

## CHAPTER-IV

### INSTITUTE OF WOOD SCIENCE AND TECHNOLOGY BANGALORE

In 1988, forestry research in India was reorganised with the setting up of Indian Council of Forestry Research and Education. The erstwhile Forest Research Laboratory at Bangalore, was upgraded and named as Institute of Wood Science and Technology (IWST) annexing Sandal Research Centre, and Minor Forest Products Unit functioning in the same campus with it. This Institute carries on research relating to forestry, forest products and non-wood forest products and caters to the needs of States of Karnataka, Andhra Pradesh, Goa, Daman and Diu.

Highlights and results of the activities of Institute during the year 1996-97 are given below:

#### WOOD PROPERTIES AND USES

1. In collaboration with Forest Research Institute (Botany Division), Dehra Dun, anatomical structure of 27 species belonging to 12 genera of Indian coniferous woods was investigated and the results were published in the form of a book.
2. Timbers alternative to rosewood, Red sanders, Sandalwood, Walnut etc. (extensively used in handicrafts by artisans) have been suggested. As the end product is dependent upon anatomical structure, properties and colour of the wood, these details alongwith tree form and distribution were given for 37 species.
3. Detailed anatomical description of 10 species alongwith multiple card key features have been completed for the purpose of identification.
4. Pith to periphery variation on various anatomical features of 10 lesser known timber species indicated that there is a definite trend of increase in length, diameter and tissue proportions of various elements with respect to radial positions.
5. Influence of anatomical features of *teak* and *Cupressus* species on growth rate, specific gravity, etc. was studied.
6. Variations in fibre characteristics, specific gravity, pulp yield, and other qualities for 3 clones of *Eucalyptus tereticornis* (four and half year old) have been studied for assessing the wood quality of different clones.
7. Work on determining physical and mechanical properties of 15 year old *E. tereticornis*, within tree variation of 30 year old tree of the same species grown in Bangalore, and 8 year old *Tecomella undulata* grown in Agro-forestry model in Tamil Nadu have been completed. Evaluation work is in progress.
8. Elastasonic technique, (an NDT method) was tested on *Eucalyptus tereticornis* and *silver oak*. Data are being processed for determining modulus of elasticity.
9. Preparation of software for computer assisted wood identification is in progress.
10. A software called CALPRO to calculate strength properties, suitability indices and classification of timber has been developed and is being further upgraded.

11. Density and calorific values of *Acacia tortalis*, *A. nilotica*, *A. eburnea*, *A. cupressiformis* and *Tectona grandis* have been determined for their use as fuel wood.
12. Quarterly market survey of the price trends of logs and sawn timber of teak, *Eucalyptus*, *Casuarina* and Bamboos was conducted in Bangalore and Hyderabad. The information thus collected is pooled at ICFRE, Dehra Dun, and published as bulletins for distribution.

#### Technical services

- a. A total number of 592 samples of wood and wood products received from various agencies and public have been examined, identified and reported upon (Total samples received 4607). Moisture content of 39 samples was determined and 14 specific gravity/density tests were conducted and reported.
- b. A number of samples of wood and wood products received for determining various physical and mechanical properties from public in general has been tested and reported upon. A number of technical enquiries on wood utilisation aspects has also been attended to.

#### WOOD SEASONING AND PRESERVATION

Wood cells, during growth of a tree, tend to contract in the fibre direction and expand transversely against restraining forces of adjoining older wood cells. In this process latent stresses are generated inside wood, which are termed as growth stresses. These inherent growth stresses pose problems in obtaining sound material during the process of felling, conversion and seasoning of timber. Since stress level forms an indicator for choosing the right technique of sawing to maximise outturn, longitudinal growth stresses in stems of different forms of *Eucalyptus tereticornis* and *Acacia auriculaeformis* were determined. The pattern and intensity of stress in *Eucalyptus* were high at bottom portions and comparatively low near upper portion (below first branch), while in *Acacia auriculaeformis*, it was high in the middle portions compared to bottom and top portion of stems.

