project No. KFRI 157/92. Investigators: Dr. E.A. Jayson, Dr. P.S. Easa, December 1995.

Abstract

Status, food and feeding habits of larger mammals in Chimmony Wildlife Sanctuary were studied during the years 1992 to 1995, mainly based on observational methods. Vegetation of the Sanctuary is composed of tropical wet evergreen forests, tropical semi evergreen forests, and South Indian moist deciduous forests. Twenty two species of larger mammals were recorded from the Sanctuary. Rare and endangered species like lion-tailed macaque, *Macaca silenus* (Linnaeus); tiger, *Panthera tigris* (Linnaeus) and Kerala forest terrapin *Heosemys silvatica* (Henderson) are reported for the first time from this area. As the density of herbivores was very low, it supported only a small carnivores community.

Prey - predator studies in Eravikulam National Park. KFRI Research Report 105, Final Report of the Project No. KFRI 152/92, Investigator : Dr. P.S. Easa, December 1995.

Abstract

A study was conducted in Eravikulam National Park in the High Ranges of the Western Ghats to identify the prey, species of large mammalian predators. Hair structure of thirty six mammalian species were studied. Distribution and abundance of prey species in the area were estimated from point count and direct sighting methods. Scats of the predators were collected in different seasons and analyzed for identification of prey species from the hair remains.

Hair structure of thirty seven mammals, at proximal, middle, and distal parts were studied and a key prepared. Analyses of the scats indicate that sambar deer formed the major prey species of wild dogs and tiger. Nilgiri tahr was preyed upon mostly by panther. The abundance of prey species and predation are not positive correlated. There had been seasonal difference in the presence of prey species evidences in the scats. However, there is not enough data to arrive at such a conclusion. Morphological adaptations and predator avoidance behaviour of the prey species seem to be the major factors determining the prey predator relations in Eravikulam National Park.

Ecological studies on Bambusa arundinacea Willd. growing in teak plantations of Kerala, India - KFRI Research Report 107, Investigator : Dr. U.M. Chandrashekara, July 1996.

Abstract

A study conducted on ecology of *Bambusa arundinacea* growing in the teak plantations of Kerala demonstrated that in a given landscape bamboo and teak per-

form differentially in terms of biomass production and nutrient cycling. The teak plantation having bamboo growth can be classified into three site types; Type A: plots having 3 or more clumps per 400 m^2 and each clump with more than 20 culms. Type B: plots having 1-3 clumps per 400 m^2 and each clump with 10-19 culms, and Type C: plots having 0-3 clumps per 400 m^2 and if clumps present each with less than 9 culms. Following conclusions were drawn from the study.

Teak does not perform well in Site type A in terms of biomass production and nutrient stability. Even from the nutrient conservation and cycling point of view, teak is not a suitable species for Site type A. This is because the Site type A is rich in potassium and poor in calcium. Since teak has the capacity to store calcium in its biomass as observed in this study, may lead to calcium deficiency in the soil of Site type A which is already calcium poor. At the same time, inability of teak as compared to bamboo to conserve potassium may lead to loss of potassium from the areas like Site type A due to absence of vegetation that can accumulate it at faster rate. Therefore attempts to cultivate teak in areas like Site type A are not advisable.

In areas like Site type B and Site type C which are rich in calcium than in Site type A, the capacity of teak with more enrichment ratio, low release pattern and faster assimilation rate for calcium makes teak suitable for the locality.

In teak plantations, bamboo should be preferred to introduce in areas like Site type A which are suitable to bamboo than for Site types B and C, where bamboo performs either at moderate or poor level in terms of biomass production.

Attempts to retain or introduce bamboo in teak plantations in areas like Site type A can also help in conservation of nutrients as well as make such land as productive as Site types B and C. Therefore, inter-planting of bamboo in teak plantations especially in areas like Site types B and C may not give yield as compared to patch-planting alone in areas like Site type A. Even from the point of view of silvicultural practices and management of teak and bamboo, the patch-planting has several advantages over inter-planting of bamboo in teak plantations.

Consultancy Report

KFRI Cons. 7/95: Trichur forest mapping (IMSD). Investigator: Dr. A.R.R. Menon, August 1996. Forest maps of Trichur District were prepared from 1: 50 000 Geocoded Satellite Imageries and submitted to ISRO, Bangalore.