Wood, being hygroscopic material, shrinks or swells, as its moisture content, vary due to influence of fluctuating atmospheric humidity causing dimensional distortions. Hence, knowledge on variation in its dimensional behaviour is essential for prescribing appropriate working allowances in joinery and fabrication of wooden items. Coefficient of anisotropic shrinkage of *Acacia auriculaeformis*, a timber from fast grown plantations was found to be equal in magnitude to that of teak. This fact helps in classifying the timber for value added uses.

Effect of different anhydride treatments in inducing dimensional stability in Rubber wood, which is abundantly used for doors, windows and furniture in Southern part of the country, was investigated. Among the three anhydrides (Acetic, Maleic and Phthalic anhydride) tested, acetic anhydride was found to be most effective in imparting dimensional stability.

*Pterocarpus marsupium* wood, which is rich in water soluble extractives, generally produces red-to-brown stain over paint coating and tarnishes the appearance produced by paint coatings. Pre-treatment of surface with appropriate combinations of inorganic chemicals viz., ammonical copper chrome ferricyanate, ammonical copper chromate, acidic copper chrome

arsenate, and acidic copper chromate, was found to arrest the leaching of extractives effectively.

Life of timber could be enhanced by treating them with wood preservatives like CCA and CCB. Performance studies carried out on test stakes of *Hevea brasiliensis*, *Eucalyptus tereticornis*, *Eucalyptus camaldulensis* and *Ficus bengalensis* in treated and untreated conditions indicated that all treated specimens having minimum absorptions level were in sound condition over a period of 42 months of exposure. Untreated stakes of rubberwood were, however, completely destroyed within a period of three months and few stakes of untreated *Eucalyptus tereticornis* had mild attack of termites. Ninety-five *Bombax ceiba* logs were treated with wood preservatives (CCA ) for fabrication of catamarans.

#### Technical services

- a. Sixty-eight wood samples received from Government/private agencies were analyzed for preservative content.
- b. Technical advice on Seasoning/Preservative treatment methods was given to a number of parties, represented by Government and private agencies.

#### CHEMISTRY OF FOREST PRODUCTS

Forests have been a rich source of several non-wood products. Chemical investigations on wood and non-wood forest products include screening, isolation of useful constituents, and qualitative improvement for value addition and rational utilization of dwindling resources.

Oils of perfumery value were prepared from *Eucalyptus* hybrid leaf oil, which is not otherwise put to any major use, by treating it with less expensive laboratory chemicals. Sensory evaluation of the modified oils was in progress with a view to standardising the method for producing oil of good perfumery value. Elimination or reduction of cineole content in the oils enhances the pleasant aroma and may help in its use in perfumery or agarbathi.

Scientific debarking experiments were carried out on sixty-one trees of *Machilus macrantha* and *Cinnamomum iners* in Somwarpet, Kodagu district, Karnataka, before the onset of monsoon. Leaving one or two strips of bark intact along the trunk of the tree and spraying the trees with insecticide/fungicide mixture helped in its survival. Regeneration of bark (Jigat) was found to be satisfactory with least damage to the trees. These trees are otherwise over-exploited with often fatal results, due to increasing demand for 'Jigat' in agarbathi. Work on the extractives of bark is in progress with a view to isolating useful compounds.

A simple method to isolate santalins, the red pigments of Red sanders wood was developed. Effect of visible/UV light on the wood was studied (the wood darkens in colour on exposure to light). A simple and rapid method of estimating oil content in small (core) sample of sandalwood by UV spectroscopy of hexane extract of 100 mg of sandalwood powder at 214 nm was developed to screen a large number of trees of different age groups.

#### Technical services

- a. Analytical service was rendered to State Police/Forest departments and public in analysis of essential oils from sandalwood samples and other oil-bearing NWFPs.
- b. A number of technical enquiries from Govt. departments and public on utilisation of various non-wood forest products was attended to.



Scientifically debarked *Machilus macrantha* tree -  
leaving strip of bark right through.



Longitudinal section of a teak log showing the  
tunnels produced by heartwood borers.



Treated catamarans ready for launching at Visakhapatnam beach.



Severe defoliation of *Rhizophora* leaves by bag-worms (several pupae can be seen hanging from the lower surface of leaves).