KFRI Cons. 9/95: Mapping of Upper Pamba river basin. Investigator: Dr. A.R.R. Menon, August 1996. Land cover maps in 1: 50 000 of Upper Pamba river basin were prepared from 1:15 000 black & white aerial photographs and submitted to the Centre for Environment and Development, Trivandrum.

New Research Projects

KFRI 250/96 : Productivity of teak and eucalypt plantations in Kerala.

Project Leader : Director; Principal Investigator : Dr. K. Jayaraman; Investigator : Mr. K.C. Chacko

Objectives: to evaluate the productivity of teak and eucalypt plantations in Kerala.

Funded by : Kerala Forest Department - World Bank
Duration : April 1996 - September 1996.

KFRI 251/96 : Monitoring degraded forests of Kerala

Project Leader : Director; Principal Investigator: Mr. U.N. Nandakumar; Investigator : Dr. A.R.R. Menon; Associates : Dr. S. Sankar, Mr. K.C. Chacko; Resource Persons : Dr. K.K.N. Nair, Dr. K. Sworupanandan, Dr. P.S. Easa.

Objectives: to assess the extent and nature of degraded forests, design and undertake base line surveys to arrive at a global estimate of degraded forests in Kerala and design a monitoring system for the Compensatory Afforestation Scheme currently implemented by KFD.

Funded by : Kerala Forest Department - World Bank.
Duration : April 1996 - September 1996.

KFRI 252/96: Weather data acquisition from selected Wildlife Sanctuaries in Kerala.

Principal Investigator : Dr. Jose Kallarackal

Objectives: to make available the hourly, daily weather data from Eravikulam, Silent Valley, Peechi-Vazhani, and Chimmony Sanctuaries to the Kerala Forest Department and other possible users.

Funded by : Kerala Forest Department (Wildlife Wing).
Duration : 3 years

KFRI 253/96: Micropropagation of important rare and endangered tree species of the Western Ghats.

Investigator: Dr. E.M. Muralidharan

Objectives : to develop tissue culture methods for mass propagation of the selected rare and endangered tree species of the Western Ghats, to harden micropropagated plantlets and transfer them to soil, and to reintroduce the micropropagated plants in the natural habitat and monitor their performance.

Funded by: Kerala Forest Department (Wildlife Wing)

Duration : 3 years (May 3 1966 to May 2 1999)

KFRI 254/96: Development and dissemination of low-cost techniques for micropropagation of *Kaempferia galanga* (Kacholam).

Investigator : Dr. E. M. Muralidharan

Objectives : to develop a simple and low-cost micropropagation techniques for application in rural household/small scale units for Kacholam (*Kaempferia galanga*) and to disseminate the knowledge through a training course.

Funded by : STEC, Govt. of Kerala

Duration : 2 years

KFRI 255/96: Seed handling and nursery practices for selected forest trees of Kerala.

Project Co-ordinator: Sri. K.C. Chacko; Investigators : Sri. K.C. Chacko, Dr.K.K. Seethalakshmi, Dr.C. Mohanan, Dr. George Mathew.

Objectives : to develop a package of practices for seed handling and nursery management of selected forest tree species, and to produce a field manual of nursery practices of important forest tree species.

Funded by : Indian Council of Forestry Research and Education (ICFRE), Dehra Dun

Duration : 3 years

KFRI 256/96: Assessment of field performance of micropropagated plants.

Investigators: Dr. E.M. Muralidharan, Dr. R.C. Pandalai

Objectives : to plant out micropropagated plants of *Eucalyptus tereticornis* and *Tectona grandis* (teak) in a field trial with appropriate controls and to assess the survival and early growth performance of the plants as compared with the controls.

Funded by : ICFRE, Dehra Dun

Duration : 3 years

KFRI 257/96 : Improvement of productivity of eucalypts and acacias.

Principal Investigator: Dr. J.K. Sharma; Investigators : Dr. M. Balasundaran, Smt. E.J. Maria Florence, Sri. T. Surendran, Dr. M. Balagopalan.

Objectives: to improve the productivity of selected pulpwood species, such as eucalypts and Australian acacias through selection, clonal multiplication and provenance trials.

Funded by: ICFRE, Dehra Dun

Duration : 3 years

KFRI 258/96 : Evaluation of high input management on growth and timber production in teak.

Principal Investigator : Dr. K.M. Bhat; Investigators : Sri. K.C. Chacko, Dr. M. Balagopalan.

Objective: to eavaluate high input management on growth and timber production in teak.

Funded by : ICFRE, Dehra Dun

Duration : 3 years

KFRI 259/96 : Developing a GIS-based management information system for forest plantations - a case study of Trichur Forest Division.

Principal Investigator : Sri. U.N. Nandakumar.

Objective: to develop a GIS-based management information system for forest plantations in Trichur Forest Division

Funded by : ICFRE, Dehra Dun

Duration : 3 years (April 1996 - March 1999)

KFRI 260/96: Vegetation mapping and analysis of Neyyar Wildlife Sanctuary using remote sensing techniques.

Principal Investigator: Dr. A.R.R. Menon; Associate: Assistant Wildlife Warden, Neyyar Wildlife Sanctuary

Objectives: Vegetation mapping and analyses of Neyyar Wildlife Sanctuary using remote sensing techniques.

Funded by : Kerala Forest Department (Wildlife Wing)

Duration : 3 years (September 1996 to September 1999)

KFRI/Cons.10/96: Minimizing the deterioration of outdoor stored pulpwood.

Investigators: Dr.R. Gnanaharan, Dr.R.V. Varma, Dr.M. Balasundaran
Objective: to minimize the deterioration loss of pulpwood, especially reed bamboo and pine.

Funded by: M/s. Hindustan Newsprint Ltd.

Duration : 5 months (June-October 1996)

Participation in Seminars Symposia and Workshops

International

Dr. P.S. Easa attended IUCN Asian Elephant Specialist Group Meeting held at The Asian Institute of Technology,

Bangkok, Thailand during March 11-13, 1996 and presented a paper on Human - elephant conflict - a case study from Kerala.

Dr.K.K. Seethalakshmi attended the Tree Biotechnology Liaison Group Meeting at the University of Bath, U.K. during 2-4 April 1996 and presented a poster on Auxin and adventitious root initiation in *Eucalyptus*.

Dr.J.K. Sharma and Smt. E.J.M. Florence attended the Project Workshop on Diseases of Exotic Acacias held at Subanjerji, Indonesia during 28 April to 3 May 1996. They presented the results of the completed project - Fungal pathogens as a potential threat to tropical acacias - a case study of India.

Dr. R.V. Varma attended the International Workshop on Hypsipyla Shoot Borer in Meliaceae held at Kandy, Sri Lanka during 20-24 August 1996 and presented a Country Report on the shoot borer infestation.

National

Dr. R.C. Pandalai attended a one day Environment Awareness Seminar at Nattika on 11 March 1996 and delivered a lecture on 'Water and soil conservation through tree planting.'

Dr. R. Gnanaharan participated in the Global Forum on Investment Opportunities in the Indian Rubberwood Industry held at Cochin, during 19-21 March 1996 and presented an invited paper.

Dr. E.M. Muralidharan participated in the National Seminars on Biotechnology of Spices and Aromatic Plants held at Indian Institute of Spices Research, Calicut during 24-25 April, 1996.

Dr.R. Gnanaharan attended the Indian Rubberwood Task Force Meetings held at Kottayam, Kerala on 2 and 16 May 1996.

Sri. U.N. Nandakumar attended a one day Regional Workshop on Indian Remote Sensing Satellite (IRS-IC) Mission and Its Application Potential held at the Centre for Earth Science Studies, Thiruvanathapuram on 22 May 1996.

Training

International

Dr. George Mathew attended 1st International Short Course on Sustainable Tropical Forest Management organized by Universiti Pertanian Malaysia and Forest Research Institute of Malaysia during 19 November to 2 December 1995.

Dr.K.K. Seethalakshmi was nominated for Technical Collaboration Training Award, ODA, U.K. for 11 months starting from 27 May 1995 and received training in Micropropagation and Molecular Biology from the University of Bath and in Hormone Biochemistry from IACR, Long Ashton Research Station, University of Bristol.