## WOOD BIODEGRADATION

Investigations were carried out on pathological and entomological problems of nurseries, natural forest, and plantations; and wood-deteriorating organisms under terrestrial and marine conditions with a view to evolving effective control measures.

### Maintenance of wood-decaying fungi

Different species of decay causing fungi were maintained in the laboratory by repeated culturing. The organisms are being used for bioassay work. Investigations on the efficacy of different fungal metabolites to prevent decay were also carried out.

### Comparative efficacy of wood preservatives

Rubber-wood samples treated with 'wood guard', fractions of creosote, and different concentration and combinations of K-othrine and Derosal were exposed to various wood-decaying fungi. The results are being analyzed. Similarly, different wood-protective chemicals from Moldrup Systems (Singapore) are being tested against sap-stain and decay fungi under Indian conditions.

### Studies on biofertilizers

VAM spores extracted from rhizosphere of different tree species were multiplied in pot culture using maize as nurse seedlings. Experiments were conducted using teak plants to study the comparative efficacy of VAM inoculum vis-a-vis organic and inorganic fertilizers. Better growth-rate was recorded by VAM-inoculated plants. Similarly, *Acacia auriculiformis* also performed well with VAM in mine-dump soil.

### Bionomics and control of pests in forest nurseries and plantations

Sandal plantations at Gottipura, Nallal and Yelwala were surveyed frequently for pest management. Though the spread of infestation by lac insect on sandal could be kept under control, sporadic fresh incidence of young nymph during May-June was observed on some trees. To contain this build-up of lac colonies, 0.1 to 0.4% of Rhogar/Ekalux/Cypermethrin was found to be effective.

Incidence of stem borers, *Aristobia octofasciculata* and *Zeuzera coffeae* was high on sandal trees at Yelwala. Occurrence of *Ceroplastes ceriferus* was also observed. Another major pest of sandal in Bangalore and Hoskote was *Inglisia bivalvata*. *Pongamia pinnata*, *Polyalthia* sp., *Acacia mangium* and *Dalbergia sissoo* have been recorded as collateral hosts of this pest. Severe infestation of the scales led to die-back and mortality of sandal plants. Detailed study revealed that the females of this pest are stationary and the pinkish red males are biwinged. Five species of parasites belonging to *Eulophidae*, *Encyrtidae* and *Aphelinidae* were collected from this pest and studied for the biological control of the latter. Quinalphos or Chlorpyrifos (0.2%) was effective in controlling the pest.

Five villages each in Karnataka and Andhra Pradesh, selected by I.W.S.T. for the U.N.D.P. Project activities, were visited during different seasons to observe the defoliators and other pests on teak plants grown under agro-forestry programme. 10 to 30% of trees in Karnataka were infested by *Indarbela* sp. and also by arboreal termites during summer months. The trees were also affected by spittle bugs (up to 10% of trees) and by coccids in the rainy season. Attack by defoliators (*Eutectona machaeralis*) and leaf-galls was very high during October-November. Parasitism by *Apanteles* sp., and by an ichneumonid parasite was also more.

Nursery plants of *Sapindus emarginatus* suffered high mortality due to attack by defoliators and fungi. Occurrence of white flies during summer was observed on almost all the plants of *Michelia champaka* grown as avenue trees in Bangalore. *Swietenia macrophylla* was found to harbour a coccid on all branches. They produce a copious secretion of honey dew. Based on the data collected, control measures were suggested.

#### **Studies on insect pests problems of timber in storage, building materials, structures etc.**

Incidence of attack by powder-post beetles and termites on wood in buildings and structures has been more during the summer months. Experiments were undertaken in the laboratory and field conditions using rubberwood stakes (30 cm x 3.8 cm x 3.8 cm and 10 cm x 2.5 cm x 2.5 cm) treated with chlorpyrifos formulations available in the market. Stakes were treated with 1% solution by pressure impregnation and also by dipping. All the 3 treatments provided protection against termites and borers during the observation period of about 1 year.