Dr. V.V. Sudheendrakumar, Scientist, Division of Entomology attended a four months advanced training in Insect Virology at NRI, U.K. from 23 March to 22 July 1996 under the Technical Collaboration Training Award, ODA, U.K.

National

Sri. C.K. Somen, Senior Scientific Assistant, Plant Physiology Division participated in a training course on "Electronics for Agricultural Field Investigations" organized by the Central Institute of Fisheries Technology, Cochin as a part of the ICAR programme from 19 to 24 August 1996.

Training Imparted

On the Job Training Programme on Teak Pest Management was organized by the Division of Entomology to train Ms. Win Win Myint, Asst. Director, Forestry Protection Division, FRI, Union of Myanmar from 21 May to 20 June 1996. The training programme included both theory and practicals related to various aspects of teak defoliator management, field work, visits to other Research Institutions, etc. The skills acquired by the trainee include rearing of *H. puera*, establishment and maintenance of light traps and automatic weather station and collection of data, identifying microbial pathogens, isolation, purification and lab bioassays, and analysis of data using computer.

At the end of the training programme, Mrs. Win Win Myint gave a presentation on the new knowledge and skills acquired by her.

Guest lectures

Dr. Jose Kallarackal gave a series of six lectures to the M.Sc.(Forestry) students of Kerala Agricultural University on Tree Physiology and Ecophysiology on 15 and 18 May 1996.

Dr. P.S. Easa delivered a lecture on 'Role of youth in diversity conservation' at the Department of Cooperation and Banking, Kerala Agricultural University in connection with World Environmental Day.

Radio Talk

Sri. K.C. Chacko delivered a talk on 'Utilization of degraded forest land' for broadcasting on 1 August 1996.

Dr. R.C. Pandalai delivered a talk on 'Planting of bamboo for soil conservation' for broadcasting on 31 August 1996.

Campus News

Sports and Games

As in the previous years KFRI participated in the 10th Kerala State Forest Sports and Games Meet held at Kottayam during 22-26 May 1996 and secured a total of 51 points. As compared to the previous years, this was a remarkable performance (21 points in 1994 and 22 points in 1995).

Events	Prize won	Name of athlete
Men		
Swimming 50 m freestyle	I	Mr. K. Mohanadas
Swimming 100 m freestyle	I	Mr. K. Mohanadas
Power lifting 67.5 kg.	I	Mr. K. Mohanadas
Power lifting 67.5 kg.	II	Mr. C.K. Vincent
Men above 45 years		
Swimming 50 m freestyle	II	Mr. K.R. Mukundan
Swimming 100 m freestyle	I	Mr. K.R. Mukundan
Shuttle-Singles	II	Mr. K.C. Chacko
Shuttle-Doubles	II	Mr. M.C.K. Nair & Mr. K.C. Chacko
Table Tennis-Singles	II	Mr. K.C. Chacko
Table Tennis-Doubles	I	Dr. R.V. Varma & Mr. K.C. Chacko
Javelin throw	III	Mr. K. Girijavallabhan
Men above 50 years		
Javelin throw	I	Mr. K. Chandran (shared by two athlets)
Women		
Javelin throw	I	Dr. K.K. Seethalakshmi
Shot put	III	Dr. K.K. Seethalakshmi
Team Captain		**Mr. K. Mohanadas**

Distinguished Visitors

Mr. Lionel Jayanetti, Head, Overseas Operations, Trada Technology Limited, Buckinghamshire, U.K. visited the Wood Science Division on the 18 March 1996.

Mr. M.F. Ahmed, Inspector General of Forests, visited KFRI Subcentre Nilambur and Teak Museum on 2 July 1996.

Mr. Norman Jones, Forestry Specialist & Consultant for World Bank visited KFRI Subcentre Nilambur and Teak Museum on 2 July 1996.

Dr. Patrick Durst, Regional Forestry Officer, FAO, Regional Office for Asia Pacific, Bangkok visited the Institute on 22 July 1996.

Dr. D.D. Awasthi, Lichenologist and INSA Scientist visited the Institute during 11-21 March 1996. The visit was in connection with the studies on the Lichen flora of the Western Ghats undertaken by the Botany Division.