#### **Bionomics and control of defoliators and wood-borers of teak**

Teak forests in the districts of Dharwad and N. Kanara in Karnataka, were surveyed to study the incidence and distribution of the teak heartwood borer, *Alcterogystia cadambae*. The trees near tribal inhabitations were found to be more prone to the attack. Two major timber depots (1) Dandeli depot and (2) Kirwatli depot were inspected to assess the level of timber damage by the borers. Random sampling revealed that 15-20% of teak timber is damaged by the heartwood borer, in varying degrees.

### **MARINE WOOD BIODETERIORATION**

#### **Natural durability of different timber species and panel products under marine conditions**

Data on natural resistance of different species were collected by exposing test panels in different locations. 54 timber species were exposed in Kochi waters, 25 timber species in Goa waters and 8 species in Visakhapatnam waters. Among the 54 species exposed in Kochi waters, *Madhuca latifolia*, *Dipterocarpus indicus* and *Hopea parviflora* offered good resistance and suffered only 5%, 8% and 15% damage respectively after 7 months, whereas *Syzygium hemisphaericum*, *Terminalia bellerica* and *Gliricidia maculata* underwent 40% to 50% destruction at the end of same period. Other 11 timbers, namely, *Anogeissus latifolia*, *Artocarpus heterophyllus*, *Artocarpus hirsutus*, *Eucalyptus camaldulensis*, *Michelia champaka*, *Pterocarpus marsupium*, *Tectona grandis*, *Terminalia alata*, *Terminalia bialata*, *Terminalia crenulata* and *Terminalia paniculata* underwent 60% to 75% deterioration in 7 months. The rest of 37 timber species were completely destroyed (76% to 99%) within 3-7 months.

Species studied at Visakhapatnam for their natural durability were *Pinus kesiya*, *Chukrasia velutina*, *Morinda citrifolia*, *Ficus mysorensis*, *Samanea saman*, *Melia dubia*, *Bombax ceiba* and *Albizia falcataria*. At this station also, all the timber species were attacked within six months and *B. ceiba* and *P. kesiya* had to be rejected at the end of 6 and 7 months respectively.

#### **Durability of preservative-treated timber under marine conditions**

(i) Test panels of rubber-wood were treated with CCA and CCB compositions by pressure impregnation using an 8% solution of the preservatives. Size of the panels was 30 x 3.8 x 3.8 cm. They were treated to a retention of 16 kg and 32 kg salts of CCA per cubic metre and 24 kg and 40 kg salts of CCB per cubic metre. Each retention was tested in triplicate.

At both the localities tested (Betim and Kochi), fouling encrustation was quite high (even within a month after exposure of treated panels) necessitating its frequent removal. Such heavy biofouling accumulation indicates inefficacy of preservative treatments. Wood-borers present in the panels in Goa were : *Martesia striata*, *Nausitora hedleyi*, *Bankia rochi*, *Lyrodus pedicellatus* and *Dicyathifer manni*. In Kochi waters, the destruction was brought out by borers like *M. striata*, *N. hedleyi* and *L. pedicellatus*. Very rare occurrence of *Teredo clappi*, *Teredo furcifera* and *Bankia campanellata* was also observed. Sphaeromatids, which are common in Kochi backwaters, were conspicuously absent on the panels.

The intensity of attack at both localities was such that the control panels were completely destroyed within a period of 4 to 6 months. Even the treated panels failed at lower dosage and panels treated with CCA at 16 kg per m<sup>3</sup> and CCB at 24 kg per m<sup>3</sup> underwent an average internal destruction of 50% and 40% at Betim and 60% and 32% at Kochi respectively within 9 months. At higher dosage i.e., CCA 32 kg per m<sup>3</sup> and CCB 40 kg per m<sup>3</sup>, the panels suffered only 23% and 15% damage respectively at Betim and 16% and 12% destruction respectively at Kochi, during the same period. Incidence of borers and consequent destruction progressively increased and, after 23 months, panels treated with CCA (32 kg per m<sup>3</sup>) underwent 55% destruction and those with CCB (40 kg per m<sup>3</sup>) suffered 40% damage. These panels also had to be rejected within 32 months, when they sustained more than 70% internal destruction. In most of the treated panels, size attained by shipworms was from 86 to 113 mm and by pholads from 31 to 39 mm. In general, length of shipworms was less in CCB at 40 kg per m<sup>3</sup>. However, *M. striata* in CCB-treated panels had reached maximum length upto 39 mm.