Dr. M.R. Das, Director, Rajiv Gandhi Centre for Development of Education, Science and Technology, Thiruvananthapuram visited the Institute on 23 August 1996.

Prachya Musikasinthorn, Laboratory of Ichthyology, Tokyo University of Fisheries, visited the Wildlife Division on 14 June 1996.

Dr. K.C. Jayaram, D.Sc.,F.N.A.Sc., Joint Director (Retd.), Zoological Survey of India, visited the Wildlife Division on 10 June 1996.

KFRI Seminars

Dr. Patrick Durst, Regional Forestry Officer, FAO Regional Office for Asia Pacific, Bangkok, delivered a talk on FAO forestry activities in the Asia Pacific region on 22 July 1996.

Dr. M.R. Das, Director, Rajiv Gandhi Centre for Development of Education, Science and Technology gave a talk on 'Molecular basis of life' on 23 August 1996.

Dr. D.D. Awasthi, Lichenologist and INSA Scientist gave a talk on Lichenology on 21 March 1996.

National Parks, Sanctuaries and Biological Parks in Kerala

National Parks	Year of formation	Area (ha)
1. Eravikulam National Park	1978	9,700
2. Silent Valley National Park	1980	8,952
Sanctuaries		
1. Periyar Wildlife Sanctuary (Tiger Reserve)	1950	77,754
2. Peechi - Vazhani Wildlife Sanctuary	1958	12,500
3. Neyyar Wildlife Sanctuary	1958	12,800
4. Parmbikulam Wildlife Sanctuary	1973	28,500
5. Wayanad Wildlife Sanctuary	1973	34,446
6. Idukki Wildlife Sanctuary	1976	7,000
7. Peppara Wildlife Sanctuary	1983	5,300
8. Thattekkad Bird Sanctuary	1983	2,516
9. Aralam Wildlife Sanctuary	1984	5,500
10. Chimmony Wildlife Sanctuary	1984	7,500
11. Chinnar Wildlife Sanctuary	1984	9,044
12. Shenduriny Wildlife Sanctuary	1984	10,032
Biological Park		
Agasthyavanam Biological Park	1993	2,300
Biosphere Reserve		
Nilgiri Biosphere Reserve* (NBR)	1986	145,500

The total area of NBR is 552,000 ha of which 152,700 and 253,800 ha are in Karnataka and Tamilnadu respectively.

Training Programme/Workshop Organized

KFRI organized a one week training to farmers on "Teak cultivation and Management" from 27 June to 3 July 1996. Sri.P.R. Kurup, Hon'ble Minister for Forests, Kerala, inaugurated the Training Programme in a function presided over by Sri.C.N. Jayadevan, M.L.A., Ollur. Sri. T.R. Raghavan Nair, PCCF and Sri. C.M. Damodaran, President Pananchery Panchayat addressed the gathering. Dr.K.S.S. Nair, Director, KFRI welcomed the gathering and Dr.R.V. Varma Convener of the Training Programme proposed vote of thanks.

Twenty farmers, including ten women took part in the training programme. The lecture classes included various aspects related to teak cultivation and management. Practical demonstration included teak seed grading, teak stump preparation, major insect pests and nature of damage, measuring teak trees, etc. As part of the training, the trainees were also taken to Nilambur for two days field trip and visited teak plantations, nurseries, and Teak Museum.

The resource persons from KFRI included Sri.K.C. Chacko, Dr.R.C. Pandalai, Sri.U.N. Nandakumar, Dr.S. Sankar, Dr.M. Balagopalan, Sri.Thomas P Thomas, Dr.C. Mohanan, Dr.R.V. Varma, Dr. George Mathew, Smt.E.P. Indira and Sri. C.N. Krishnankutty. Sri. Manoharan, IFS, CCF and Prof. Oomen Mathew, IMG also served as resource persons. An information bulletin "Teak" in Malayalam was brought out on this occasion.

On the concluding day certificates were issued to the participants by Mr. Chris Keil, Forestry Specialist of the World Bank, who was on a visit to KFRI.

Paulownia

Paulownia, native to China, is a fast growing, high yielding species suitable for a wide range of situations. It could be an ideal tree for use in plantations and agroforestry in many parts of the world, providing fuel, fodder and timber to local people, thus helping alleviate pressure on natural forests.

In India, different clones of the species have been raised on a trial-scale at Dehra Dun, U.P. by Social Forestry Research Wing (FRI). The growth performance of the species seems to be promising.

The Institute of Scientific and Technological Information of Forestry at the Chinese Academy of Forestry in Beijing, China, is willing to share the management technology of *Paulownia* with any institution or individual through providing plant material, training courses, personal exchange, etc.

Contact : Mr. Meng Yongqing
Associate Professor, P.O. Box 39
Chinese Academy of Forestry
Beijing - 100 091
People's Republic of China.

Sri.. P.R. Kurup, Hon'ble Minister for Forests, Kerala, inaugurating the Training Programme

Forthcoming Forestry/ Environment Events

3-6 December 1996. Biodiversity, Conservation and Management at the Beni Biosphere Reserve. La Paz. Contact: Carmen Miranda, Academia Nacional de Ciencias de Bolivia, Av. 16 de Julio 1732, Casilla 5829, La Paz, Bolivia; Fax 591-2-350 612. Email cMiranda @ebb.bo.

25 February-1 March 1997. 1997 International Symposium on Human Dimensions of Natural Resource Management in the Americas. Belize City, Belize. Contact: Jennifer Pate, Symposium Coordinator, Human Dimensions in Natural Resource Unit, College of Natural Resources, Colorado State University, Ft. Collins CO 80523, USA. Fax 1-970-491 2255; Email ipate@cnr.colostate.edu.

March 1977. International Symposium on Sustainable Utilization of Biodiversity. SAI Institute of Environment. Contact : The Convenor, International Symposium on Sustainable Utilization of Biodiversity, 374, Mohit Nagar, Lane No. 13. P.O. New Forest, Dehra Dun 248 006 (UP), India.

12-17 May 1997. Forestry in a Changing Political Environment: Challenge for the 21st Century, Victoria Falls, Zimbabwe. Contact: The Secretary General, the 15th Commonwealth Forestry Conference, Forestry Commission, PO Box HG 139, Highlands, Harare, Zimbabwe, Ph. 263-14-09 8430. Fax. 263-14-49 7066.

7-12 July 1997. Forest Products for Sustainable Forestry, Pullman, USA, IUFRO Division 5, Contact: WSU Conference and Institute, Ph. 1-509-335 0945; Email wsuconf@mail.wsu.edu.

13-22 October 1997. Forestry for Sustainable Development: Towards the 21st Century. XI World Forestry Congress, Antalya, Turkey. Contact: Mesut Y.Kamiloglu, Secretary General, XI World Forestry Congress, Ministry of Forestry, Ataturk Bulvari 153, Ankara, Turkey; Ph 90-312-417 7724; Fax 90-312-417417 9160; Email obdi-f@servis.net.tr.

Educational Videos (VHS)

The Teak Defoliator

A 20 minute scientific documentary produced by the Kerala Forest Research Institute on the teak defoliator, *Hyblaea puera* (Lepidoptera), the most dangerous forest plantation pest of the Asian tropics.

Depicts the biology and the spectacular drama of the pest population outbreaks and defoliation which no words can fully describe.

Summarises our present knowledge on outbreak causation and suggests management methods.

Priced at US$ 50 per copy. Add US$ 30 for packing and postage. Special rate of Rs. 600 for bonafide users within India.

Bamboo - A Crop

A 22 minute documentary video on Bamboo - A Crop (English) - മുളയും. വിളയാണ് (Malayalam) produced by KFRI to use it as a communication medium to promote cultivation and management of bamboo as one of the crops in rural Kerala.

Depicts the traditional knowledge of bamboo clump management for obtaining sustainable yield, on-farm experiments on undercropping of bamboo, cultivation in low rainfall dry agroclimatic zone and on kole bunds, scientific methods of propogation, supply and demand of bamboo, and economics of bamboo cultivation.

Priced at Rs. 500 per copy.

Available from : The Librarian,
Kerala Forest Research Institute,
Peechi - 680 653, Trichur, Kerala, INDIA

Please make the Demand Drafts payable to Director, Kerala Forest Research Institute, Peechi.