(ii) Timber species selected were *Eucalyptus tereticornis*, *Acacia auriculiformis*, *Prosopis juliflora*, *Leucaena leucocephala* and *Hevea brasiliensis*. Panels of these species, treated with CCA and CCB, were exposed at Visakhapatnam in 1990 and the test was continued. CCA-treated panels underwent a damage of about 35% during this period, whereas panels treated with CCB had less attack. Seven species of timber, namely *Toona ciliata*, *Erythrina indica*, *Ficus mysorensis*, *Trema orientalis*, *Samanea saman*, *Melia dubia* and *Bombax ceiba*, treated with CCA, and the first three species treated with CCB, in addition are also undergoing exposure trials at Visakhapatnam harbour. The control panels were all destroyed by borers within 6 to 7 months, whereas the treated ones are in sound condition. The experiment is continuing.

In general, the results, suggest that reliable conclusions on improvement of durability by chemical treatment may be drawn only after a series of well-designed test conducted in as many localities as possible. The data so far collected, however, indicate the possibility of up-gradation of non-durable rubber-wood and its utilization in several coastal structures as well as fishing craft.

#### Demonstration-cum-service trials on treated catamarans

Three catamarans made of *Bombax ceiba* and treated with CCA are undergoing service-cum-demonstration trials at Lauson's Bay fishing village at Visakhapatnam since 1986. Regular observations were conducted on their condition. It was noted that they are still in sound condition without showing any signs of biodeterioration (neither fungal decay nor borer attack), even after continuous operation for 11 years. *B. ceiba* panels last only 4 to 6 months under marine conditions and the normal service life of an untreated catamaran fabricated out of this timber is only 3 to 4 years, that too with constant maintenance periodically. The marine wood protection technology, perfected by I.W.S.T, thus leads not only to an enhanced life for the craft but also

results in an investment reduction due to usage of inferior, cheaper timber after upgradation. Almost 4 to 5 times enhanced service life contributes to forest conservation and environmental protection.

#### **Studies on distribution, ecology, biology and physiology of marine wood-borers and foulers**

Monitoring the biodeteriorating communities at Visakhapatnam harbour indicated, that at the outer harbour, *Serpula vermicularis*, *Hydroides norvegica*, *Balanus amphitrite*, *Crassostrea madrasensis*, unidentified ascidians, bryozoans, hydroids and sponges formed the fouling community. At the inner harbour, *Mytilopsis sallei* was the dominant fouler, though *B. amphitrite*, entoprocts and encrusting bryozoans were also present in small numbers. Important wood-borers encountered were *Lyrodus pedicellatus*, *Teredo furcifera*, *Teredo parksi* and *Martesia striata*.

Experiments on the effect of lead on oxygen consumption in the fouling bivalve, *Mytilopsis sallei*, were conducted. It was observed that oxygen consumption decreased with increase in lead concentration in the medium. Concentration of lead in different size groups of *M. sallei* were analyzed. Lead concentration was highest in younger animals compared to older ones. Analysis of concentration of lead in *M. sallei* collected along a gradient of pollution at Visakhapatnam harbour revealed that it increases with the increase in the lead content in the medium.

#### **STUDIES ON THE MANGROVES ALONG GOA COAST**

##### **Studies on biodeterioration of mangroves by marine organisms along Goa coast**

Mangroves along Goa coast were regularly monitored for the incidence of marine wood-borers and foulers both on natural vegetation and seedlings transplanted under afforestation programme. Control measures were suggested to the Goa State Forest Department.

Data, collected during a detailed study under a Project sponsored by Ministry of Environment and Forests, Government of India, on the biodeterioration aspects of mangroves along Goa coast along with 40 photographs were under publication as *Indian Forest Bulletin* by Indian Council of Forestry Research and Education, Dehra Dun.

A key to the identification of all the 27 species of marine wood-borers, so far recorded from mangroves along Indian coasts, was prepared and published. The key will facilitate easy identification of these harmful pests, which are quite destructive to the economically important mangrove ecosystem.

##### **Studies on the entomofauna of the mangrove ecosystem along Goa coast**

Survey of the mangroves along Goa coast revealed heavy infestation of a pschid pest, *Pteroma plagiophleps* on the seedlings and young plants of *Rhizophora mucronata*. The life-cycle and behaviour of the pest was studied in the laboratory on the leaves of *Acacia mangium*. The life-cycle takes about 3 months from 1st instar larva to adult. The females do not emerge from the puparium, as they are degenerate and larviform. The hatched larva crawl out of the female, get dispersed using silken threads, and produce a conical larval case made of silk and leaf bits. The pupae hang on to the undersurface of the leaves.

##### **Technical services**

- a. A technical report on the condition of logs imported at Visakhapatnam from Malaysia was submitted to the surveyors of the consignment on request.

## **WORLD BANK F.R.E.E. PROJECT**

A World Bank Project on Forestry research, education and extension is being implemented by ICFRE. Under this programme three projects and two programmes have been identified for IWST, Bangalore, for funding. There is provision for procurement of sophisticated equipments to strengthen the research capabilities of the Institute. The programmes which are being implemented are as follows :

1. Research on Sandal
2. Tree Improvement
3. Utilisation of alternative timber for catamarans
4. Planting Stock Improvement Programme
5. Extension Programme

### **1. RESEARCH ON SANDAL**

#### **Identification of provenances**

A cluster of 30 sandal trees was selected in each potential provenance areas of Harur and Tirupattur Forest Divisions of Tamil Nadu; Tangli and Mandagadde locality in Karnataka; and Koraput range in Rayagadah Division of Orissa. Study of phenology and collection and testing of seeds are in progress.

#### **Development of nursery practices**

- (i) Experiments on potting mixtures and root trainers technique are being continued. Callus initiation from clones has been completed.
- (ii) Differentiation of tissue has been initiated using different hormones.
- (iii) The work on production of high quality planting stock was completed by March, 97.

#### **Development of suitable silvicultural and management practices**

Statistical designs for field trials on soil Management, hosts density, irrigation and spacing have been developed. Field trial on soil management is being conducted at Gottipura. Irrigation facilities are being created at Chilanwadi in Ramanagar range, Bangalore District for starting field trials. Socio-Economic survey has been initiated.

#### **Study of various pathogens and development of suitable protective measures**

- (i) Survey and experiments conducted at Seoni RF (MP) revealed that there is no spike disease in the area.
- (ii) Survey of the incidence of pests and disease in parts of Karnataka, Madhya Pradesh, Orissa, Tamil Nadu and Kerala has been completed and suitable protective measures have been suggested. Koraput, Jeypore regions of Orissa state and Arakku valley in Andhra Pradesh are free from spike disease.

#### **Study on variation in heartwood and oil productivity**

Analysis of 55 sandal samples collected from various depots for their heartwood and sandal oil content has been completed. Study of variation of leaf is in progress.

## 2. TREE IMPROVEMENT

### Establishment and evaluation of provenance and progeny trials

- a) CSO of Teak at Sollepura and Kananakote and seed production areas were surveyed.
- b) Land for progeny trials has been identified at Chilandawadi.

### Study of variability of growth rate, yield, quality of timber

- a) Within tree variation of specific gravity of 5 clones was analysed.
- b) Variation in fibre morphology i.e., fibre length, fibre diameter, lumen diameter, fibre wall thickness from bottom to top of 5 clones has been studied.
- c) Variation in percentage of tissues of 5 clones has been initiated.
- d) Study of pulpwood characteristics of 5 clones has been completed.

### Studies on vegetative propagation of teak, bamboo and mass production technique

- (i) Construction of mist chamber, green house and shade house is under way.
- (ii) Teak clones are being multiplied using single nodal cuttings.
- (iii) Callus initiation has been effected into clones of Teak and Sandal.

## UTILISATION OF ALTERNATIVE TIMBER FOR CATAMARANS

- a. Successful trial runs were conducted with 30 catamarans made of *Bombax ceiba* and treated with CCA, launched along North Andhra coast in February, 1997.
- b. Performance of treated catamarans made of *Albizia falcataria* and *Samanea saman* was monitored.

## 3. PLANTING STOCK IMPROVEMENT

Clones of Teak were multiplied using bud graft technique. CSO was established at Mulugu, Hyderabad, using 25 clones and 25 ramets. Randomised neighbourhood design has been followed over 3 ha during August 96. Initial readings on the growth and survival were taken during December and subsequently at 6 month interval. Application of fertilizer was made at 6 month interval. Pests and diseases problems were also monitored.

## • EXTENSION

1. To popularise the technology of treated catamarans, a batch of 31 catamarans, fabricated out of *B. ceiba* and treated with CCA, was launched along Visakhapatnam coast during February, 1997. Fishermen from five neighbouring villages were brought to Visakhapatnam and the treatment technology and benefits of using treated catamarans, were explained to them. They were also taken to the treatment plant at Rajamundry to have a first-hand knowledge of the treatment technique. These training activities preceded the actual launching and handing over of 31 treated catamarans.
2. A Workshop on "Wood for marine structures and craft" was organised at Visakhapatnam.

### **Extension programme under world bank FREE project**

1. Industries Technology Demonstration.
  - a) Catamaran were treated to benefit poor traditional fishermen in 5 villages of Andhra Pradesh.
  - b) Workshop on timber for marine craft structure was organised.
  - c) Quality sandal seedlings/seeds were distributed to farmers.
2. Brochures and Pamphlets were published to create awareness among people.
3. Other Extension activities :-
  - i) Courses were run in timber identification, wood seasoning and preservation, for farmers, NGO's.
  - ii) Linkages were developed with State Forest Department, Universities, Fisheries Organisations, Defence establishments, CBI, Police, Indian Railways, PWD, etc.

Support fund under ICFRE is being used to fund programs designed to demonstrate the results of research in the field. This covers a group of panchayats and includes rapid sociological surveys, project planning and costing, implementation of the programme, and evaluation.

### **Extension programme under UNDP project**

Workshops on forestry, nursery practices and other aspects of wood were organised at different places in rural areas for generating awareness about the benefit of the programme amongst farmers, NGO's and foresters. A total of 3240 farmers NGO's and forester have been trained till date.

Periodic visits were made to the villages under the project for monitoring the growth. Advice was given to the farmers on protection of plantation from pests and disease.

### **EDUCATION/TRAINING**

1. A course on "Field Identification of Timber" was conducted for nineteen in-service officials of National Thermal Power Corporation Ltd., Surat.
2. Lectures were delivered on Wood Technology to the Probationers of Indian Railways Institute of Civil Engineering, Pune.
3. Lectures and practicals were arranged in Wood Anatomy for M.Sc. students of Deemed University, FRI, Dehra Dun, in Wood Science and Technology course.
4. Demonstrated various aspects of Wood Technology to the NGOs from "Tropical Centre for Eco Restoration and Rural Systems", and progressive farmers of Karnataka .
5. Lectures on Timber Identification and Wood Properties were given to Foresters, NGOs, etc. from Karnataka and Andhra Pradesh at Bangalore, Chintamani, Sirsi and Anantpur.
6. Lectures were delivered on methods of "Wood Preservation and Seasoning of Timber" to Trainees and Officers from Forest Department and NGO's at Chintamani and Sirsi in

Karnataka State, and in Ananthapur in Andhra Pradesh, under an extension programme of UNDP.

7. Lectures were delivered in the joint workshop of training-cum-demonstration programme on forestry for farmers, NGOs, school teachers and foresters' under ICFRE/UNDP Project at Sericulture College, University of Agricultural Sciences, Chintamani and at College of Forestry, Sirsi, Uttar Kannada District, Karnataka.
8. Lectures were delivered in the Training Course on "Coastal Zone Management", organised by Ministry of Environment and Forests, at Vasco.